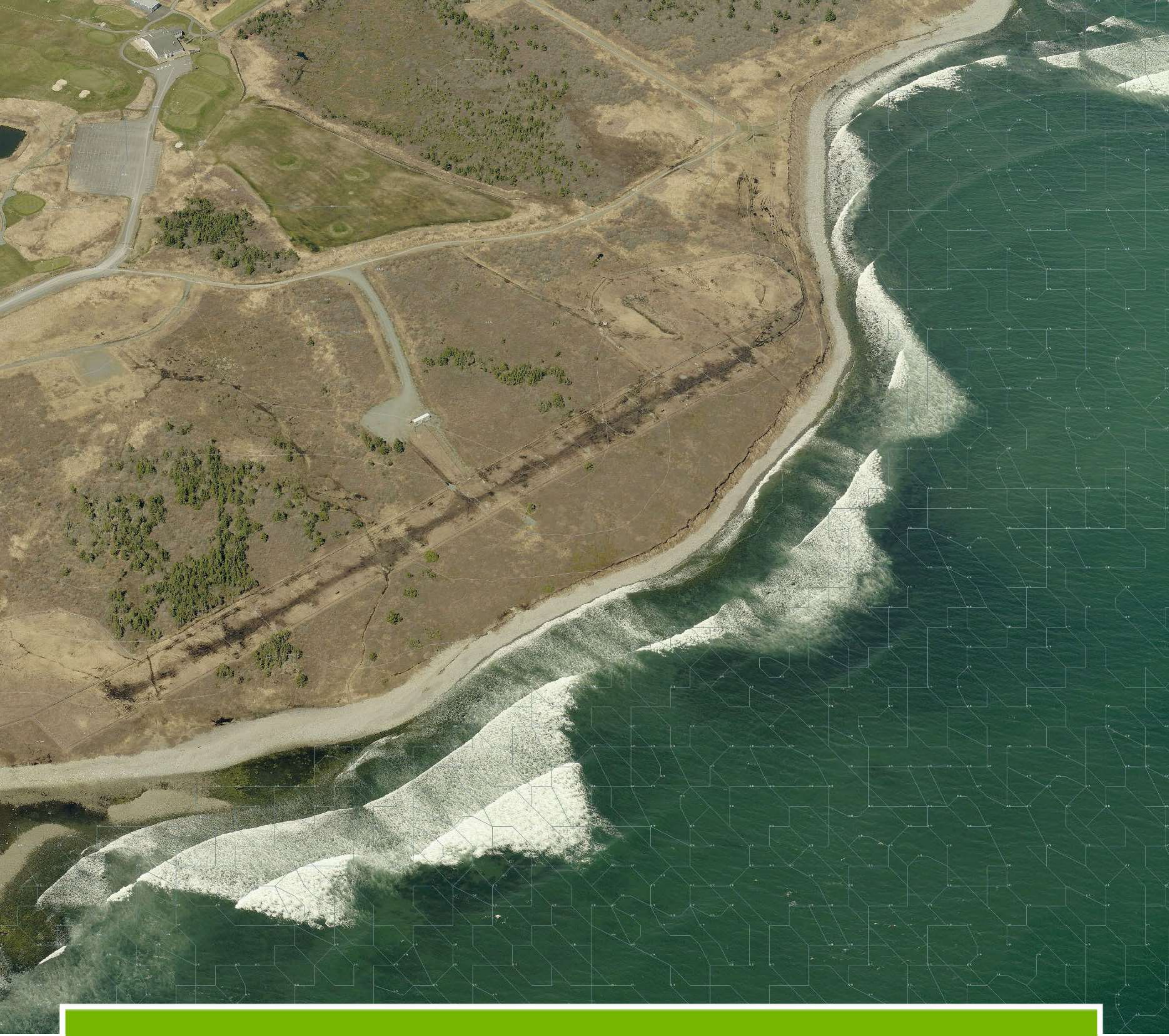

Assessment of Wetland Impacts and Wetland Compensation Options

Hartlen Point, Eastern Passage, NS

DCC Project No. IE036102_74469KN

Final Report

CBCL

211207.00 • March 2023

01	Final Report (Rev01)	L. Hardwick	03/22/2023	L. MacDonald
00	Final Report	L. Hardwick	03/19/2023	L. MacDonald
00	Draft Report	J. Bernier	11/08/2021	L. MacDonald
Issue or Revision		Reviewed By:	Date	Issued By:

