4.0 Environmental Assessment Scope and Methods

The scope of the environmental impact assessment (EIA) of the Project under the New Brunswick *Environmental Impact Assessment Regulation – Clean Environment Act* (EIA Regulation) is discussed within the following sections.

4.1 Scope of the Assessment

As noted in **Section 1.3.1.1**, the proposed Project must be registered under the New Brunswick EIA Regulation. This registration document is intended to fulfill the requirements for registration of the Project under the provincial regulation, to initiate the EIA review of the Project. However, as described in **Section 1.3.2**, there are no known requirements for a federal environmental assessment under the *Canadian Environmental Assessment Act, 2012,* since the Project is not located on federal land and gypsum extraction is not a designated project as defined in the *Regulations Designating Physical Activities* under that Act.

The Project includes the development of an open pit, onsite processing operations, and transportation route for the extraction and transportation of gypsum mineral for use in the manufacturing of wallboard. Refer to **Section 2.3** (Description of Project Components) and **Section 2.4** (Description of Project Phases and Activities) for specific details of the Project. The scope of the Project to be assessed under the EIA Regulation includes construction of the open pit and related facilities and infrastructure, operation of the open pit quarry and related facilities, and eventual reclamation and closure of the site at the end of Project life. The scope of Project to be assessed is limited to the facilities and activities that will be conducted on the Project site, up to and including the time that trucks arrive at and leave the Project site, but excludes the transportation of materials on the provincial highway network as well as any activities that are carried out by third parties (e.g., the manufacture of gypsum wallboard).

The related Project phases, and activities to be conducted within each phase, that are subject to this EIA Registration and that will be carried forward within this assessment, were defined in **Section 2.4** and are summarized in **Table 4.1.1**, below.

Table 4.1.1: Project Phases and Activities to be Carried Forward within the EIA

Project Phase	Activities to be Conducted
Construction	• Vegetation clearing • Grubbing • Grading, levelling and contouring • Construction of storage areas • Removal and stockpiling of topsoil and overburden • Construction of perimeter channels, drainage channels, sump, and settling pond • Development of internal site roads and paving of access road • Installation of optional truck scale, optional portable trailer/office, and security gate
Operation	• Open pit operation (drilling, blasting, excavation, hauling, crushing) • On-site transportation, storage, loading, and transportation to customers • Surface water management
Reclamation and closure	• Decommissioning • Reclamation • Closure

The scope of this EIA Registration has been developed by Hammond River Holdings and Dillon, and is based upon the current understanding of the nature of the Project and the environmental setting within which it will be carried out, the proposed Project phases/activities listed above, the professional judgment of the Study Team, as well as consultation with the regulatory authorities (including the technical review committee) and anticipated issues and concerns of the public as informed by experience with similar projects conducted elsewhere.

4.1.1 Selection of Valued Components

Valued components (VCs) are those components of the biophysical and socio-economic environments that are of value or interest to regulatory agencies, the public, other stakeholders, and/or Aboriginal peoples. VCs are typically selected for assessment on the basis of: regulatory issues, legislation, guidelines, policies, and requirements; consultation with regulatory agencies, the public, stakeholder groups, and Aboriginal communities; field reconnaissance; and professional judgment.

The VCs selected for this EIA Registration and the rationale for their selection in relation to the Project are outlined in **Table 4.1.2**, below.

Table 4.1.2: Valued Components for the Project, and Rationale for their Selection

Valued Component (VC)	Rationale for Selection of the VC
Atmospheric environment	• Emissions of particulate matter (particularly dust), combustion gases, and sound related to Project activities may affect the atmospheric environment or adjacent receptors.
Water resources (surface water and groundwater)	• The Project will result in a change in surface water drainage and groundwater seepage as a result of site development and the presence of the open pit.
Fish and fish habitat	• Fish and fish habitat are protected by the federal *Fisheries Act*. The Project may interact with fish and fish habitat through the loss of some segments of watercourses and/or wetlands located on the Project site.
Vegetation and wetlands	• The Project will result in the loss of immature vegetation and wetlands located on the Project site, with potential associated loss of biological functions. Indirect loss of wetlands located on adjacent properties is also possible due to potential drainage into the open pit.
Wildlife and wildlife habitat	• The loss of immature vegetation on the Project site may result in the loss of wildlife habitat, and Project activities may interact with wildlife (e.g., sensory disturbance due to Project activities).
Socioeconomic environment	• The Project will interact with labour and economy through the generation of employment and associated expenditures. • The Project may result in a change in land use from forestry to industrial activity for the duration of the Project. • The Project will result in increased trucking on provincial roads leading to the Project site.
Heritage resources	• Heritage resources (e.g., archaeological, palaeontological, or built heritage resources) are protected under the New Brunswick *Heritage Conservation Act.* • Though there are no known heritage resources that will be affected by the Project, earth moving activities on the Project site may result in the potential accidental discovery of any previously unknown heritage resources that may be present on the Project site.
Traditional land and resource use	• The Project is located in the traditional territory of the Wolastoqey Nation and the area is subject to a land claim by the Elsipogtog First Nation. It is possible that the Project site has historically been, or may be currently used by, Aboriginal persons for practicing traditional activities such as hunting, fishing, trapping and gathering through the practice of unextinguished Aboriginal and treaty rights. Consultation with Aboriginal peoples is required at the planning stage of the project to determine the extent of potential traditional land and resource use of the site.

Table 4.1.2: Valued Components for the Project, and Rationale for their Selection

Valued Component (VC)	Rationale for Selection of the VC
Effects of the environment on the Project	• Natural forces and other effects of the environment (such as climate change and other natural hazards or risks) may pose a risk to the Project components and their longevity, or cause delays in the construction or operation of the Project.

The following sections provide a description of the methods of desktop and/or field studies that were required to assess the VCs detailed in **Table 4.1.2**, based on professional judgment, the nature of the Project, knowledge of the Project area, and previous experience on projects of a similar nature. In addition, the methods employed for the analysis of environmental effects are discussed.

4.2 Environmental Assessment Methods

Environmental assessment is used as a planning tool in the initial stages of project conceptualization, planning and design. Its intention is to identify or predict Project-related effects (based on results of scientific assessment or traditional knowledge), as well as design mitigative strategies to avoid, reduce, or eliminate adverse environmental effects. The methods used to conduct this environmental effects assessment, including the characterization of the study boundaries, the factors to be considered, and the details of the assessment of each VC selected in **Section 4.1.1**, are provided below.

4.2.1 Study Boundaries (Temporal and Spatial)

Study boundaries set the limits of the area (spatial) and period of time (temporal) examined within the assessment. Boundaries for the EIA were defined by good practice and professional judgment, as well as through discussions with the Proponent, NBDELG, and other stakeholder agencies.

Temporal boundaries vary according to the different Project phases and potential effects. In the construction phase, specific construction-related effects are typically short-term (for example, effects related to the use of laydown areas for construction activities). Effects associated with the operation phase tend to be longer term (i.e., lifespan of the quarry); however, the effects associated with the open pit are unique in the sense that they will be long lasting and will extend past the life of the quarry.

The temporal boundaries for the Project correspond to the periods of construction, operation, and reclamation and closure as were defined in the Project schedule in **Section 2.5**, as follows:

- **Construction:** Construction will proceed for a period of up to 6 months, commencing as soon as the EIA review has been completed and the applicable permits, approvals or other forms of authorization have been obtained. For the purpose of this EIA Registration, it has been assumed that construction will begin in the second quarter of 2019. Clearing of trees and vegetation from the site would be conducted outside of the normal breeding bird season (early April to end of August).

- **Operation:** Operation will commence immediately following the construction phase and will continue for approximately 10 years or until the mineral resource is depleted. For the purpose of this EIA Registration, it has been assumed that the operation phase will begin in the fourth quarter of 2019.
- **Reclamation and closure:** Decommissioning of Project facilities and reclamation and closure of the Project site will occur following the completion of the operation phase. Closure will commence during the initial reclamation period and will be complete when the open pit is full of water.

The spatial boundaries of the assessment, which represent the area in which a potential effect could occur and will vary by VC, will typically be based on natural system boundaries for biophysical VCs, or administrative/political boundaries for socio-economic VCs. The spatial boundaries to be defined for the EIA will include:

- the **Project Development area (PDA)**, where physical alterations occur to enable the Project to be carried out (common for all VCs), as defined in **Section 2.1**. It can be thought of as the area of physical disturbance associated with the Project facilities; and,
- the **Local Assessment Area (LAA**), where the potential direct and indirect interactions of the Project may occur with each VEC (defined for each VC). It can be thought of as the "zone of influence" of the Project.

4.2.2 Factors to be Considered

The EIA will consider the following factors:

- the environmental effects of the physical activities associated with the Project;
- mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the Project, including requirements for follow-up studies or monitoring;
- the environmental effects of malfunctions or accidents that may occur in connection with the Project;
- any change to the Project that may be caused by the environment; and,
- comments from the public, Aboriginal persons, or other stakeholders.

4.2.3 Scope of Factors to be Considered

The VCs selected for this EIA will be assessed at an appropriate level based on professional judgement, existing information, regulatory issues, legislation, guidelines, policies, requirements and consultation. In order to characterize the baseline conditions of each VC, both qualitative and quantitative assessment methods were employed. The characterization and description of the VC is limited to the spatial and temporal boundaries (as described in **Section 4.2.1**) that were applied to that specific VC for the purposes of the assessment. The factors to be considered during the assessment as well as the approach that will be used to carry out the assessment are further discussed in **Table 4.2.1**, below.

Table 4.2.1: Scope of Factors to be Considered and Approach to the Assessment for each Valued Component

Valued Component (VC)	Scope of Factors to be Considered	Approach to the Assessment
Atmospheric environment	• Air contaminant emissions • Ambient air quality • Sound quality (noise) • Greenhouse gas (GHG) emissions	• Quantitative and qualitative assessment of ambient air quality and trends • Quantitative assessment and emissions estimation of air contaminant emissions and GHG emissions • Baseline noise monitoring, and noise modelling
Water resources (surface water and groundwater)	• Physiography and surface water drainage • Bedrock and surficial geology • Hydrogeology • Groundwater resource use within 2 km of the Project • Groundwater and surface water quality and quantity	• Quantitative and qualitative desktop assessment of regional groundwater environment • Quantitative assessment/ reconnaissance of surface water features and hydrogeological assessment
Fish and fish habitat	• Fish and fish habitat • Species at risk and their habitat • Species of conservation concern and their habitat • Fisheries including sport or subsistence fisheries • Fish migration routes/movement corridors • Surface water quality	• Review of historical occurrences of species at risk/species of conservation concern • Biological field studies of fish and fish habitat
Vegetation and wetlands	• Vegetation including rare plants • Species at risk and their habitat • Species of conservation concern and their habitat • Wetland delineation and function	• Review of historical occurrences of species at risk/species of conservation concern • Field wetland delineation and functional assessment
Wildlife and wildlife habitat	• Wildlife and wildlife habitat • Species at risk and their habitat • Species of conservation concern and their habitat	• Review of historical occurrences of species at risk/species of conservation concern • Biological field studies of avian wildlife, incidental wildlife observations

Table 4.2.1: Scope of Factors to be Considered and Approach to the Assessment for each Valued Component

Valued Component (VC)	Scope of Factors to be Considered	Approach to the Assessment
Socioeconomic environment	• Nuisance effects to adjacent receptors (noise, dust, viewscape, vibration) • Change in land use • Road transportation network • Local economy and Project-related employment	• Public and stakeholder consultation • Qualitative assessment of local socioeconomic environment • Results of baseline noise monitoring and modelling • Understanding of local planning requirements
Heritage resources	• Structures, sites or things of historical, archaeological, palaeontological, or architectural significance	• Qualitative (desktop and database review of high potential areas) • Quantitative archaeological assessment based on desktop review • Provision for later field investigation (walkover and/or shovel testing) as follow-up
Traditional land and resource use	• Biophysical resources of cultural importance • Current use of land and resources for traditional purposes by Aboriginal persons	• Aboriginal consultation • Information from secondary sources
Effects of the environment on the Project	Changes or potential effects on the Project caused by: • Extreme weather • Climate change • Seismic activity • Natural forest fires	• Qualitative assessment of current regional/local climate conditions and predictions

4.2.4 Environmental Effects Assessment Methods

Dillon uses a streamlined and focussed approach in the preparation of the effects analysis. During the environmental effects analysis, Project-VC interactions are first identified through a matrix table. If a Project-VC interaction is not identified, a rationale is provided to explain its exclusion from the assessment.

Following the identification of Project-VC interactions, effects that may occur as a result of the interactions are predicted and proposed mitigation is outlined. Effects are assessed assuming that standard industry design/mitigation practices will be implemented. The environmental effects assessment methodology involves the following generalized steps.

- **Scope of VC** – This involves the scoping of the assessment for the VC, and includes a definition of the VC and a rationale for its selection, a description of temporal and spatial boundaries, and the definition thresholds that are used to determine the significance of environmental effects. This step relies upon the scoping undertaken by regulatory authorities; consideration of the input of the public, stakeholders, and First Nations (as applicable); and the professional judgment of the Study Team.

- **Existing Conditions** – This step involves the establishment of existing (baseline) environmental conditions for the VC, in the absence of the Project. In many cases, existing conditions expressly and/or implicitly include those environmental effects that may be or may have been caused by other past or present projects or activities that have been or are being carried out.
- **Environmental Effects Assessment** – Project-related environmental effects are assessed. The assessment includes:
    - a description of how a potential environmental effect could occur (in the absence of mitigation);
    - a discussion of the mitigation and environmental protection measures that are proposed to avoid, reduce, or eliminate the environmental effect; and,
    - a characterization of the residual environmental effects of the Project (i.e., the environmental effects that remain after planned mitigation has been applied). All phases of the Project are assessed (i.e., construction, operation, and reclamation and closure), as are accidents, malfunctions, and unplanned events. The evaluation also considers the effects of the environment on the Project.
- **Summary** – A summary of the assessment for the VC is provided, leading to an overall conclusion in respect of the effects of the Project on the VC. The significance of residual environmental effects is then determined, in consideration of the significance thresholds that have been established for each VC.

The Study Team will consider the direction, magnitude, frequency, duration, geographical extent, and reversibility of potential Project-related effects. Residual effects (i.e., those that remain after the application of mitigation, or those that will not be avoided/mitigated) are predicted, and thresholds of significance are characterized using regulatory standards or other thresholds, where available, within the defined spatial and temporal boundaries. Where regulatory standards are not available, the significance threshold may be determined through indicators derived from existing scientific knowledge (e.g., status of biological populations and critical habitats). Through this process, potential effects on the environment are evaluated with a view to mitigating them such that effects can be avoided, reduced, or controlled through mitigation. A determination is then provided as to whether residual effects are positive or negative, their significance, and the likelihood of a significant effect. Consideration is also given to the potential for accidents or malfunctions during the Project phases (provided in a standalone section).

Follow-up measures and monitoring programs for potential residual environmental effects are outlined and described, where applicable, for planned implementation as a means of verifying the environmental effects predictions or the effectiveness of mitigation.

5.0 Environmental Effects Assessment

An assessment of the environmental effects of the Project on each of the identified valued components (VCs) is provided in this chapter.

In this chapter, following an identification of Project interactions with the environment, potential environmental effects in the absence of mitigation are described at a high level with a view to determining if an interaction between the Project and the VC could occur. The identification of Project-VC interactions is done for each Project phase in a matrix format (see **Section 5.1**, Project Interactions with the Environment) to determine which potential interactions may occur; justification is provided for those VCs for which the Project is not expected to interact. Then, for each VC for which an interaction with the Project was identified, a more detailed assessment is provided in a standalone section whereby: the scope of the VC is defined; existing conditions are established; potential effects without mitigation are identified; mitigation to avoid, reduce, or eliminate environmental effects are described; and residual environmental effects after the application of mitigation are described.

5.1 Project Interactions with the Environment

The identification of potential interactions between the Project and the VCs has been undertaken in consideration of the nature of the Project and its planned activities during each phase. Additionally, accidents and malfunctions will be considered in **Section 7.0**.

The phases of the Project include:

- Construction;
- Operation; and,
- Reclamation and closure.

This initial screening (i.e., project interaction matrix) assists in determining if an interaction between the activities being carried out in each phase of the proposed Project and the VC is possible. A qualitative rating system was used to evaluate the potential for interactions between the Project and the environment. One of the following two ratings was prescribed for each individual VC:

- An interaction between the Project and the environment could occur (which is identified with a checkmark in the matrix below); or,
- No interaction occurs between the Project and the environment.

Based on the Project Description (refer to **Section 2.0**), the Environmental Setting (refer to **Section 3.0**), and the scope of the environmental assessment (refer to **Section 4.0**), the potential interactions between the Project and the environment are summarized in **Table 5.1.1** below.

Table 5.1.1: Potential Interactions between the Project and the Environment

Valued Component (VC)	Project Phases		
	Construction	Operation	Reclamation and Closure
Atmospheric environment	✓	✓	
Water resources	✓	✓	✓
Fish and fish habitat	✓	✓	
Vegetation and wetlands	✓	✓	✓
Wildlife and wildlife habitat	✓	✓	✓
Socioeconomic environment	✓	✓	✓
Heritage resources	✓	✓	
Traditional land and resource use	✓		✓

Legend: ✓ = Potential interaction

In the table above, the interaction with a particular VC is identified when the interaction first occurs.

VCs for which an interaction occurs are carried forward in the environmental effects assessment in **Sections 5.2** to **5.9**, below. Some VCs were found to not have any interactions during a Project activity. A brief justification/rationale behind the selection or omission of an interaction is provided below (this is also related to the selection of VCs for the assessment which can be referenced in **Section 4.1.1**).

5.1.1 Atmospheric Environment

Emissions of particulate matter (particularly dust), combustion gas, and sound related to project activities may occur during construction activities (site development) and operation (resource extraction and processing) and affect the atmospheric environment or adjacent receptors. Substantive interactions during reclamation and closure are not expected.

5.1.2 Water Resources

The Project will result in a change in both surface water and groundwater flow across the landscape as a result of the loss of on-site wetlands (construction activities) and the development of the open pit (construction and operation activities). Upon reaching the end of the lifespan of the quarry, water will require further management for site reclamation and closure as the open pit will act as a reservoir for surrounding drainage.

5.1.3 Fish and Fish Habitat

The Project will interact with fish and fish habitat through the loss of wetlands and watercourses during the construction activities. Additionally, an interaction will occur during operation as there may be water drainage into the natural environment from a settling pond on-site. Substantive interactions during reclamation and closure are not expected.

5.1.4 Vegetation and Wetlands

During construction, the Project will require the loss of vegetation and wetlands, which will result in the loss of biological functions. During operation, water drainage into the natural environment will occur from a settling pond on-site, and may interact with adjacent wetlands. Upon reclamation and closure, vegetation will be able to naturally regenerate over time, and wetlands that were not lost through the development of the open pit may be naturally restored. Additionally, wetland creation/enhancement around the open pit may occur as a part of the wetland compensation plan or site reclamation plan for water management.

5.1.5 Wildlife and Wildlife Habitat

During construction, the Project will result in the loss of wildlife habitat (from clearing activities). During operation, Project activities may interact with wildlife through noise, vibration, or increased traffic in the area. Following site reclamation and closure, wildlife will be able to return to the site and some wildlife habitat will be restored through revegetation, providing a positive effect.

5.1.6 Socioeconomic Environment

During construction, the Project may interact with the socioeconomic environment through noise, vibration, and emissions from the Project, as well as from a change in land use as the character of the site changes from forestry to industrial activity. During operation, potential nuisance effects from noise, vibration, and emissions could be experienced in a manner similar to those experienced during construction. Additionally, the Project will interact with labour and economy through employment and expenditures during both construction and operation phases. Upon site reclamation and closure, the Project will cease to interact with the socioeconomic environment through employment and expenditures. Once reclaimed, though not encouraged, the local population could access the site for recreational purposes.

5.1.7 Heritage Resources

During the construction phase of the Project, there is potential for accidental discovery of archaeological or heritage resources—the effect would be permanent in such a case, as no archaeological or heritage resource can be returned to the ground undisturbed following its discovery. During operation, though the discovery of archaeological resources would not be expected (as those resources are typically located in surficial soils rather than bedrock), there is a potential for accidental discovery of palaeontological resources (fossils) during the operation phase (i.e., during extraction of gypsum). Substantive interactions during reclamation and closure are not expected.

5.1.8 Traditional Land and Resource Use

During the construction phase, any Aboriginal peoples that may have used or are using the Project site to carry out their traditional activities will no longer be able to access the entirety of the PDA for safety and security purposes while Project activities are taking place, and therefore this area will no longer be accessible for potential traditional land and resource use. This interaction will extend through the lifespan of the Project, until the end of the operation phase. Upon site reclamation and closure, the PDA will become re-accessible for traditional land and resource use.

The following sections are organized by VC, and describe: the scope of each VC; their existing conditions (based on the qualitative and quantitative assessments described herein); potential environmental effects that could occur in the absence of mitigation; planned mitigation to offset, reduce or eliminate predicted effects; and residual effects that may occur after the implementation of site specific and general mitigation. Furthermore and where applicable, specific follow-up or monitoring plans to verify the effects predictions or the effectiveness of mitigation will be described.

5.2 Atmospheric Environment

The potential environmental effects of the Project on the atmospheric environment are assessed in this section.

5.2.1 Scope of VC

The atmospheric environment is defined as the layer of air above the earth's surface to a height of approximately 10 km. The atmospheric environment includes three key aspects: air quality, climate (including greenhouse gases), and sound quality, as follows.

- Air quality is characterized by the composition of the ambient air, including the presence and quantity of air contaminants in the atmosphere in comparison to applicable air quality objectives.
- Climate is characterized by the historical seasonal weather conditions of a region, which can include temperature, humidity, precipitation, sunshine, cloudiness, and winds. Statistical climate data are typically averaged over a period of several decades (GOC 2018). Project-based releases of greenhouse gases (GHGs), such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), are typically used as an indicator of the potential for environmental interactions with climate change. It is understood that GHG releases on a global scale from both natural processes/sources and human activities are increasing global concentrations of GHGs in the atmosphere and they contribute to climate change.
- Sound quality is characterized by the type, frequency, intensity, and duration of noise (unwanted sound) in the outdoor environment. Vibration, or oscillation in matter that may lead to noise or stress in materials of adjacent structures, is also considered as an element of sound quality.

The atmospheric environment has been selected as a valued component (VC) because the atmosphere helps maintain the health and well-being of humans, wildlife, vegetation, and other biota. Emissions from the Project to the air may cause adverse environmental effects through the various transport, dispersion, deposition, and transformation processes that occur in the atmosphere. GHG emissions are thought to be a major factor in affecting global climate.

The atmospheric environment includes consideration of potential environmental effects on air quality, including GHG emissions. These components constitute a VC due to:

- Emissions of contaminants to the atmosphere during construction and operation of the Project, which may present a pathway for humans and biota to be exposed to air contaminants;
- Provisions regarding air contaminant emissions and noise under the New Brunswick *Air Quality Regulation*;
- Releases of GHGs and their accumulation in the atmosphere influence global climate and may affect emission reduction targets for GHGs that have been set or are being developed federally and provincially; and/or,
- Emissions of sound pressure (including vibration) to the atmosphere during construction and operation of the Project may present a disturbance or nuisance for humans and wildlife nearby.

This assessment of the atmospheric environment considers the air contaminants that are typically associated with this type of project, which are regulated provincially (and in some cases federally). These air contaminants are generated from fuel combustion and fugitive dust generated from the movement of mobile equipment and material transfer mechanisms required for construction and operation. For the Project components and activities assessed herein, combustion gases (including but not limited to sulphur dioxide [SO_2], carbon monoxide [CO], and nitrogen oxides [NO_x]), and particulate matter (PM) are considered to be the potential contaminants of concern relating to air quality. Releases of GHGs from the combustion of fossil fuels in mobile equipment are also considered in relation to the potential for interactions with climate change. Sound pressure levels and vibration in the vicinity of the Project are considered relating to sound quality.

Air quality in New Brunswick is regulated pursuant to the New Brunswick *Air Quality Regulation* 97-133 under the *Clean Air Act*. Federally, the main instrument for managing air quality is the *Canadian Environmental Protection Act* (CEPA) as well as Canada-Wide Standards (CWS) developed by the Canadian Council of Ministers of the Environment (CCME).

New Brunswick's *Air Quality Regulation* specifies maximum permissible ground-level concentrations for five air contaminants, namely total suspended particulate (TSP), carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and hydrogen sulphide (H_2S). The criteria in the regulation are based on the National Ambient Air Quality Objectives (NAAQOs), although the two do differ slightly, as presented in **Table 5.2.1**. The Regulation is legally binding in New Brunswick, whereas the NAAQOs are guidelines used as a benchmark to assess the effects of air pollutants.

Table 5.2.1: Ambient Air Quality Standards and Objectives

		New Brunswick Air Quality Regulation	National Ambient Air Quality Objectives (NAAQO)	
Air Contaminant	Averaging Period	Maximum Permissible Ground Level Concentration (µg/m3)	Maximum Acceptable Level (µg/m^3)	Maximum Desirable Level (µg/m^3)
Total suspended particulate (TSP)	24 hour	120	120	--
	Annual	70 (geometric mean)	70	60
Carbon monoxide (CO)	8 hour	15,000	15,000	6,000
	1 hour	35,000	35,000	15,000
Nitrogen dioxide (NO_2)	1 hour	400	400	--
	24 hour	200	--	--
	Annual	100	100	60
Sulphur dioxide (SO_2)	1 hour	450*	900	450
	24 hour	150*	300	150
	Annual	30*	60	30
Hydrogen sulphide (H_2S)	1 hour	15	--	--
	24 hour	5	--	--

Source: New Brunswick Regulation 97-133; NAPS (2018)
Note: NAAQO uses conditions of 25 °C and 101.3 kPa in converting from µg/m^3 to ppm.
Note: * SO_2 standard applicable in Saint John, Charlotte, and Kings Counties

Regulations or guidelines related to sound quality have not been established in New Brunswick and may be addressed through the Certificate of Approvals process for industrial facilities under the *Air Quality Regulation*. In the absence of local guidance, the following generally accepted criteria that have been applied in New Brunswick in the past are proposed for the purpose of the assessment:

- 65 A-weighted decibels (dBA) measured as a 1-hour equivalent sound level (Leq) from 06:00 to 22:00 (Daytime); and,
- 55 dBA measured as a 1-hour Leq from 22:00 to 06:00 (Nighttime).

5.2.1.1 Temporal Boundaries

The temporal boundaries for the Project include the following:

- Construction: extending for a period of approximately six months, anticipated to begin in the second quarter of 2019 (subject to the receipt of all approvals and permits required for the Project);
- Operation: beginning in approximately the fourth quarter of 2019, and lasting for approximately 10 years or until the mineral resource has been depleted; and,

- Reclamation and closure: To be initiated following the completion of operations at the site, with decommissioning and reclamation of the surface facilities at the site for an anticipated duration of six months following operation.

5.2.1.2 Spatial Boundaries

The Project Development Area (PDA) is defined as the area of physical disturbance associated with construction and operation of the Project. Specifically, the PDA consists of an area of approximately 61.81 ha (i.e., conservatively assumed to be the entirety of PID No. 00149013) that includes the open pit and all related surface facilities located on the property. The PDA is the area represented by the physical Project footprint.

The Local Assessment Area (LAA) is the maximum anticipated area within which Project-related environmental effects are expected. For the atmospheric environment, the LAA includes an area consisting of a 2 km radius centred on the PDA, and includes the PDA and any adjacent areas where Project-related environmental effects could be expected to occur. Beyond this radius, based on experience with similar facilities and professional judgment, emissions of air contaminants and noise from the Project would not likely be distinguishable from background levels.

5.2.1.3 Significance Threshold

A significant adverse residual environmental effect on the atmospheric environment is one where Project-related releases result in:

- a frequent exceedance of the ambient air quality standards defined in Schedules B and C of the New Brunswick *Air Quality Regulation* under the *Clean Air Act* (as listed in **Table 5.2.1** above); or,
- the sound pressure levels at the nearest noise sensitive receptor to frequently exceed a 1-hour Leq of 65 dBA during the day (06:00-22:00) or 55 dBA during the night (22:00-06:00).

A frequent exceedance is defined as one that occurs more than 1% of the time.

5.2.2 Existing Conditions

The existing conditions for atmospheric environment are defined in terms of climate, ambient air quality, and sound quality.

5.2.2.1 Climate

New Brunswick has a humid continental climate, with slightly milder winters on the Gulf of St. Lawrence coastline. Northern New Brunswick experiences a subarctic climate, particularly in the more elevated area in the far north. Southern New Brunswick experiences a more moderate maritime climate than the northern or central parts of the province as the Bay of Fundy never fully freezes, thus moderating the winter temperatures and providing generally cooler summer temperatures compared to other inland locations. The cold Bay of Fundy air combining with the inland warmer temperatures often creates onshore winds and periods of fog.

Climate Normals from the nearest representative weather station (located at Saint John Airport) are presented in **Table 5.2.2** below.

Table 5.2.2: Climate Normals, Saint John (Saint John Airport), New Brunswick (1981-2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature Normals, Saint John (1981 - 2010)													
Daily Average (°C)	-7.9	-7.1	-2.5	3.7	9.5	14	17.1	16.8	13	7.6	2.3	-4.4	5.2
Daily Maximum (°C)	-2.5	-1.5	2.4	8.5	15	19.6	22.6	22.4	18.2	12.3	6.4	0.5	10.3
Daily Minimum (°C)	-13.3	-12.6	-7.4	-1.2	3.9	8.4	11.6	11.2	7.7	2.8	-1.9	-9.3	0
Precipitation Normals (1981 - 2010)													
Rainfall (mm)	66.1	49	66.6	85.7	108.5	101	88.4	81.7	105.6	115.8	123.7	84	1,076
Snowfall (cm)	64.3	48.4	44.4	20	1.2	0	0	0	0	0.5	10.8	49.9	239.6
Precipitation (mm)	123.5	91	108.2	105.3	109.8	101	88.4	81.7	105.6	116.4	134.1	130.4	1,295.5
Wind Normals (1981-2010)													
Speed (km/h)	16.9	17.1	17.5	17.2	15.4	13.4	12	11.3	13	15.1	16.4	17.1	15.2
Most Frequent Direction	NW	NW	N	N	S	S	S	S	SW	SW	NW	NW	SW
Maximum Hourly Speed (km/h)	111	100	80	85	64	61	76	68	97	89	89	83	Not applicable
Direction of Maximum Hourly Speed	SW	S	S	N	S	S	W	N	S	N	S	S	Not applicable

Source: Canadian Climate Normals (GOC 2018)

Greenhouse gas emissions in Canada totaled 704 million tonnes (Mt CO_2e, as CO_2-equivalents) in 2016 (ECCC 2018a), as published in Canada's most recent annual report on greenhouse gas emissions. Greenhouse gases from heavy industry represented 11% of total Canadian emissions. Total greenhouse gases for New Brunswick were 15.3 Mt CO_2e in 2016, whereas they were 16.1 Mt CO_2e in 1990 and 20.1 Mt CO_2e in 2005. Since 2005, New Brunswick has seen a 24% decrease in total greenhouse gas emissions.

5.2.2.2 Ambient Air Quality

The air quality within the assessment can be defined from historical air quality monitoring conducted in the region for the key contaminants of concern. Data collected at New Brunswick's Forest Hills monitoring station is used as it is the closest representative station to the Project site. The monitoring data, collected as part of the National Air Pollution Surveillance (NAPS) Network, are presented in **Table 5.2.3**.