CBCL

Report: 211207.00

March 22, 2023

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Dear Ms. Darrow and Mr. Bradley:

RE: Assessment of Potential Wetland Impacts and Identification of Wetland Compensation Options – Hartlen Point, Eastern Passage, NS – Final Report (DCC Project No. IE036102_74469 KN)

CBCL Limited (CBCL) is pleased to provide you with this Assessment of Potential Wetland Impacts and Identification of Wetland Compensation Options Final Report in connection with the proposed Land Based Test Facility at Hartlen Point, NS. This report is being submitted under the DCC Atlantic Environmental Source List for Natural Resources (AE16SLNR).

Should you have any questions or require clarification of any matter raised in this submission, please contact the undersigned at your convenience. We appreciate the opportunity to work with DCC/DND on this project.

Yours very truly,

CBCL Limited

Prepared by:
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Loretta Hardwick, M.Sc., B.Sc.H.
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Project No: 211207.00

Executive Summary

The Department of National Defence (DND) is proposing to construct a Land Based Test Facility (LBTF) at the Hartlen Point Canadian Forces Base property (Study Area) in Eastern Passage, NS (the Project). The Project Area for the proposed LBTF is located on a point near the eastern property boundary. The Project Area is approximately 62,468 m^2 and consists of the space that will be fenced off around the LBTF for operational and security purposes. The LBTF building itself will be approximately 11,500 m^2 within this fenced area.

The Project is anticipated to interact with one or more wetlands within the Study Area. The Government of Canada has established several objectives to conserve wetlands at the national level. These objectives are outlined in the Federal Policy on Wetland Conservation (FPWC; Government of Canada, 1991) and include the no net loss of wetland functions on federal lands. Avoidance, minimization, and compensation are ways in which the loss of wetland functions can be reduced or avoided.

CBCL Limited (CBCL) was engaged by Defence Construction Canada (DCC), on behalf of DND, to assess potential adverse impacts to wetlands that may occur as a result of the proposed Project. CBCL was also tasked with determining whether the identified impacts to wetlands can be avoided or minimized and, if not, to identify two conceptual onsite compensation options within the Study Area. Information required to fulfill these objectives was collected through a combination of desktop and field studies.

CBCL determined that approximately 0.15 ha within three wetlands (HP-2, HP-5, and HP-6) would be directly altered as a result of the Project and identified four preliminary conceptual compensation options. The proposed options were submitted to, and reviewed by, DCC/DND and the Canadian Wildlife Service (CWS), a division of Environment and Climate Change Canada (ECCC) responsible for overseeing wetland management and conservation on federal lands. Through consultation with CWS, one preliminary concept was selected as an adequate compensation option and was explored further by CBCL. The compensation option entailed the restoration of hydrologic connectivity between two wetlands that were presumably connected in the past but have since been bisected by a gravel access road.

CBCL completed a hydrologic and hydraulic analysis to further assess the proposed compensation option and to calculate the size of two culverts proposed for installation along the gravel access road. Culvert sizing was calculated for two options, and a Class D level cost estimate was developed for the installation of the culverts for each option. A wetland monitoring plan was also developed based on scheduling typically recommended by CWS. This option is based on the assumption that the existing road remains in place. Should the road be decommissioned and removed, this could both restore hydrologic connectivity and provide wetland habitat.