Table 5.2.3: Ambient Monitoring Data – Forest Hills, Saint John, New Brunswick, 2014-2016 Maximums

Air Contaminant	Averaging Period	2014 Maximum	2015 Maximum	2016 Maximum
Particulate matter less than 2.5 microns ($PM_{2.5}$) (µg/m^3)	24 hour	23	25	23
	Annual	6	7	8
Carbon monozide (CO) (ppm / mg/m^3) *	1 hour	0.8/0.9	0.9/1.0	0.9/1.0
	8 hour	0.5/0.6	0.7/0.8	0.5/0.6
	Annual	0.2/0.2	0.2/0.2	NR
Nitrogen dioxide (NO_2) (ppb / µg/m^3)	1 hour	41/77	46/87	31/58
	Annual	3/6	3/6	3/6
Sulphur dioxide (SO_2) (ppb / µg/m^3)	1 hour	100/262	149/391	72/189
	24 hour	27.6/72.3	22.1/58	26.7/70.0
	Annual	2/5	2/5	2/5

Notes: http://www.endmemo.com/sconvert/mg_m3ppm.php
* Results from nearest monitoring station with available data, located at 189 Prince William Street, Saint John, NB
NR = not reported
Source: NAPS (2018)

The Saint John and southern New Brunswick areas may experience some short-term challenges with ambient air quality due to their location downwind of large urban centres in eastern North America (as a result of long-range transport of air contaminants), their proximity to the Bay of Fundy (a large body of cool water that may produce weather conditions that inhibit dispersion), and the presence of several large emission sources in the area (particularly from heavy industry). Despite this, air quality in the region has improved considerably in the past decades and continues to improve. Based on the data from NAPS (2018), in general, air quality in Saint John (i.e., an urban area subject to occasional air quality challenges) can be characterized as good to very good, most of the time, with occasional short-term periods of poor air quality (particularly in summer). By extension, ambient air quality in more rural areas of Southern New Brunswick (such as the Upham area) can be inferred to be equivalent to, or better than, that in Saint John.

5.2.2.3 Sound Quality

In order to establish existing conditions for sound quality, baseline sound monitoring was conducted at the boundaries of the Project area near the closest potential sensitive receptors. The program consisted of 24-hours of continuous sound monitoring at two locations identified in **Figure 5.2.1**. The two locations selected include one monitor at the north end of the property located near the northeast corner of the quarry at a distance approximately equidistant from Route 820 as the residences on the north side of the road are to Route 820. Since baseline noise is currently generated from road traffic, this location is considered representative of those residences on the north side of Route 820 (Receptor 1). The second monitor location is on the edge of the site access road off of Route 111 at a distance from Route 111 similar to the distance of the residences (Receptor 2) from Route 111.

The monitoring was conducted using two calibrated RION Type II sound level meters, each being equipped with wind-screen and data logger. The monitoring was completed between September 24 and 25, 2018. The A-weighted maximum, minimum, and mean hourly sound level equivalents (LeqA) for daytime (06:00 – 22:00) and nighttime (22:00 – 06:00) are presented in **Table 5.2.4**. Also included in **Table 5.2.4** are the 90th percentile sound levels (i.e., Lp90). Refer to **Figure 5.2.1**.

Table 5.2.4: Sound Monitoring Results – September 24-25, 2018

Monitoring Location ID	Monitoring Location Description	Maximum 1-Hour Leq (dBA)	Minimum 1-Hour Leq (dBA)	Geometric Mean 1-Hour Leq (dBA)	Average Lp90 (dBA)
Daytime (06:00-22:00)					
Monitor 1	Residential properties located adjacent to road (Route 820) near the northern boundary of the PDA.	44.5	26.9	37.4	24.3
Monitor 2	Residential properties adjacent to Route 111 south of the PDA.	45.5	33.7	39.5	24.5
Nighttime (22:00 to 06:00)					
Monitor 1	Residential properties located adjacent to road (Route 820) near the northern boundary of the PDA.	33.7	21.5	26.5	17.9
Monitor 2	Residential properties adjacent to Route 111 south of the PDA.	33.7	20.0	27.6	16.6

The baseline sound monitoring results were all well below the criteria at both locations for both daytime and night time. The 1-hour maximum Leq values at both locations were similar and in the order of 45 dBA during the daytime and 34 dBA during the nighttime.

HAMMOND RIVER HOLDINGS LIMITED
PROPOSED UPHAM EAST GYPSUM QUARRY

NOISE MONITORING LOCATIONS
FIGURE 5.2.1

- NOISE MONITOR LOCATION
- RECEPTOR LOCATION
- PROPERTY BOUNDARY
- PROJECT DEVELOPMENT AREA

PROPOSED SITE FEATURES

- DITCH
- TRUCK SCALE (OPTIONAL)
- SITE AREAS
- SETTLING POND
- DISCHARGE POINT
- SECURITY GATE
- PORTABLE TRAILER/OFFICE

0 50 100 200 m
SCALE 1:8,000
N W E S

MAP DRAWING INFORMATION:
DATA PROVIDED BY DILLON CONSULTING LIMITED, CANVEC
SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISS TOPO, OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

MAP CREATED BY: BQS
MAP REVISED BY: JH
MAP CHECKED BY: AS
MAP PROJECTION: NAD_1983_CSRS_New_Brunswick_Stereographic

FILE LOCATION: \\DILLON.CA\DILLON_DFS\FREDERICTON\FREDERICTON CAD\CAD\GIS\188346 UPHAM GYPSUM QUARRY\MXD

DILLON CONSULTING

PROJECT: 18-8346
STATUS: FINAL
DATE: OCT 2018

5.2.3 Environmental Effects Assessment

The environmental effects of the Project on the atmospheric environment are assessed in this section.

5.2.3.1 Potential Effects

Without mitigation, the Project could interact with the atmospheric environment in several ways:

- Emissions of combustion gases and fugitive dust from earth moving activities and transport of materials on site during construction could result in air contaminants that could disperse in the atmosphere to off-site receptors;
- Emissions of combustion gases and fugitive dust from quarrying activities including blasting, excavating, crushing, on-site transport, and storage of gypsum on-site during operation could result in air contaminants that could disperse in the atmosphere to off-site receptors;
- Noise emissions from on-site equipment during construction could result in off-site receptors experiencing a change in ambient sound;
- Noise emissions from on-site equipment and blasting activities during operation could result in off-site receptors experiencing a change in ambient sound; and,
- The operation of mobile equipment and on-site trucks during construction and operation could result in emissions of greenhouse gases.

5.2.3.2 Mitigation

The following mitigation measures will be implemented to reduce environmental effects on the atmospheric environment:

- Maintaining a tree buffer between on-site activities and nearby receptors to mitigate the effect of sound and emissions;
- Application of dust suppressants via water truck during dry periods when appropriate;
- Instituting and following a non-idling policy;
- Vehicles and equipment will be maintained in proper working order;
- Hours of operation of the quarry and crusher will be limited to daytime hours; and,
- Blasting will be limited to daytime hours.

5.2.3.3 Characterization of Residual Effects

Construction Phase

With respect to air quality, emissions during the construction phase are expected to be primarily related to the operation of mobile equipment, trucking, and related construction activities. Construction activities have the potential to result in changes in the local air quality, primarily related to fugitive dust and particulate matter from material movement as well as emissions from combustion associated with construction equipment.

The construction phase will consist primarily of material stripping and clearing using excavators, hauling to material stockpiles using articulated rock trucks, and material movement for stockpiling using a dozer. Estimates of emissions associated with the 6-month construction phase are summarized in **Table 5.2.5**.

Table 5.2.5: Total Emissions Associated with Construction (Over an Assumed 6 Month Period)

Air Contaminant	Excavating	On-Site Trucking	Stockpiling	TOTAL
PM (tonnes)	0.016	0.022	2.625	**2.66**
PM_{10} (tonnes)	0.016	0.022	0.503	**0.54**
$PM_{2.5}$ (tonnes)	0.016	0.022	0.282	**0.32**
CO (tonnes)	0.039	0.054	0.019	**0.11**
NO_X (tonnes)	0.187	0.259	0.091	**0.54**
SO_2 (tonnes)	0.111	0.153	0.054	**0.32**
CO_2 (tonnes)	174.029	240.909	84.106	**499.04**

Notes: Emission Factors from AP-42, Sections 11.9, 11.19, 13.2 and 13.3 (USEPA 2018)

It should be noted that the majority of emissions associated with the construction phase are related to fugitive dust due to the removal of the overburden. The removal of all of the overburden is accounted for in the construction phase emissions summary above, for simplicity. However, some of the overburden will be removed in stages during the operation of the Project. Emissions associated with combustion of diesel fuel is expected to be very localized and minimal.

Emissions related to operation activities are expected to be fairly localized. Emissions associated with fuel combustion from operations are not expected have a substantive effect on air quality. Fugitive emissions of particulate matter will largely be localized to the activity at the site and primarily during removal and handling of the overburden. The surface of the stockpiled topsoil and overburden piles will naturally harden over time, and will naturally re-vegetate over time; therefore fugitive emissions from wind erosion of the topsoil and overburden storage piles are not anticipated.

With respect to climate, total greenhouse gas emissions during construction are estimated to be 499 tonnes (as CO_2-equivalents), which represents less than 0.004% of New Brunswick's last reported total of 15.3 Mt CO_2e in 2016. Given the relatively low magnitude of emissions, no further action is taken in the analysis as per the guidance provided in the document titled *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (CEA Agency 2003).

With respect to sound quality, modelling was conducted to further asses construction related noise using the Roadway Construction Noise Model (RCNM) (USDOT 2018). Modelling was conducted assuming that two excavators and four trucks are operating simultaneously in the centre of the quarry, with the dozer, loader, and one truck operating in the centre of the storage area (where the overburden is assumed to be stored, for the purposes of this model). This set up represents the worst case scenario of maximum potential sound power levels closest to the two nearest residential receptors to the north

(Receptor 1) and east (Receptor 2) of the Project site. It was also conservatively assumed there was no natural shielding of noise, despite the presence of a treed buffer. The results of the noise modelling during construction are presented in **Table 5.2.6**.

Table 5.2.6: Noise Modelling Results – Construction Phase

Equipment	Equipment Lmax (dBA)	Distance to Receptor 1 (m)	Predicted Leq at Receptor 1 (North) (dBA)		Distance to Receptor 2 (m)	Predicted Leq at Receptor 2 (South) (dBA)	
			Lmax	Leq		Lmax	Leq
Dozer	81.7	1,119	44.4	40.4	361	54.2	50.2
Excavator	80.7	381	52.8	48.8	1,183	42.9	38.9
Excavator	80.7	381	52.8	48.8	1,183	42.9	38.9
Front End Loader	79.1	1,119	41.8	37.8	361	51.6	47.6
Truck	76.5	1,119	39.1	35.2	361	49	45
Truck	76.5	381	48.5	44.5	1,183	38.7	34.7
Truck	76.5	381	48.5	44.5	1,183	38.7	34.7
Truck	76.5	381	48.5	44.5	1,183	38.7	34.7
Truck	76.5	381	48.5	44.5	1,183	38.7	34.7
TOTAL	--	--	**52.8**	**54.9**	--	**54.2**	**54.1**

The predicted sound pressure level at each residential receptor modelled were well below the daytime criterion of 65 dBA and below the nighttime criterion of 55 dBA, both as a 1-hour Leq.

Operation Phase

With respect to air quality, emissions during the operation phase are primarily related to fuel combustion from on-site equipment. Additionally, fugitive emissions of particulate matter are anticipated, primarily from blasting activities. These activities have the potential to result in changes in the local air quality.

Estimates of emissions associated with the operation phase of the Project are summarized in **Table 5.2.7**.

Table 5.2.7: Annual Emissions Associated with Operation

Air Contaminant	Blasting	Excavating	On-Site Trucking	Crushing	Stockpiling	TOTAL
PM (tonnes/yr)	0.252	0.008	0.011	0.009	0.030	**0.31**
PM_{10} (tonnes/yr)	0.195	0.008	0.011	0.009	0.030	**0.25**
$PM_{2.5}$	0.182	0.008	0.011	0.009	0.030	**0.24**

Table 5.2.7: Annual Emissions Associated with Operation

Air Contaminant	Blasting	Excavating	On-Site Trucking	Crushing	Stockpiling	TOTAL
(tonnes/yr)						
CO (tonnes/yr)	0.010	0.020	0.027	0.022	0.075	**0.15**
NO_X (tonnes/yr)	0.048	0.094	0.131	0.104	0.360	**0.74**
SO_2 (tonnes/yr)	0.028	0.055	0.078	0.062	0.213	**0.44**
CO_2 (tonnes/yr)	44.670	87.015	122.015	96.856	334.844	**685.40**

Notes: Emission Factors from AP-42, Sections 11.9, 11.19, 13.2 and 13.3 (USEPA 2018)
Blasting emissions include fugitive dust and combustion emissions from drilling, and blasting
On-site Trucking includes combustion emissions from transport of material on-site and from water trucks
Stockpiling includes emissions form the loader and dozer operations.

Based on the low magnitude of annual emissions estimates provided in **Table 5.2.7** above during operation, ambient air quality is not expected to be affected as a result of the Project. Given the low magnitude of these emissions and the intermittent operation of the Project, dispersion modelling was not determined to be required.

There are additional activities of blasting and crushing during the operation phase of the Project that have the potential to contribute to fugitive particulate matter emissions. Emissions of fugitive particulate matter associated with material movement during the construction phase are much higher than those anticipated during operation. This is due to the nature of the gypsum material and that the crushed material is still very coarse.

Emissions of combustion gases and fugitive particulate matter during the operation phase is expected to be very localized and minimal. Emissions associated with fuel combustion from operations are not expected have a substantive effect on air quality. Fugitive emissions of particulate matter will largely be localized to the activity at the site and primarily during blasting activities. Fugitive emissions are not anticipated from the stockpiled gypsum, due to the nature and size of the material stored (i.e., 15-20 cm diameter rocks, rather than a finely crushed powder). As a result, fugitive emissions are not anticipated to have a substantive effect on air quality beyond the property boundary.

With respect to climate, total greenhouse gas emissions during construction are estimated to be 685 tonnes per year (as CO_2-equivalent), which represents less than 0.005% of New Brunswick's last reported total of 15.3 Mt. Given the relatively low magnitude of emissions, no further action is taken in the analysis as per the guidance provided in the document titled *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (CEA Agency 2003).

With respect to sound quality, modelling was conducted to further assess operation-related noise using the Roadway Construction Noise Model (RCNM) (USDOT 2018). Modelling was conducted assuming that two excavators, crusher, driller, and four trucks are operating simultaneously in the centre of the quarry, with the dozer, loader, and one truck operating in the centre of the storage area. It should be noted that noise generated from blasting was not modelled in this scenario, as it is infrequent and of very short duration (i.e., instantaneous impulse). Drilling associated with preparations for blasting was included. This set up represents the worst case scenario of maximum potential sound power levels closest to the two nearest residential receptors to the north and east of the Project site. It was also conservatively assumed there was no natural shielding of noise, despite the presence of a treed buffer and the fact that operations in the open pit/quarry will be conducted at depth, with the pit walls providing some shielding of noise emissions compared to those that would result if the equipment were located at surface. These result in a very conservative prediction of anticipated noise levels arising from the Project. The results of the noise modelling during operation are presented in **Table 5.2.8**.

Table 5.2.8: Noise Modelling Results – Operation Phase

Equipment	Equipment Lmax (dBA)	Distance to Receptor 1 (m)	Predicted Leq at Receptor 1 (North) (dBA)		Distance to Receptor 2 (m)	Predicted Leq at Receptor 2 (East) (dBA)	
			Lmax	Leq		Lmax	Leq
Dozer	81.7	1,119	44.4	40.4	361	54.2	50.2
Excavator	80.7	381	52.8	48.8	1,183	42.9	38.9
Excavator	80.7	381	52.8	48.8	1,183	42.9	38.9
Front End Loader	79.1	1,119	41.8	37.8	361	51.6	47.6
Truck	76.5	1,119	39.1	35.2	361	49	45
Truck	76.5	381	48.5	44.5	1,183	38.7	34.7
Truck	76.5	381	48.5	44.5	1,183	38.7	34.7
Truck	76.5	381	48.5	44.5	1,183	38.7	34.7
Truck	76.5	381	48.5	44.5	1,183	38.7	34.7
Drilling	81.0	381	53	46.1	1,183	43.2	36.2
Crushing	85.0	381	57	54	1,183	47.4	44.4
TOTAL	-	-	**57**	**57.6**	-	**54.2**	**54.1**

The predicted sound pressure level at each modelled residential receptor were well below the daytime criterion of 65 dBA as a 1-hour Leq. The worst case modelling predicted nighttime 1-hour Leq at Receptor 1 was 57.6 dBA, which is just above the nighttime criterion of 55 dBA; however, operations in the quarry are not expected to occur during nighttime (even though they were conservatively modelled in this scenario), and therefore the actual levels at this receptor are expected to be far below 55 dBA at nighttime. The predicted nighttime 1-hour Leq at Receptor 2 was within the nighttime criterion of 55 dBA.

Given the relative distance between Project activities and the nearest residential receptors, blasting activities are not expected to result in noticeable or measurable vibration levels that could cause property damage or nuisance at nearby residences. Blasting activities will be limited to approximately

25 blasts per year as an annual average (excluding nights, weekends, and statutory holidays), and a communication plan will be developed for residents who wish to be notified. Blasting activities will be periodically monitored using a seismograph to verify that concussion noise levels do not exceed a peak pressure level limit of 128 decibels (dBL) and that peak particle velocities (PPV) remain within 1.25 cm/s, as a best industry practice for quarry operations.

Reclamation and Closure Phase

Activities during the reclamation and closure phase are expected to be similar in nature to those occurring during construction (though somewhat in reverse order). Though not specifically quantified for the reclamation and closure phase, emissions of air contaminants, noise, and vibration are expected to be similar to, or less than, those could occur during construction. As such, environmental effects on the atmospheric environment during the reclamation and closure phase are not expected to be substantive.

5.2.4 Summary

The effects of construction on ambient air quality due to fugitive dust and emissions from equipment are expected to be very localized and minimal, using standard and site-specific mitigation as identified. Appropriate mitigative measures will be taken when required to ensure nuisance dust levels are controlled such that they do not cause an exceedance of ambient air quality standards at the property line or a nuisance at nearby residential receptors. It is unlikely that emissions will exceed New Brunswick or federal air quality standards beyond the property boundary for the Project.

The modelled sound pressure levels related to on-site activities are not predicted to exceed the criteria for daytime or nighttime for both construction and operation.

Greenhouse gas emissions from the Project are not anticipated to materially contribute to overall emissions in the region and represent less than 0.005% of greenhouse gas emissions in the province.

In light of the above, and in consideration of the nature of the Project, its anticipated environmental effects, and the implementation of mitigation and best practices that are known to reduce environmental effects, the residual environmental effects of the Project on the atmospheric environment during all phases of the Project are rated not significant, with a high level of confidence. No follow-up or monitoring is proposed, though it is anticipated that monitoring of dust or noise emissions may be required as part of the Project's Approval to Operate to be issued under the New Brunswick *Air Quality Regulation.*

5.3 Water Resources

The potential environmental effects of the Project on water resources are assessed in this section.

5.3.1 Scope of VC

Water is essential for life on Earth. As humans, we need water for drinking, bathing, sanitation, recreation, and for the production of food and goods. Fish, birds, animals, and plants also rely on the availability of water to live and flourish. Changes in the availability of water, both in the amount of water and the quality of the water, may affect the lives of people and other living things.

In this document, water resources include groundwater and surface water resources available for use by humans and wildlife (including vegetation). Water resources was selected as a VC based on the importance of the resource, and because of the potential for these resources to be affected by the Project through changes in surface water or groundwater quality or quantity.

The water resources VC can be discussed as two separate elements: surface water and groundwater. Surface water consists of wetlands, watercourses (mapped and unmapped), water bodies, and surface water drainage channels that are within the property boundary or within the areas that may be potentially affected by the Project. Watercourses and areas meeting the definition of a wetland in New Brunswick, are regulated by the New Brunswick *Clean Water Act* including its *Watercourse and Wetland Alteration Regulation,* and the New Brunswick *Wetlands Conservation Policy* (NBDNRE-NBDELG 2002). Wetlands are further discussed and assessed in **Section 5.5**. Surface water supplies used as public drinking water sources are protected under the *Watershed Protected Area Designation Order - Clean Water Act.*

Groundwater consists of water that is contained within the ground and recharged through infiltration of precipitation or surface water, and is important to local ecosystems and private potable wells. In general, groundwater flows from recharge areas (i.e., areas of high elevation) to discharge areas (i.e., areas of low elevation), which are commonly lakes, streams, and rivers. Groundwater is contained in aquifers, which are geological units such as gravels, sands, or fractured bedrock. The quality of the water contained in aquifers varies depending on the geochemical composition of the material within which the water flows. The construction of potable wells and the extraction of groundwater is regulated under the New Brunswick *Clean Water Act* and associated *Water Well Regulation* and *Potable Water Regulation*. Groundwater sources used as public drinking water supplies are protected under the *Wellfield Protected Area Designation Order - Clean Water Act.*

Objectives for the quality of surface water and groundwater as a source of drinking water are provided in Health Canada's *Guidelines for Canadian Drinking Water Quality* (GCDWQ) (Health Canada 2017). Though not having force of law unless formally adopted by provincial legislation, these guidelines provide guidance to decision-makers with respect to the potability of drinking water for human use.

The groundwater and surface water environment are considered VCs as they are an important part the hydrologic cycle, are critical to the water balance, and are contributing components to both ecological and human health. The overall groundwater environment includes consideration of potential effects on both surface water and groundwater quality as well as quantity.

5.3.1.1 Temporal Boundaries

The temporal boundaries for the Project include the following:

- Construction: extending for a period of approximately six months, anticipated to begin in the second quarter of 2019 (subject to the receipt of all approvals and permits required for the Project);
- Operation: beginning in approximately the fourth quarter of 2019, and lasting for approximately 10 years or until the mineral resource has been depleted; and,
- Reclamation and closure: To be initiated following the completion of operations at the site, with decommissioning and reclamation of the surface facilities at the site for an anticipated duration of six months following operation.

5.3.1.2 Spatial Boundaries

The Project Development Area (PDA) is defined as the area of physical disturbance associated with construction and operation of the Project. Specifically, the PDA consists of an area of approximately 61.81 ha (i.e., conservatively assumed to be the entirety of PID No. 00149013) that includes the open pit and all related surface facilities located on the property. The PDA is the area represented by the physical Project footprint.

The Local Assessment Area (LAA) is the maximum anticipated area within which Project-related environmental effects are expected. For water resources, the LAA is defined by the Hammond River to the east, south, and west and Route 820 to the north. The LAA includes the PDA and any adjacent areas where Project-related environmental effects could be expected to occur.

5.3.1.3 Significance Threshold

A significant adverse residual environmental effect on water resources is one where Project-related activities:

- degrade the quality of previously unaffected surface water or groundwater by exceeding the objectives of one or more parameters as specified in the Guidelines for Canadian Drinking Water Quality (Health Canada 2017) for potable domestic water supplies for a period of more than 30 days;
- result in a significant loss of provincially significant watercourses or wetlands that cannot be compensated for as defined by the New Brunswick Wetlands Conservation Policy (NBDNRE-NBDELG 2002);
- cause a significant geochemical alteration or dewatering of the Hammond River; or,
- reduce the quantity of groundwater recoverable from an aquifer on a sustainable basis such that it no longer meets present or future needs of current users or land owners.

5.3.2 Existing Conditions

The existing conditions for water resources are defined below in terms of surface water resources and groundwater resources.

5.3.2.1 Surface Water Resources

The Project is located in southern New Brunswick, approximately 16 km east of the Town of Hampton and lies within the Hammond River watershed. The Hammond River ultimately discharges into the Kennebecasis River which is part of the lower Saint John River. The Hammond River has a total drainage area of approximately 513 km^2 (NBDOE 2007). The Hammond River originates in the Caledonia Highlands near the rural community of Hammondvale and runs in a westerly direction for a distance of approximately 40 km into the Kennebecasis River at Nauwigewauk/Darlings Island. The Hammond River flows from the eastern side of the LAA, around the south and flows away from the LAA towards the Kennebecasis River to the west.

Figure 5.3.1 presents the general site location and general topographical features of the site. The topography of the Project site rises to over 105 m above mean sea level (m amsl) in the central portion of the Project site, and slopes downward to the east, south, and west towards the Hammond River (approximately 70 m amsl), and slopes upward in the north towards Route 820 (approximate maximum elevation of 99 m amsl).

A number of the wetlands are interconnected by small watercourses and unnamed tributaries of the Hammond River that may only contain water during recharge events and seasonal run-off. A detailed description of each wetland is presented in **Section 5.5**.

There are three small mapped watercourses that intersect the PDA, as shown in **Figure 5.3.1**. Water quality information for these watercourses is provided in **Section 5.4.2**.

5.3.2.2 Groundwater Resources

The surficial geology of the LAA consists of Late Wisconsonian glaciofluvial sediments deposited consisting of hummocky, ribbed, and rolling ablation till, some lodgement till, clay, minor silt, sand, gravel, and boulders; generally consisting of 1.5 m in thickness (Rampton 1984). These are generally consistent with those findings during exploration drilling, in that overburden was between 6.1 m and 30.5 m in thickness and consisted of red/brown mud containing some sandstone pebbles, gravel, and boulders, and occasionally containing grey/green limestone pebbles and/or gravel. A shallow groundwater table may be present within this surficial material; however, it is likely localized and discontinuous across the PDA.

The bedrock geology of the area is made up of the Gays River Formation and the Macumber Formation. These formations are early Carboniferous aged, sedimentary deposits that form part of the Windsor Group. The Gays River Formation is grey to brown or black fossiliferous and algal limestones. The Macumber Formation is grey to black sparsely fossiliferous, interclastic and/or pelletoidal limestone with minor intraformational breccia (Barr and White 2004). Overlying these limestone units on the northern portion of the PDA is between 1.5 m and an unknown thickness of gypsum and anhydrite.

Karst features are openings in bedrock caused by the dissolution of bedrock material by groundwater over long periods of time. Depending on their age, these features may be filled with mud or debris. Karst features typically occur in limestone and gypsum related bedrock, and were noted in the area of the

PDA, including sinkholes observed at the surface in multiple locations. During exploration drilling activities at the Project site, voids were encountered in the gypsum and anhydrite, up to 4.5 m in vertical thickness, indicating that subterranean karst features may also be present. Dissolution zones were also noted within the gypsum and anhydrite layers up to 5 m in vertical thickness. Dissolution zones where gypsum and anhydrite have washed away have been in-filled with layers of compact silt, clay, and sand. Due to the intrinsic low permeability of gypsum and anhydrite along with the observation of backfilled karstic features, it is not likely that significant groundwater flow is present within the gypsum and/or anhydrite deposits.

From a recharge to groundwater perspective, the PDA is situated at a topographic divide whereby precipitation in this area is draining to the east and west into the Hammond River. To gain a better understanding of the known sources of groundwater in the area, a desktop review of the New Brunswick Online Well Log System (OWLS; NBDELG 2018b) search was completed by Dillon. For the review (Dillon 2018), a search radius of 2 km was selected. It should be noted that the radial search is property based, and the OWLS will return wells that are affiliated with any property in which a portion of the property falls within the search radius. Therefore, the wells discussed may be located beyond the 2 km search radius surrounding the subject property. Another important limitation of the OWLS database is that it includes only wells that were completed after 1994; thus there may be other wells present in an area if they existing prior to that year. The OWLS query yielded results for 12 water wells near or within the 2 km radius surrounding the subject property. Available information regarding well construction details are outlined below in **Table 5.3.1**.

Table 5.3.1: Well Construction Details For 12 Wells Within Approximately 2 km of the Project (NBDELG 2018b)

Well Identification	Overall Well Depth (m)	Well Casing Diameter (cm)	Well Casing Depth (m)	Estimated Safe Yield (L/min)[1]
DW1	21.34	25.4	6.1	3.41
DW2	68.58	15.24	20.12	22.75
DW3	32	15.24	12.19	136.5
DW4	45.72	15.24	12.19	52.32
DW5	83.82	15.24	6.1	31.85
DW6	30.48	15.24	12.19	0
DW7	30.48	15.24	9.14	31.85
DW8	44.2	15.24	11.58	45.5
DW9	15.24	15.24	12.19	27.3
DW10	53.34	15.24	12.19	13.65
DW11	45.72	15.24	20.42	6.82
DW12	42.67	15.24	12.19	20.48

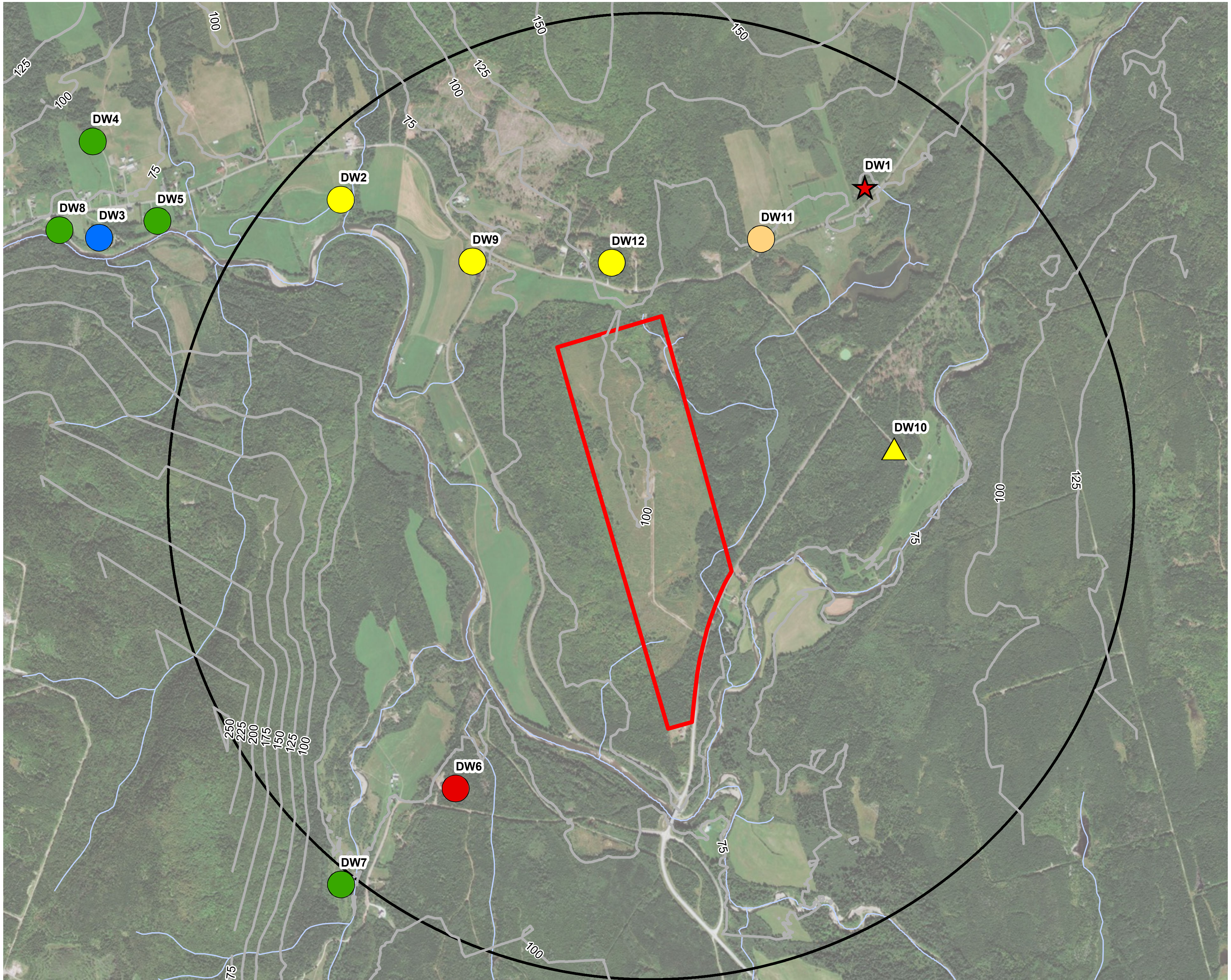
Notes:

1. The estimated safe yield is based upon the well driller's estimate at the time of well drilling and may not represent the long term sustainability of the well.

HAMMOND RIVER HOLDINGS LTD.
PROPOSED UPHAM EAST GYPSUM QUARRY

DOMESTIC WELL LOCATIONS

FIGURE 5.3.1



OBSERVED STRATIGRAPHY
- ☆ GYPSUM/SULPHATES
- △ GRANITE/IGNEOUS
- ○ SHALE/SANDSTONE/SLATE

ESTIMATED SAFE YIELD (L/MIN)
- EXCELLENT (>60)
- VERY GOOD (30 - 60)
- GOOD (10 - 30)
- MARGINAL (5 - 10)
- INSUFFICIENT (0 - 5)
- SEARCH RADIUS (2 KM)
- PROJECT DEVELOPMENT AREA
- WATERCOURSES
- CONTOURS

0 125 250 500 m

SCALE 1:15,500

N W E S

MAP DRAWING INFORMATION:
DATA PROVIDED BY DILLON CONSULTING LIMITED, CANVEC
SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISS TOPO, OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

MAP CREATED BY: CS
MAP CHECKED BY: JH
MAP PROJECTION: NAD_1983_CSRS_New_Brunswick_Stereographic

FILE LOCATION: \\DILLON.CA\DILLON_DFS\FREDERICTON\FREDERICTON CAD\CAD\GIS\188346 UPHAM GYPSUM QUARRY\MXD

DILLON CONSULTING

PROJECT: 18-8346
STATUS: FINAL
DATE: OCT 2018

Observed stratigraphy is recorded by the licensed well drillers during each well installation. Available information regarding observed stratigraphy is presented below in **Table 5.3.2**.

Table 5.3.2: Observed Stratigraphy for 12 Wells Within Approximately 2 km of the Project (NBDELG 2018b)

Well Identification	Depth of Top of Zone (m)	Depth of Bottom of Zone (m)	Stratigraphy[1]
DW1	0	4.88	Brown Clay
	4.88	21.34	White Gypsum
DW2	0	0.91	Brown Topsoil
	0.91	4.88	Brown Sand and Gravel
	4.88	12.19	Brown Sand
	12.19	18.29	Red Clay
	18.29	68.58	Red Shale
DW3	0	9.14	Brown Sand and Gravel
	9.14	21.34	Red Shale
	21.34	24.38	Grey Shale
	24.38	32	Red Shale
DW4	0	6.1	Brown Mud and Stones
	6.1	45.72	Red Sandstone
DW5	0	1.52	Brown Mud and Gravel
	1.52	83.82	Red Sandstone
DW6	0	9.14	Brown Sand
	9.14	30.48	Grey Shale
DW7	0	3.05	Brown Mud
	3.05	30.48	Grey Slate
DW8	0	0.61	Brown Soil
	0.61	8.84	Brown Hardpan
	8.84	10.67	Brown Gravel
	10.67	44.2	Brown Shale
DW9	0	10.67	Red Clay and Gravel and Rock
	10.67	15.24	Red Sandstone
DW10	0	4.27	Brown Mud and Rock
	4.27	53.34	Grey Granite

Table 5.3.2: Observed Stratigraphy for 12 Wells Within Approximately 2 km of the Project (NBDELG 2018b)

Well Identification	Depth of Top of Zone (m)	Depth of Bottom of Zone (m)	Stratigraphy[1]
DW11	0	18.9	Red Clay and Mud
	18.9	45.72	Red Shale
DW12	0	10.06	Brown Clay
	10.06	42.67	Red Shale

Notes:

1. The stratigraphy is based upon the observations of drill cutting made by the well driller at the time of drilling. The stratigraphy should be considered as a general description only and not an interpreted geologic unit.

Available information regarding water bearing zones observed during well construction is presented below in **Table 5.3.3**.

Table 5.3.3: Water Bearing Zones for 12 Wells Within Approximately 2 km of the Project (NBDELG 2018b)

Well Identification	Water Bearing Zone Depth (m)	Estimated Water Flow Rate (L/min)[1]
DW1	21.34	3.41
DW2	53.34	4.55
	60.96	18.2
DW3	24.38	136.5
DW4	21.34	2.28
	38.1	4.55
	42.06	45.5
DW5	30.48	2.28
	60.96	2.28
	71.93	27.3
DW6	13.72	2.28
	27.43	29.58
DW7	10.67	13.65
	27.43	18.2
DW8	35.05	4.55
	42.98	40.95
DW9	13.72	27.3
DW10	50.29	13.65
DW11	22.86	2.28
	35.05	4.55

Table 5.3.3: Water Bearing Zones for 12 Wells Within Approximately 2 km of the Project (NBDELG 2018b)

Well Identification	Water Bearing Zone Depth (m)	Estimated Water Flow Rate (L/min)[1]
DW12	39.62	20.48

Notes:

1. The estimated water flow rate is a representation of the well driller's estimate of the yield of each water bearing fracture identified during the drilling of the well.

In accordance with the New Brunswick *Clean Water Act*, the OWLS database does not attribute any reported water quality analytical data to its corresponding well. The OWLS search completed as part of this assessment yielded analytical data for 9 samples. The reported analytical data are presented in **Table 5.3.4**. For reference, the data have been compared to the applicable Health Canada Guidelines for Canadian Drinking Water Quality (Health Canada 2017).

Additionally, the analytical results for general chemistry and trace metals were used to develop a trilinear Piper plot to illustrate and summarize the chemical composition of the water samples relative to major ionic constituents. The trilinear Piper plot is presented on **Figure 5.3.2**.

Based upon the results of the OWLS search and water chemistry review, the following assumptions have been made.

- According to the observed stratigraphy and well construction details, the wells included in the OWLS search all appear to be constructed to source groundwater from bedrock, with casing installed into bedrock.
- Based on the observed stratigraphy and water bearing data, it appears as though gypsum was encountered during the construction of DW1, and that DW1 is sourcing groundwater from this gypsum zone. It should be noted that this water bearing zone produces less than 4 L/min.
- The water quality analytical data indicate low-level detections of bromide (common constituent of sea water) in samples from Well 6 and Well 9. These detections of bromide could be attributed to relic seawater in the surrounding formation, or by dissolution in the bedrock geology.
- The topography of the study area suggests that groundwater is anticipated to flow from the site to the south/west/east towards the Hammond River. Elevation contours are displayed on **Figure 5.3.1**.
- Based on the available groundwater analytical data, various health-based and aesthetic objective-based exceedances were observed in samples from Well 4, Well 5, Well 6, and Well 8.

TABLE 5.3.4
GENERAL CHEMISTRY AND TRACE METALS - OWLS SURVEY ANALYTICAL DATA
Upham Gypsum Exploration Project
Upham, New Brunswick
Project No. 17-5121

Parameter	Units	GCDWQ 2014	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9
General Chemistry											
Sodium	mg/L	200**	63.3	3.41	4.45	14.2	12.8	78.6	8.83	5.4	3.33
Potassium	mg/L	NG	3.2	0.4	1.1	1.6	1.4	0.992	0.93	0.681	0.31
Calcium	mg/L	NG	99.2	50.1	49.2	20	27.1	7.68	94.01	37.5	45.8
Magnesium	mg/L	NG	3.81	1.11	2.75	2.16	2.11	0.343	4.4	2.1	1.76
Iron	mg/L	0.3**	0.295	<0.01	0.037	**3**	0.085	0.02	0.003	<0.05	0.016
Manganese	mg/L	0.05**	<0.005	<0.005	<0.005	**0.140**	0.047	<0.005	-	**0.052**	0.0068
Copper	mg/L	1**	<0.010	<0.010	<0.010	0.015	<0.010	0.037	-	<0.010	<0.010
Zinc	mg/L	5**	0.24	<0.005	<0.005	0.05	<0.005	0.019	-	<0.01	0.0098
pH	units	7-10.5*	8.05	7.56	7.96	7.16	8.24	8.46	8.08	7.9	8.2
Total Alkalinity	mg/L	NG	123	112	113	62.8	75.7	131	82.12	101	83.8
Chloride	mg/L	250**	78.3	4.55	5.07	2.8	3.54	8.31	4.89	4.13	3.38
Sulfate	mg/L	500**	147	4.09	4.22	11.1	19.4	38.4	165	15	45
Nitrate + Nitrite (as N)	mg/L	10* [A]	0.5	0.36	1.1	<0.05	<0.05	0.45	0.29	<0.05	0.07
Total Dissolved Solids	mg/L	NG	471.887	132.711	139.772	93.809	112.45	215.966	-	-	150.334
Conductivity	µS/cm	NG	799	254	273	154	208	383	530	228	283
Calculated Parameters											
Bicarbonate as $CaCO_3$	mg/L	NG	121.7	111.6	112	62.71	74.4	131	-	-	83.8
Carbonate as $CaCO_3$	mg/L	NG	1.3	0.4	1	0.0852	1.215	0	-	-	0.000
Hydroxide as $CaCO_3$	mg/L	NG	0.100	0.000	0.000	0.007	0.087	0.000	-	-	0.000
Cation sum	EPM	NG	8.125	2.754	2.911	2.0728	2.1375	3.861	-	-	2.587
Anion sum	EPM	NG	7.80	2.49	2.60	1.57	2.03	3.74	-	-	2.72
Theoretical Conductivity	µS/cm	NG	773.643	229.219	253.348	156.31	194.44	338.079	-	-	263.178
Hardness	mg/L	NG	263	130	134	58.8	76.4	20.6	252.9	102.3	122
Trace Metals											
Aluminum (Al)	µg/L	100**	<25	<25	51	**630**	**110**	<25	-	<25	<25
Antimony (Sb)	µg/L	6*	<1	<1	<1	<1	<1	**6.31**	-	<1	<1
Arsenic (As)	µg/L	10*	<1.5	<1.5	<1.5	<1.5	<1.5	**26.1**	3.1	<1	<1.5
Barium (Ba)	µg/L	1000*	53	160	291	139	100	24	25	101	212
Bromide (Br)	µg/L	NG	<100	<100	<100	<100	<100	124	-	<100	134
Boron (B)	µg/L	5000*	98	<10	21	121	124	159	60	<200	<10
Cadmium (Cd)	µg/L	5*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.01	<0.05	<0.05
Calcium (Ca)	µg/L	NG	99200	50100	49200	20000	27100	7680	94010	37500	45800
Chromium (Cr)	µg/L	50*	<10	<10	<10	<10	<10	<10	3	11	<10
Copper (Cu)	µg/L	1000**	<10	<10	<10	15	<10	37	-	<10	<10
Iron (Fe)	µg/L	300**	295	<10	37	**3000**	85	20	3	<50	16
Fluoride (F)	µg/L	1500*	386	<100	<100	<100	<100	938	120	109	<100
Lead (Pb)	µg/L	10*	1.1	<1	<1	**13**	<1	3.29	-	<1	<1
Magnesium (Mg)	µg/L	NG	3810	1110	2750	2160	2110	343	4400	2100	1760
Manganese (Mn)	µg/L	50**	<5	<5	<5	**140**	47	<0.005	-	**52**	6.8
Potassium (K)	µg/L	NG	3200	400	1100	1600	1400	992	930	681	305
Selenium (Se)	µg/L	50*	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	-	<1	<1.5
Sodium (Na)	µg/L	200000**	63300	3410	4450	14200	12800	78600	8830	5400	3330
Thallium (Tl)	µg/L	NG	<1	<1	<1	<1	<1	<1	-	<1	<1
Uranium (U)	µg/L	20*	7.4	0.5	2.1	<0.5	<0.5	16	-	-	<0.5
Zinc (Zn)	µg/L	5000**	240	<5	<5	50	<5	19	-	<10	9.8

Notes:

* Health Canada Federal-Provincial-Territorial Committee on Canadian Drinking Water (FTP CDW) Guidelines for Canadian Drinking Water Quality (GCDWQ, 2017) Health Based Objective (HBO).

** Health Canada Federal-Provincial-Territorial Committee on Canadian Drinking Water (FTP CDW) Guidelines for Canadian Drinking Water Quality (GCDWQ, 2017) Aesthetic Based Objective (ABO).

[A] The GCDWQ does not have a specific guideline for nitrate + nitrite (as N), However, the associated nitrate (as N) guideline is 10 mg/L.

-	denotes not applicable/parameter not analyzed.
NG	denotes No Guideline established.
7,500	**BOLD**/shaded value denotes concentration exceeds GCDWQ HBO.
7,500	**BOLD**/shaded value denotes concentration exceeds GCDWQ ABO.

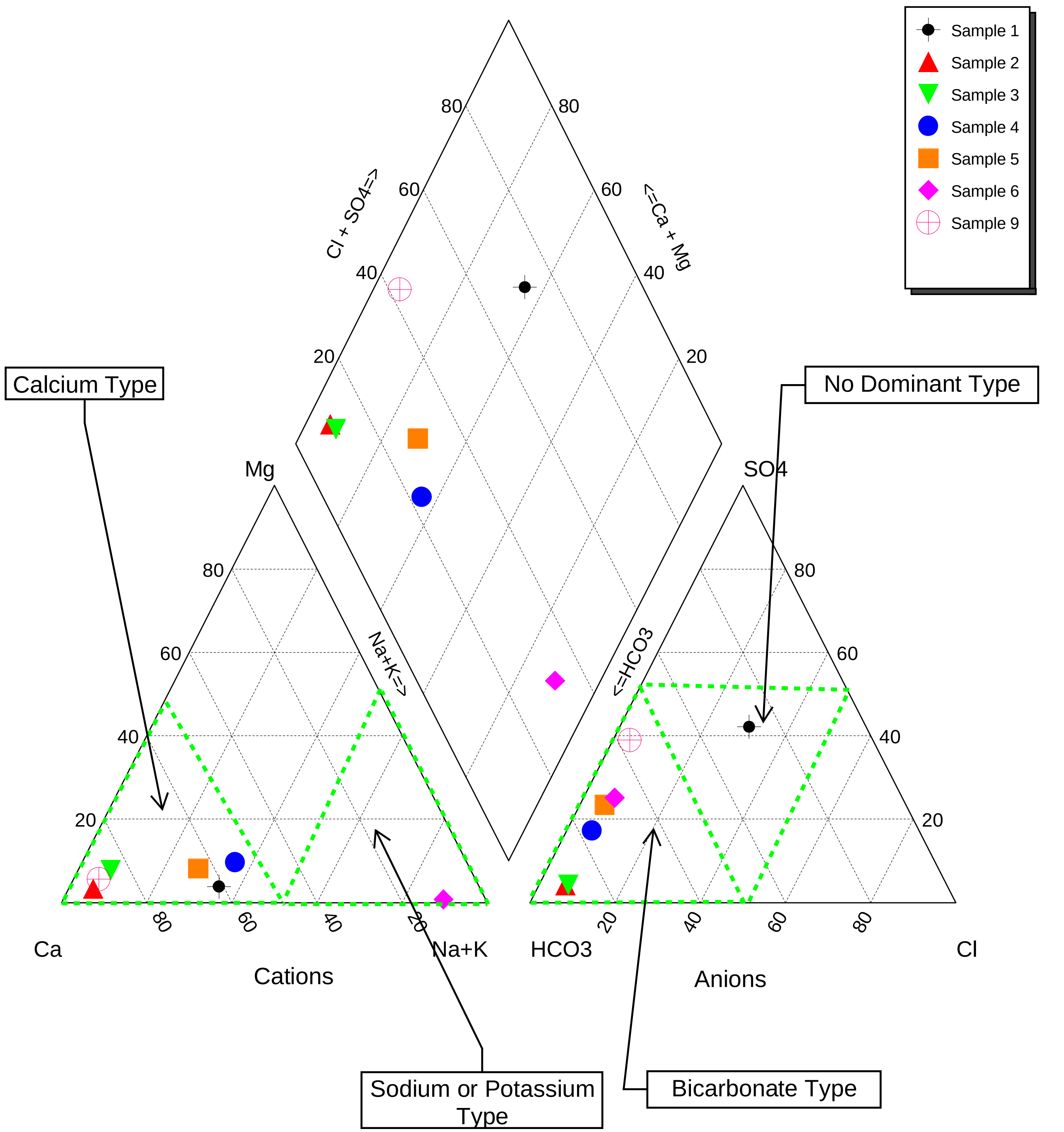


Figure 5.3.2: Groundwater Chemisty Trilinear Piper Plot

DILLON CONSULTING	PROJECT: Upham East Gypsum Quarry	PROJECT NO: 18-8346
	CLIENT: Hammond River Holdings Limited	DATE: October 2018

5.3.3 Environmental Effects Assessment

The environmental effects of the Project on water resources are assessed in this section.

5.3.3.1 Potential Effects

The Project may interact with water resources in the following ways:

- Surface drainage patterns will be altered with the reshaping of the Project site during construction and from the creation of the open pit quarry, and several wetlands and unnamed streams are likely to be affected. These effects are expected to begin during construction and continue throughout operation and into reclamation and closure until such time as the open pit fills with water at the end of quarry life.
- The ongoing presence of the open pit during operation and into closure could result in groundwater seepage from surrounding bedrock to drain into the open pit, requiring periodic dewatering and management and potentially changing groundwater availability and/or quality on a localized basis throughout the life of the Project (until the open pit is filled with water at closure).
- Localized water balance may be disrupted through groundwater flow redirection towards the open pit rather than towards the Hammond River. Localized groundwater flow change is not anticipated to cause negative water quality or quantity issues within the LAA and regional groundwater flow in the area is expected to remain unchanged.
- Although groundwater flow is unlikely to have potential effects, there is a potential for Project-related activities to affect localized groundwater quality and quantity due to the presence of the open pit, within which groundwater is expected to seep.
- Blasting will be the primary method for releasing the deposit. Blasting has the potential to cause damage and increased turbidity in potable wells as a result of vibration in the ground.
- Water quality could be affected by accidental spills of lubricants, fuels, or residual chemical effects from blasting (assessed in **Section 7.0**).
- Many of the unmapped wetlands on the site will either be reduced in size or be destroyed during the construction and operation phases of the Project. The environmental effects assessment for vegetation and wetlands is provided in **Section 5.5.2**.

It should be noted that acid rock drainage can occur through exposure of sulphide-rich rocks in oxidizing environments. However, not all sulphur-containing rocks generate acid under these conditions. Due to the chemical composition of gypsum and anhydrite, which do not contain sulphides, acid rock drainage (and associated metal leaching) is not considered to be a potential concern for this Project.

5.3.3.2 Mitigation

Mitigation is identified for each interaction and/or effect in relation to water resources in an attempt to prevent the interaction from occurring if possible, or to reduce the severity, magnitude, geographic extent, frequency, or duration of the interaction. Best management practices (based on industry guidelines and regulatory guidance documents) have been identified as appropriate mitigative strategies. In addition, several acts, codes, regulations and guidelines may require appropriate actions be conducted as mitigative measures prior to or during the interaction.

The following mitigation will be implemented as a part of the Project:

- Where possible, avoid construction within 30 m of watercourses or wetlands.
- The area of disturbance associated with the development of the physical components of the proposed project will be minimized to the extent possible to limit the associated environmental effects associated with such disturbance.
- Proper erosion and sediment control measures will be installed and checked regularly and prior to and after storm events to ensure they are continuing to operate properly to minimize potential effects to adjacent habitat.
- Exposed soils will be stabilized as soon as practical to minimize emissions of particulate matter, erosion, and the release of sediment-laden runoff.
- Wetlands and unnamed tributaries that are affected as a result of the construction of the open pit mine will be compensated for under the New Brunswick *Clean Water Act* and New Brunswick Wetlands Conservation Policy (NBDNRE-NBDELG 2002). Further information on potential effects to wetlands is provided in **Section 5.5**.
- An Environmental Protection Plan (EPP) will be put in place to establish procedures to minimize the potential for spills or uncontrolled releases. As part of the EPP, spill response measures will be put in place to address unplanned Project-related releases. Project-related accidents, malfunctions, and unplanned events are assessed in **Section 7.0**.
- It is planned that up to 20 potable wells in the LAA will be sampled to establish baseline water quality data (subject to landowner permission). These results be tabulated and compared to the Canadian Drinking Water Quality Guidelines (Health Canada 2017) prior to the beginning of construction. In the unlikely event that a potable well experiences quantity or quality issues during operation and becomes unusable, steps will be taken to provide an alternate water supply. This is usually done through the drilling of a new potable well, providing bottled water, or other means.
- Four shallow monitoring wells and four deep bedrock wells will be drilled in the LAA to establish baseline conditions on the site and to monitor changes in the water level, over time. Water levels will be monitored through the use of pressure transducers (data loggers) that can be programmed to record water levels at set time intervals, or by taking manual water level readings at set time intervals, during construction and operation of the Project. A groundwater monitoring plan will be developed as part of the permitting phase of the Project.

5.3.3.3 Characterization of Residual Effects

From the beginning of operation, surface water contained within wetlands and unnamed watercourses located within the PDA and LAA will be drained and may not return to current conditions with the completion of the Project. This potential residual effect is expected to be limited to the PDA, and the watercourses that extend from the PDA into the LAA. At the end of the quarry's operational life, the open pit will, over time, partially fill with water and become a small lake, as groundwater levels equilibrate. These effects are not expected to reach the main branch of the Hammond River due to the following factors:

- the PDA and LAA comprise a small portion (i.e., 0.61 km^2) of the entire Hammond River watershed (i.e., 513 km^2);
- Following the creation of the open pit, surface water and groundwater will continue to discharge to the Hammond River;
- Current conditions onsite include a limited tree canopy due to the former forest harvesting activities; therefore, it is anticipated that surface water temperature conditions (i.e. bassline conditions) are generally warmer; and,
- The groundwater that fills the open pit is expected to provide cooling of the surface water that drains into the open pit; therefore, water discharging from the pit may be cooler than current baseline surface water temperatures.

Groundwater draining into the open pit will be stored in a sump located in the deepest portion of the open pit, and periodically pumped back to surface and release to receiving waters when total suspended sediments meet discharge standards (i.e., a target TSS concentration of less than 25 mg/L above background levels of the receiving waters, measured as a monthly average of grab samples, or as specified in the facility's Approval to Operate to be issued under the *Water Quality Regulation*). If the target TSS concentration cannot be met, pumped water will be held in the settling pond to further allow for suspended solids to settle out of the water before being discharged to the natural environment. Water quality will be monitored throughout the operation phase to ensure the quality of water being discharged to the environment meets the applicable discharge criteria, and that the rate of release is such that discharged water does not overwhelm the capacity of the receiving watercourse.

It is planned that up to 20 potable wells in the LAA will be sampled to establish baseline water quality data (subject to landowner permission). These results be tabulated and compared to the Canadian Drinking Water Quality Guidelines (Health Canada 2017) prior to the beginning of construction. In the unlikely event that a potable well experiences water quantity or quality issues during operation and/or becomes unusable, steps will be taken to provide an alternate water supply. This is usually done through the drilling of a new potable well, providing bottled water, or other means.

Four shallow monitoring wells and four deep bedrock wells will be drilled in the LAA to establish baseline conditions on the site and to monitor changes in the water level over time. Water levels will be monitored through the use of pressure transducers (data loggers) that can be programed to record water levels at set time intervals, or by taking manual water level readings at set time intervals during the Project.

5.3.4 Summary

Based on the above, with planned mitigation and environmental protection measures, the residual environmental effects of the Project on water resources during all phases of the Project are rated not significant, with a moderate level of confidence.

Follow-up measures to be implemented including a water well sampling program and routine monitoring of discharge water quality and groundwater levels on site throughout the Project life, with associated adaptive management as required, will improve the level of confidence of this prediction.

5.4 Fish and Fish Habitat

The potential environmental effects of the Project on fish and fish habitat are assessed in this section.

5.4.1 Scope of VC

Fish and fish habitat includes aquatic life (such as fish and benthic macro-invertebrate species/populations) and the habitat that supports them, including mapped and unmapped (field identified) watercourses. Fish and fish habitat are considered a valued component (VC) of the environment because of their importance in supporting freshwater aquatic life as a fisheries resource for humans, as food source for other wildlife, and in providing recreational opportunities, which are of importance to the public, stakeholders, and First Nation communities.

Fish and fish habitat was selected as a VC due to the possible environmental effects of:

- A potential change or alteration of, disruption to, or removal of aquatic (including fish) habitat as a result of the Project; and,
- Effects to aquatic species listed under the federal *Species at Risk Act* (SARA) and/or the New Brunswick *Species at Risk Act* (NB SARA).

In addition, fish and fish habitat are protected through the federal *Fisheries Act* as well as the provincial *Fish and Wildlife Act* and the *Watercourse and Wetland Alteration Regulation* under the New Brunswick *Clean Water Act*. The federal *Fisheries Act* protects fish or fish habitat that are part of commercial, recreational or Aboriginal (CRA) fisheries, or that support such a fishery (DFO 2013). Section 35(2) of the *Fisheries Act* prohibits *serious harm to fish,* which is defined in the Act as "*the death of fish or any permanent alteration to, or destruction of, fish habitat*". Additionally, aquatic species at risk are protected under both the federal and provincial *Species at Risk Act.*

The Project has the potential to affect fish and fish habitat through changes in hydrology, water quality and quantity, productivity, and loss of fish habitat.

5.4.1.1 Temporal Boundaries

The temporal boundaries for the Project include the following:

- Construction: extending for a period of approximately six months, anticipated to begin in the second quarter of 2019 (subject to the receipt of all approvals and permits required for the Project);
- Operation: beginning in approximately the fourth quarter of 2019, and lasting for approximately 10 years or until the mineral resource has been depleted; and
- Reclamation and closure: To be initiated following the completion of operations at the site, with decommissioning and reclamation of the surface facilities at the site for an anticipated duration of six months following operation.

5.4.1.2 Spatial Boundaries

The Project Development Area (PDA) is defined as the area of physical disturbance associated with construction and operation of the Project. Specifically, the PDA consists of an area of approximately 61.81 ha (i.e., conservatively assumed to be the entirety of PID No. 00149013) that includes the open pit and all related surface facilities located on the property. The PDA is the area represented by the physical Project footprint, as presented on **Figure 5.4.1**.

The Local Assessment Area (LAA) is the maximum anticipated area within which Project-related environmental effects are expected. For fish and fish habitat, the LAA includes the PDA, as well as a 500 m radius around the PDA that includes the Hammond River, as well as watercourses that extend off of the property and interconnect with tributaries of the Hammond River, or are connected to the main branch of the Hammond River, including a 30 m buffer around such watercourses.

5.4.1.3 Significance Threshold

A significant adverse residual environmental effect on fish and fish habitat is defined as one that results in an unmitigated or non-offset loss of fish habitat that results in “serious harm to fish” as defined under the *Fisheries Act*. For fish populations, a significant adverse residual environmental effect would result from a Project-related destruction of fish resulting in a decline of regional fish populations that was not authorized under the *Fisheries Act*.

Such an environmental effect may alter the aquatic environment physically, chemically, or biologically, in quality or extent, that could include, for example, exceeding long-term Canadian Council of Ministers of the Environment (CCME) guidelines for the Protection of Freshwater Aquatic Life (CCME 1999), or from an unapproved Project-related alteration of water quality that would constitute water pollution as defined in the New Brunswick *Clean Environment Act*.

5.4.2 Existing Conditions

The information regarding the presence and characterization of fish and fish habitat within the PDA and LAA was derived from several sources including existing databases and secondary information sources (i.e., desktop analysis), as well as field assessment.

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5.4.2.1 Regional Setting

The Project is located in Kings County in southeastern New Brunswick within the Hammond River watershed, which drains into the Kennebecasis and Saint John Rivers (Bradford et al. 2015). The Hammond River watershed drains an area of 513 km^2 where forestry and agriculture are the predominant land uses (NBDOE 2007). The mapped watercourses (as mapped on the GeoNB website) that intersect with the PDA include the reaches of three small unnamed tributaries to the Hammond River, which are generally associated with wetland features on the Project site.

Fish species that typically reside in the Hammond River include Atlantic salmon (*Salmo salar*), brook trout (*Salvelinus fontinalis*), smallmouth bass (*Micropterus dolomieu*), rainbow smelt (*Osmerus mordax*), striped bass (*Morone saxatilis*), and shortnose sturgeon (*Acipenser brevirostrum*) (NBDOE 2007). The Hammond River maintains an annual run of returning adult Atlantic salmon (outer Bay of Fundy population) (HRAA 2015). The outer Bay of Fundy population of Atlantic salmon is in decline and has been listed as “Endangered” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); that designation is currently under review under the federal *Species at Risk Act* (SARA). The inner Bay of Fundy population of Atlantic salmon has been listed as “Endangered” under SARA.

The Hammond River Angling Association (HRAA) is a membership based group that has engaged in many Atlantic salmon habitat and population enhancement programs since its inception including: fish stocking programs, population and spawning assessments, habitat restoration, and community outreach and education (HRAA 2018).

5.4.2.2 Desktop Analysis

Prior to completing the fish and fish habitat field assessments, Dillon reviewed readily available information from reputable sources. The information was reviewed to evaluate the potential for aquatic species of conservation concern (SOCC) and/or aquatic species at risk (SAR) within the general area of the Project and to assist in scoping the field programs. The information was reviewed, along with information on aquatic habitats and wetlands present in the general area. Dillon completed a review of the following sources and data lists prior to completing the field assessments:

- Atlantic Canada Conservation Data Centre (AC CDC);
- Department of Fisheries and Oceans (DFO);
- New Brunswick Department of Energy and Resource Development (NBDERD);
- New Brunswick Department of the Environment and Local Government (NBDELG);
- The federal Species at Risk Registry;
- The provincial Species at Risk Registry;
- The Committee on the Status of Endangered Wildlife in Canada (COSEWIC);
- Publicly-available GIS map layers (e.g., ecological land classification, forest and non-forest inventory, draft beta wetland mapping inventory, Protected Natural Areas, and Wildlife Management Zones);

- High resolution aerial photography; and,
- GeoNB wetland and watercourse mapping.

In this report, we define "species at risk" (abbreviated SAR) as those species that are listed as "Extirpated", "Endangered", or "Threatened" on Schedule 1 of the federal *Species at Risk Act* (SARA) or the New Brunswick *Species at Risk Act* (NB SARA). We also define "species of conservation concern" (abbreviated SOCC) as those species that are not SAR but are listed in other parts of SARA, NB SARA, COSEWIC, or as regionally rare or endangered by the AC CDC.

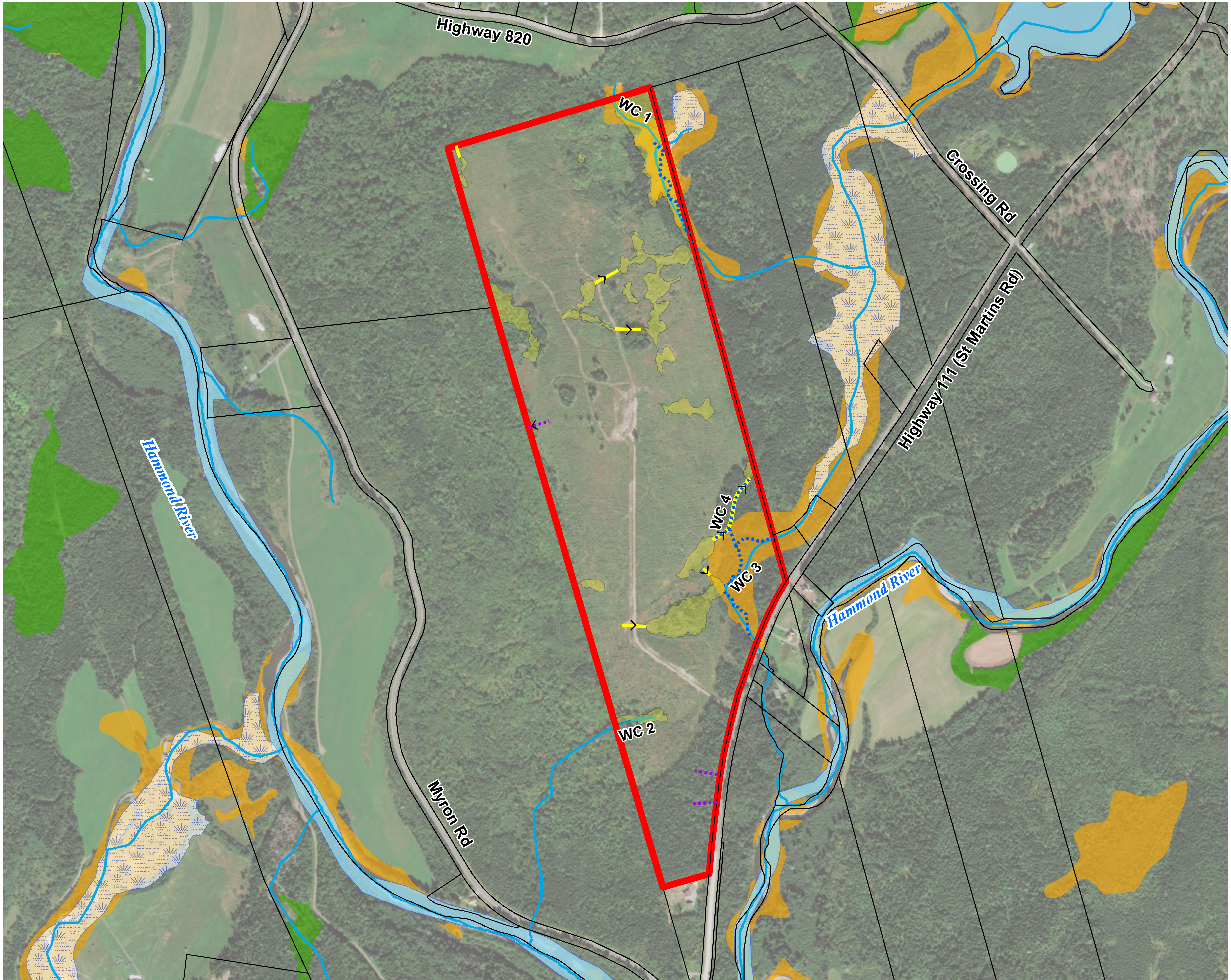
A custom Atlantic Canada Conservation Data Centre (AC CDC) (2018) data report (refer to **Appendix A**) was obtained for a 5 km radius around the PDA. According to the AC CDC records review, there is one record of aquatic SAR that has been historically observed within 5 km of the Project: the Atlantic salmon (*Salmo salar)* outer Bay of Fundy population is ranked as S2 (rare) by the AC CDC and is also listed as "Endangered" by COSEWIC but is not listed under SARA or NB SARA. In addition, the DFO aquatic species at risk mapping (DFO 2018) identified shortnose sturgeon (*Acipenser brevirostrum*) (listed as "Special Concern" under Schedule 1 of SARA) as potentially occurring within the Hammond River. Although there are no identified critical habitat or sightings of shortnose sturgeon in the Hammond River (a sub-drainage of the Kennebecasis River), the Kennebecasis River is known as an overwintering ground location (DFO 2018).

Additionally, there is one managed area, the Hanford Porters Brook Sandstone Beds ESA, within 5 km of the PDA. There were no other biologically significant, or designated Environmentally Significant Areas (ESA) or Protected Natural Areas (PNA) containing significant or unique aquatic habitats, identified within 5 km of the PDA.

The GeoNB watercourse mapping (1:10,000) database identified three small mapped watercourses that intersect the PDA (**Figure 5.4.1**). These small unnamed tributaries to the Hammond River are associated with wetland features on the Project site.

5.4.2.3 Field Assessment

A field assessment of fish and fish habitat in the PDA was conducted on August 29-30, 2018 by Dillon biologists experienced in conducting aquatic/fish habitat surveys. A member of Tobique First Nation (TFN) worked with Dillon's biologists during the field surveys to provide a traditional knowledge perspective. During the assessment, three mapped watercourses (identified as Watercourse 1 (WC1), WC2, and WC3) and one unmapped watercourse (WC4) were identified (**Figure 5.4.1**). Based on the knowledge of the member of TFN, the Project area did not offer unique aquatic habitat or contain fish species of special significance to traditional activities or uses. Traditional activities such as fishing and trapping that may occur within the Hammond River could continue in the area subsequent to the development of the proposed Project. The detailed methods and results for fish and fish habitat assessments of WC1 to WC4 are summarized in the following sections.



HAMMOND RIVER HOLDINGS LTD.
PROPOSED UPHAM EAST GYPSUM QUARRY

FISH HABITAT
FIGURE 5.4.1

PROPERTY BOUNDARY
PROJECT DEVELOPMENT AREA
GEO NB MAPPED WATERCOURSE
FIELD DELINEATED WETLANDS
FIELD IDENTIFIED DRAINAGE CHANNEL
FIELD IDENTIFIED WATERCOURSE
FIELD IDENTIFIED WETLAND DRAINAGE CONNECTION (WITH FLOW DIRECTION ARROW)
REGULATED WETLAND

NBDELG DRAFT BETA WETLAND MAPPING (UNREGULATED)

PROVINCIALLY SIGNIFICANT WETLANDS
INTERMEDIATE WETLANDS
FORESTED WETLANDS

WC = WATERCOURSE

0 50 100 200 m

SCALE 1:8,000

N W E S

MAP DRAWING INFORMATION:
DATA PROVIDED BY DILLON CONSULTING LIMITED, CANVEC
SERVICE LAYER CREDITS: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISS TOPO, OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

MAP CREATED BY: BQS
MAP REVISED BY: JH
MAP CHECKED BY: AS
MAP PROJECTION: NAD_1983_CSRS_New_Brunswick_Stereographic

FILE LOCATION: \\DILLON.CA\DILLON_DFS\FREDERICTON\FREDERICTON CAD\CAD\GIS\188346 UPHAM GYPSUM QUARRY\MXD

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PROJECT: 18-8346
STATUS: FINAL
DATE: OCT 2018

Fish Habitat Assessment

The aquatic habitat assessment was conducted using sampling protocol based on the NBDERD (formerly Department of Natural Resources [NBDNR]) and DFO standard aquatic assessment forms (Hooper et al. 1995) and the NBDNR Provincial Brook Trout Assessment Outline (NBDNR 2010). Fish habitat and aquatic features were assessed on all mapped and field-identified watercourses within the PDA. The assessment criteria included:

- **Description of aquatic habitat type:** Habitat types within each watercourse was described as riffle, run, pool or flat, where possible;
- **Dominant substrate type and embeddedness:** Dominant substrate types were described and documented by percent of relative abundance. Substrate type (e.g., gravel or silt) is especially important for fish spawning habitat;
- **Stream channel characteristics:** Stream channel characteristics including average wet width, approximate bankfull width, average wetted depth, and maximum wetted depth were measured in the field;
- **Instream cover and overhead canopy cover ratings:** Instream cover such as submerged woody debris, cobble, boulders, aquatic vegetation was documented, and overhead canopy cover ratings (percent covered by shrubs and trees) were scored;
- **Fish habitat suitability:** Habitat suitability for fish is assessed (based on the evaluation of habitat type, substrate type, instream cover, overhead cover and general observations of fish in the area);
- **Environmental Conditions and Water Level:** Environmental conditions (e.g., drier than normal seasonal conditions) were noted during the assessment and water level was rated as "low, moderate or high". Hotter and drier environmental conditions resulting in lower water levels will stress salmonid fish populations;
- **Riparian vegetation community:** The riparian vegetation community was described by percent trees, shrubs, grasses and bare ground; and,
- **Representative photos** (provided in **Table 5.4.1**) and Geographic Positioning System (GPS) points (using a handheld GPS unit and Arc Geographic Information Systems (ArcGIS) applications) were collected for each watercourse during the field assessments.

During the field assessment of fish and fish habitat conducted within the PDA, three mapped watercourses (WC1, WC2, and WC3) and one unmapped watercourse (WC4) were identified, as well as two small drainage connections between WL4 and WL5 (refer to **Section 5.5** for wetland descriptions). The Hammond River Angling Association (HRAA) has collected extensive water quality and fish and fish habitat data for the Hammond Rive over several years, and given that the Hammond River is located more than 100 m from the PDA and will not be directly affected by the Project, a field survey of the Hammond River was not considered to be required. It is noted that substantial historical data for the Hammond River are available from thee Hammond River Angling Association.

The results of the fish and fish habitat assessments are presented in the following sections and summarized in **Table 5.4.1**, below. For further details on the wetlands located within the PDA, refer to **Section 5.5**.

Table 5.4.1: Summary of Watercourse Characteristics

Watercourse ID	Representative Photo	Average Stream Dimensions (m)	Dominant Aquatic Habitat Type and Other Observations
WC1 – Unnamed (Mapped) Tributary to Hammond River		**Wet Width:** 1.44 m **Bankfull Width:** 2.7 m **Average Depth:** 0.17 m	Small watercourse with good run/pool (fish) habitat associated with WL3. Fish were observed during the field survey. **Dominant Substrate:** 10% Cobble, 60% Gravel, 20% Sand, 10% Silt
WC2 – No Defined Channel (though Mapped)		**Wet Width:** N/A **Bankfull Width:** N/A	**Fish Habitat Suitability:** Not fish habitat. Drainage area of field identified WL9 with no defined channel in the PDA.
WC3 – Unnamed (Mapped) Tributary to Hammond River		**Wet Width:** 1.8 m **Bankfull Width:** 2.96 m **Average Depth(s):** 0.13 m	**Fish Habitat Suitability:** A fish-bearing watercourse with run and pool habitats. Brook trout present. Drainage input from WL8, WL11, and WC4. **Dominant Substrate:** 65% Cobble, 25% Gravel, 10% Sand

Table 5.4.1: Summary of Watercourse Characteristics

Watercourse ID	Representative Photo	Average Stream Dimensions (m)	Dominant Aquatic Habitat Type and Other Observations
WC4 – Dry drainage channel (Unmapped)		**Wet Width:** 0.78 m **Bankfull Width:** 0.85 m **Average Depth(s):** N/A (dry at time of survey)	**Fish Habitat Suitability:** Intermittent stream/Wetland Drainage connected to WC3, WL11, and WL12. Not fish habitat (no fish observed at the time of survey). **Dominant Substrate:** 25% Cobble, 20% Gravel, 15% Sand, 40% Silt

Unnamed Tributary to Hammond River – Watercourse 1 (WC1) – WC1 is a mapped watercourse determined to be a small fish-bearing stream during the field survey, which flows through a GeoNB mapped wetland (WL3). The upstream reach of the watercourse near the northeast boundary of the PDA is in a former beaver impoundment, while the downstream reach consists of run/pool habitat in softwood dominant forest. The upper reach within the former beaver impoundment provides little overhead cover with the bank vegetation consisting of only grasses, but has moderate amount of submerged woody debris which provides instream cover for fish. The substrate in the upstream reach consisted of mostly fines, sand and small amounts of gravel. The downstream reach below the old beaver dam impoundment provides more overhead canopy cover for fish with shrubs and trees as the dominant bank vegetation, but has very little submerged woody debris for instream cover. The substrate in the downstream reach was dominated by gravel and sand with some cobble and fines. Fish (minnows) were observed during the assessment.

Unnamed Tributary to Hammond River (No Defined Channel) – Watercourse 2 (WC2) – WC2 is a mapped watercourse located in the southwest side of the PDA which was characterized during the field survey as a wetland drainage of field-identified wetland WL9. No defined channel or fish were observed during the field survey within the PDA.

Unnamed Tributary to Hammond River – Watercourse 3 (WC3) – WC3 is a small mapped fish-bearing stream located near the southeast boundary of the PDA. The mapped watercourse has an average wetted width of 1.8 m and bankfull width of 2.98 m. The surveyed portion of WC3 was approximately 300 m long and consisted mainly of run habitat with a few small pools. The dominant substrates were cobble (65%), gravel (25%), and sand (10%). Bank vegetation consisted of grasses (25%), shrubs (20%), and trees (5%), which provided a good amount of overhead canopy cover (approximately 41-70 %). Fish (brook trout and minnows) were observed during the field survey.

Field Identified (Unmapped) Dry Drainage Channel (Unnamed Tributary to WC3) – Watercourse 4 (WC4) – WC4 is a field-identified (unmapped) intermittent stream with a defined channel that was completely dry at the time of the survey. The drainage channel is connected to WL11, WL12, and WC3, and would likely contain water during spring melt and high runoff events. No fish were present at the time of the survey.

Fish Presence Assessment

Qualitative fish presence assessments using backpack electrofishing techniques were conducted in the mapped and field-identified (unmapped) watercourses within the PDA where potential fish habitat was present. Assessment methods were designed to collect a representative sample of the fish community by distributing assessment efforts between habitat types (i.e., riffle, pool, and undercut banks) within the assessed reach. A backpack electrofishing unit (Halltech HT2000) equipped with an 11-inch anode ring was used for the fish surveys, with two technicians to recover the fish using with dip nets. Unit settings ranged from 150 to 250 V and frequency of 40 to 60 Hz, depending on the conductivity of the watercourse and observed fish response. Fish presence surveys were completed in WC1 and WC3 on August 29 and 30, 2018, respectively. Electrofishing surveys of WC2 (no defined channel) and WC4 (dry at the time of the field survey) could not be conducted.

Based on the qualitative electrofishing surveys, fish species detected in WC1 included common white sucker (*Catostomus commersoni*), blacknose dace (*Rhinichthys atratulus*), and creek chub (*Semotilus atromaculatus*), which are typical species of warm (“cool”) water streams.

Fish species present in WC3 included brook trout (*Salvelinus fontinalis*), blacknose dace, creek chub, and common white sucker. Salmonids (such as brook trout and Atlantic salmon) are generally considered cooler (“cold”) water species, and prefer water with a higher dissolved oxygen (DO) level (associated with cooler water) when compared to slower moving and warmer bodies of water (CRI 2011).

There were no SOCC or SAR species observed during the field observations.

Water Quality Sampling and Analysis

Measurements of water quality parameters using a YSI Pro Plus water quality meter were obtained at WC1 and WC3 located within the PDA. WC2 was determined to have no defined channel or open water within the PDA, and WC4 was dry at the time of the field survey, thus water quality could not be determined. In-situ measurements were recorded for water temperature (°C), conductivity (µS/cm), dissolved oxygen (DO) (mg/L and %), total dissolved solids (TDS), and pH. Water clarity and water level were also characterized at each watercourse using a visual assessment.

In addition, water samples were collected from each of the identified watercourses and submitted to the Research and Productivity Council (RPC) laboratory in Fredericton, New Brunswick for analysis of the following parameters:

- General chemistry (including total organic carbon, turbidity, alkalinity, hardness, pH, nitrate and nitrite, total ammonia, sulphate, chloride, and fluoride); and,

- Trace metals (full metal scan, including: aluminum, cadmium, cobalt, copper, iron, nickel, lead, vanadium, zinc, and mercury).

The CCME has established environmental quality guidelines for contaminant concentrations in various environmental media, as established in its Canadian Environmental Quality Guidelines (CEQG) for the protection of freshwater aquatic life (FWAL) (CCME 1999). Relevant to aquatic life, the CEQGs for FWAL were used for comparison for laboratory water quality results.

The field measurement and analytical results for water quality of WC1 and WC3 are presented in **Table 5.4.2**. Based on the results of water quality measurements collected in WC1 and WC3, there were no exceedances of the CCME FWAL guidelines. High conductivity levels were observed in WC1 at the time of the field survey (refer to **Table 5.4.2**), which can likely be attributed to the close proximity of WC1 to the gypsum deposit. WC1 and WC3 had relatively warm temperatures, which would be expected in slow-flowing first order tributaries. Low DO levels and warmer temperatures observed in both WC1 and WC3 denotes that the water quality is less suitable for cold water fish species but is suitable for more tolerant species observed during the surveys (NBDELG 2012). The low DO values were below the CCME FWAL (early life stages require a DO of 9.5 mg/L) (CCME 1999), however, these conditions are typical in New Brunswick streams that contain abundant fish and diverse fish populations. It should be noted that water levels were low at the time of the surveys and dry, hot conditions were experienced throughout the region.

Table 5.4.2: Summary of In-situ and Laboratory Water Quality Results

Parameter	Units	CCME FWAL [1] (Long-Term)	Sample ID		
			WC1	WC3	Duplicate (WC3B)
General Chemistry					
Sodium	mg/L	NA	3.38	6.48	6.24
Potassium	mg/L	NA	0.47	0.65	0.62
Calcium	mg/L	NA	450	121	114
Ammonia (as N)	mg/L	41 [2]	<0.05	<0.05	<0.05
pH		6.5 - 9.0	7.3	7.6	7.5
Alkalinity (as $CaCO_3$)	mg/L	NA	64	56	56
Chloride	mg/L	120	4.3	10.8	9.3
Fluoride	mg/L	0.12	-	-	-
Sulphate	mg/L	NA	1,010	240	250
Nitrate + Nitrite (as N)	mg/L	NA	<0.25	0.12	0.12
o-Phosphate (as P)	mg/L	NA	<0.01	<0.01	<0.01
r-Silica (as SiO_2)	mg/L	NA	4.2	2.6	2.6
Carbon - Total Organic	mg/L	NA	3.9	7.3	7.5

Table 5.4.2: Summary of In-situ and Laboratory Water Quality Results

Parameter	Units	CCME FWAL [1] (Long-Term)	Sample ID		
			WC1	WC3	Duplicate (WC3B)
Turbidity	NTU	2	0.2	0.3	0.3
Conductivity	µS/cm	NA	1,720	625	625
Calculated Parameters					
Bicarbonate (as $CaCO_3$)	mg/L	NA	63.9	55.8	55.8
Carbonate (as $CaCO_3$)	mg/L	NA	0.12	0.209	0.166
Hydroxide (as $CaCO_3$)	mg/L	NA	0.01	0.02	0.016
Cation sum	meq/L	NA	22.8	6.47	6.1
Anion sum	meq/L	NA	22.4	6.43	6.59
Percent difference	%	NA	0.87	0.29	-3.9
Theoretical Conductivity	µS/cm	NA	2,140	687	680
Hardness (as $CaCO_3$)	mg/L	NA	1,130	308	290
Ion Sum	mg/L	NA	1,510	418	419
Saturation pH (5°C)	units	NA	7.4	7.9	7.9
Langelier Index (5°C)	units	NA	-0.07	-0.26	-0.38
Trace Metals					
Aluminum [2]	µg/L	100	16	14	14
Antimony	µg/L	NA	<0.1	<0.1	<0.1
Arsenic	µg/L	5	<1	<1	<1
Barium	µg/L	NA	66	33	31
Beryllium	µg/L	NA	<0.1	<0.1	<0.1
Bismuth	µg/L	NA	<1	<1	<1
Boron	µg/L	1,500	144	38	38
Cadmium	µg/L	0.09	0.02	<0.01	<0.01
Calcium	µg/L	NA	450,000	121,000	114,000
Chromium	µg/L	1	<1	<1	<1
Cobalt	µg/L	NA	<0.1	<0.1	<0.1
Copper	µg/L	2	1	<1	<1
Iron	µg/L	300	130	80	80
Lead	µg/L	1	<0.1	<0.1	<0.1
Lithium	µg/L	NA	0.7	0.3	0.3

Table 5.4.2: Summary of In-situ and Laboratory Water Quality Results

Parameter	Units	CCME FWAL [1] (Long-Term)	Sample ID		
			WC1	WC3	Duplicate (WC3B)
Magnesium	µg/L	NA	2,410	1,500	1,430
Manganese	µg/L	NA	55	37	39
Mercury	µg/L	0.026	<0.025	<0.025	<0.025
Molybdenum	µg/L	73	0.2	0.2	0.2
Nickel	µg/L	25	<1	<1	<1
Potassium	µg/L	NA	470	650	620
Rubidium	µg/L	NA	0.8	1.4	1.3
Selenium	µg/L	1	<1	<1	<1
Silver	µg/L	0.25	<0.1	<0.1	<0.1
Sodium	µg/L	NA	3,380	6,480	6,240
Strontium	µg/L	NA	1,780	431	412
Tellurium	µg/L	NA	<0.1	<0.1	<0.1
Thallium	µg/L	0.8	<0.1	<0.1	<0.1
Tin	µg/L	NA	<0.1	<0.1	<0.1
Uranium	µg/L	15	0.3	<0.1	<0.1
Vanadium	µg/L	NA	<1	<1	<1
Zinc	µg/L	7	1	<1	<1
In-situ water quality measurements					
Temperature	°C	NA	17.0	18.1	NA
pH		6.5 - 9.0	7.07	7.33	NA
Specific Conductivity	µS/cm	NA	1,689	620	NA
Total dissolved solids (TDS)	mg/L	NA	1,099	403	NA
Dissolved oxygen (DO)	mg/L	9.5	5.00	6.76	NA
Dissolved oxygen (DO)	%		53.8	71.5	NA
Water Clarity	"Poor, moderate, fair"	NA	Fair	Fair	NA
Water Level	"low, moderate, fair"	NA	Low	Low	NA

[1] CCME (1999)

[2] The guideline for ammonia is temperature and pH dependent.

[3] Guidelines for cadmium, copper, lead, and nickel are variable depending on water hardness. Guideline was calculated using lowest value of hardness of 6.3 mg/L.

A value in **bold** denotes an exceedance of the applicable CCME FWAL guideline.

NA indicates not available.

Concentrations of all parameters in the water samples met the CCME FWAL guidelines, where such guidelines exist.

5.4.3 Environmental Effects Assessment

The environmental effects of the Project on fish and fish habitat are assessed in this section.

5.4.3.1 Potential Effects

Without mitigation, the Project could interact with fish and fish habitat in the following ways:

- Construction activities have the potential to result in the direct loss of fish habitat in areas to be occupied by the open pit or other surface facilities and related flow diversions, with potential for direct mortality of fish in those affected watercourse segments;
- Construction and operation could also result in the indirect loss of fish habitat in areas where the presence of Project-related facilities cause a change in surface water availability (e.g., draining into the open pit), with potential for direct mortality of fish in those watercourse segments;
- Construction in the areas of the wetlands and watercourses will require removal of surface materials including vegetation and soils (i.e., topsoil and overburden) above the gypsum deposit. This could increase erosion rates or alter natural drainage patterns in proximity to the aquatic receptors;
- Storage of site runoff in the pit sump or settling ponds during operation may result in a change in surface water hydrology and a change In surface water levels in receiving waters from sequestering water in these features;
- Release of untreated surface water, or out of specification treated water, could result in a change in water quality in the receiving environment;
- Loss of wetland area or function(s) (such as hydrological regime, habitat and water quality maintenance) could occur due to clearing of trees and vegetation within the wetland(s) which may affect the quality and quantity of water to watercourses; and,
- A spill or fire could occur as an accident or unplanned event which could affect water quality and fish habitat.

5.4.3.2 Mitigation

The following standard mitigation measures have been identified to reduce the likelihood of occurrence, or minimize potential extent of effects of the Project on fish and fish habitat. Planned standard mitigation measures for the proposed project include the following:

- The area to be disturbed by the Project will be minimized to the extent possible to only that area which is required to accomplish the Project objectives;
- Design surface water drainage to minimize changes in drainage;

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- Potential installation and/or upgrades to watercourse crossings (culverts) will be designed as per the New Brunswick Watercourse and Wetland Alteration (WAWA) Guidelines (NBDELG 2012);
- Maintaining a 30 m buffer around watercourses and wetlands, or if not possible, obtaining a watercourse and wetland alteration (WAWA) permit for any alterations of watercourses and their 30 m buffers;
- Obtaining an authorization under Section 35(2) of the *Fisheries Act* for any Project activities that would result in the loss of fish habitat or other activities that result in serious harm to fish (as determined by DFO), with appropriate offsetting;
- Construction and operation activities will comply with the conditions of the WAWA permit and *Fisheries Act* authorization;
- Efforts will be made to maintain as much mature vegetation that remains along the edges of the site as possible, so as to act as a tree and watercourse/wetland buffer; in particular, existing treed buffers surrounding watercourses and wetlands located on the southeastern and southwestern portions of the PDA will be maintained to the extent possible;
- In watercourses where direct loss of fish habitat may occur, a fish rescue program will be implemented prior to undertaking construction activities, and fish will be removed and relocated as per DFO guidance and consultation;
- Implement a water management plan that incorporates measures aimed at retaining site water in a pit sump and settling pond to allow for settling of suspended sediments prior to release to the environment;
- Release of surface water from the Project site will target a total suspended sediment (TSS) concentration of less than 25 mg/L above background levels of the receiving watercourse and a pH of between 6.5 and 9.0, as a monthly average of grab samples;
- Implement requirements and limitations for blasting as outlined in the DFO *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998);
- Proper erosion and sediment control measures will be installed and checked regularly and prior to and after storm events to ensure they are continuing to operate properly to minimize potential effects to adjacent habitat; and,
- An emergency response plan (ERP) for accidental spills, emergencies, incidents or storm events will be completed and detailed in the Environmental Protection Plan (EPP), and the contractor will be required to provide spill response training to construction personnel.

5.4.3.3 Characterization of Residual Effects

The Project will result in the direct loss of the upper stretches of watercourse 1 (WC1) and watercourse 3 (WC3) that intersect the PDA, to allow for the construction of the open pit and related surface facilities to be located on the site. This is an unavoidable loss to accomplish the Project, which will occur during construction and persist through the life of the Project. The Project has been developed to minimize the area of disturbance of the PDA to that which is required to meet the Project objectives, maintaining treed buffers around wetlands and watercourses (except for WC1 in the open pit area, for which the portion of WC1 that is present in the PDA will be lost), to minimize the extent of fish habitat loss.

During operation, it is anticipated that additional indirect loss of, or alterations to watercourses could occur from localized changes in surface water hydrology arising from the reshaping of the Project site and the storage of runoff in the pit sump and settling pond. The localized changes to drainage patterns occurring on or adjacent to the PDA are expected to be small in magnitude (given the small size of WC1, WC3, and WC4), and given that the Hammond River is located more than 100 m from the nearest portion of the PDA, potential environmental effects to the Hammond River itself are not expected.

The direct and indirect loss of fish habitat that is deemed by DFO to result in serious harm to fish will be authorized under Section 35(2) of the *Fisheries Act* (with appropriate offsetting to achieve no net loss of fish productivity, as measured by habitat area) prior to beginning the Project. Additionally, a WAWA permit will be obtained for any alterations to, or loss of, watercourses or their 30 m buffers.

Without mitigation, construction activities and some operation activities (e.g., blasting) could result in injury or direct mortality of fish in nearby watercourses. The implementation of a fish rescue program prior to undertaking construction activities that could affect watercourses, and compliance with the DFO guidelines for the use of explosives near water (Wright and Hopky 1998), will reduce the potential for mortality to occur.

Activities during construction and operation could result in erosion of surficial soils and corresponding sedimentation of surface runoff that, unmitigated, could affect receiving water quality. The Project will be conducted in a manner that minimizes the potential for such effects to occur, including the use of properly designed, sized, and maintained erosion and sedimentation control structures to prevent such releases. These structures will be visually inspected prior to and following major precipitation events and following the spring freshet, and maintained accordingly to ensure their effectiveness. With these measures, and given that gypsum is inert, water quality is not expected to be adversely affected. The potential failure of erosion and sedimentation control devices is assessed as an accident, malfunction, or unplanned event in **Section 7.0**.

Storage of site runoff in the pit sump or settling ponds during operation may result in a localized change in surface water hydrology and a change in surface water levels in receiving waters arising from sequestering water in these features. However, given the large size of the watershed and the limited size of the PDA (with corresponding relatively small amount of water to be sequestered then released in comparison to the amount of water in the Hammond River and watershed), these effects are not expected to be measurable nor to affect fish and fish habitat.

The release of untreated surface water, or treated water that does not meet discharge standards, could result in a change in water quality in the receiving environment. The use of the water management features planned for the Project (i.e., pit sump, settling pond, perimeter ditches, and drainage channels) is intended specifically to reduce these potential effects on fish and fish habitat. The release of stored surface water from the Project site will target a total suspended sediment (TSS) concentration of less than 25 mg/L above background levels of the receiving watercourse and a pH of between 6.5 and 9.0, as a monthly average of grab samples, to minimize the environmental effects on water quality in receiving waters.

Other than a small quantity of emulsion explosives (a viscous liquid) stored on-site and the small amount of fuel contained in mobile equipment, there are no liquid wastes or hazardous materials planned to be stored on-site. Equipment refuelling will be conducted on a daily basis using fuel trucks that will refuel the equipment, then leave the site. Refuelling will be conducted a minimum of 30 m from a watercourse or wetland. As such, spills are not likely to occur for the Project as planned. Spills or releases of hazardous materials, in the unlikely event that they were to occur, would be an accident, malfunction, or unplanned event, and are assessed in **Section 7.0**.

5.4.4 Summary

In light of the above, and with authorization and offsetting measures as mitigation for direct loss of fish habitat, the relocation of fish from within the PDA, and the implementation of other mitigation measures aimed at reducing or minimizing environmental effects on fish and fish habitat, the residual environmental effects of the Project on fish and fish habitat during all phases are rated not significant, with a moderate level of confidence. The implementation of water management features, water quality monitoring, groundwater level monitoring, and other follow-up and monitoring measures to be implemented to monitor changes to water quality or water levels arising from the Project, with adaptive management measures implemented as necessary to address those changes, will improve the confidence of this prediction.

5.5 Vegetation and Wetlands

The potential environmental effects of the Project on vegetation and wetlands are assessed in this section.

5.5.1 Scope of VC

Wetlands are defined as land where the water table is at, near, or above the land's surface, or land which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophytic vegetation, and various kinds of biological activities adapted to the wet environment (NBDNRE-NBDELG 2002; NTNB 2018). Vegetation is included due to the potential for interactions with rare plants and Project activities, particularly species at risk (SAR) or species of conservation concern (SOCC) as identified as "extremely rare" (S1), "rare" (S2) or "uncommon" (S3), if they are present (AC CDC 2018) and/or pursuant to the federal *Species at Risk Act* (SARA) and the New Brunswick *Species At Risk Act* (NB SARA). Wetlands often support rare or uncommon species assemblages and New Brunswick Wetlands Conservation Policy and regulatory processes are guided towards the goal of achieving no net loss of wetland function (NBDNRE-NBDELG 2002).

Vegetation and wetlands were selected as a VC because of their relationship with water resources, wildlife and wildlife habitat, and other biological and physical components addressed as VCs in this EIA