Contents

Appendices

Tables

Figures

Acronyms

AC CDC	Atlantic Canada Conservation Data Centre
CBCL	CBCL Limited
CCG	Canadian Coast Guard
CHI	Computational Hydraulics International
CS	Carbon Sequestration
CSC	Canadian Surface Combatant
CWS	Canadian Wildlife Service
DCC	Defence Construction Canada
DEM	Digital Elevation Model
DND	Department of National Defence
ECCC	Environment and Climate Change Canada
ELP	East Low Point
EMP	Environmental Management Plan
ERIS	Environmental Risk Information Services
FA	Anadromous Fish Habitat
FPWC	Federal Policy on Wetland Conservation
FR	Resident Fish Habitat
GCM	Global Climate Models
GIS	Geographic Information Systems
GPS	Global Positioning System
HRM	Halifax Regional Municipality
IDF	Intensity, Duration and Frequency
INV	Aquatic Invertebrate Habitat
LBTF	Land Based Test Facility
LiDAR	Light Detection and Ranging
MARLANT	Maritime Forces Atlantic
NR	Nitrate Removal & Retention
NS	Nova Scotia
NSE	Nova Scotia Environment
OE	Organic Nutrient Export
PCSWMM	Personal Computer Storm Water Management Model
PR	Phosphorus Retention
RCN	Royal Canadian Navy
SAR	Species at Risk
SFS	Stream Flow Support
SoCC	Species of Conservation Concern
SR	Sediment Retention & Stabilization
SWMM	Storm Water Management Model
WC	Water Cooling

WESP-AC	Wetland Ecosystems Services Protocol for Atlantic Canada
WLP	West Low Point
WS	Water Storage & Delay

1 Introduction

1.1 Introduction

CBCL was contracted by Defence Construction Canada (DCC), on behalf of the Department of National Defence (DND), to assess the wetland impacts anticipated from the proposed construction of a Land Based Test Facility (LBTF) at Hartlen Point in Eastern Passage, Nova Scotia (NS) and to identify onsite wetland compensation options (the Study). This work was completed in accordance with the DCC Atlantic Environmental Source List for Natural Resources (AE16SLNR).

1.2 Project Background

The Royal Canadian Navy (RCN) has committed to replacing ships in its existing federal fleet with Canadian Surface Combatant (CSC) ships. DND is proposing to construct an LBTF at the Hartlen Point Canadian Forces Base (the Project) in support of the CSC Program and the Land Based Test Capability Strategy. The LBTF will be constructed to simulate an operational CSC configuration, will meet specific security requirements, and will be equipped with the ship systems. The LBTF will be a two-story steel and concrete building with an approximate area of 11,500 square metres (m^2). Associated site infrastructure is anticipated to include paved vehicle parking and security fencing surrounding the facility.

In addition to the construction of the LBTF building, the Project will entail the widening of an existing gravel access road to a 6.0 m wide, two-lane paved road. A portion of this road will be realigned. Road upgrades will accommodate site access and the extension of infrastructure for municipal services to the facility.

1.3 Project Location and Site Overview

The Hartlen Point Canadian Forces Base property is located in the community of Eastern Passage within the larger Halifax Regional Municipality (HRM), NS (Figure 1.1). The Project Area for the proposed LBTF is located on a point near the eastern property boundary and is bordered by the golf course to the north, the Canadian Coast Guard (CCG) communications facilities to the west, and the Halifax Harbour/Atlantic Ocean to the northeast and southeast. The Project Area is approximately 62,468 m^2 and consists of the space that will be fenced off around the LBTF for operational and security purposes; the LBTF building itself will be approximately 11,500 m^2 within this fenced area (Figure 1.1). Coordinates for the centre point of the proposed LBTF building are 464771 m northing and 4938265 m easting (NAD82 UTM Zone 20T).

The Hartlen Point property (CBCL Study Area) covers approximately 154 ha and is situated on a point at the mouth of the Halifax Harbour, approximately 7 kilometres (km) southeast of the 12 Wing Shearwater Royal Canadian Air Force base. The site includes antenna facilities and a golf course. Originally developed as a coastal defence site in 1940, Hartlen Point was used for military purposes until the mid-1950s. It was then redeveloped as a golf course in 1962.

1.4 Study Rationale and Objectives

There are several wetlands on the Hartlen Point property, and the proposed Project is anticipated to interact with three wetlands (HP-2, HP-5, and HP-6). The Federal Government has committed to conserving wetlands through the development of several goals outlined in the Federal Policy on Wetland Conservation (FPWC; Government of Canada, 1991), among which includes the goal of no net loss of wetland functions on federal lands and waters. The Canadian Wildlife Service (CWS), a division of Environment and Climate Change Canada (ECCC), is responsible for reviewing projects that are anticipated to interact with wetlands on federal lands for compliance with the FPWC. To avoid the net loss of wetland functions, CWS has considered the following hierarchical mitigation sequence: avoidance, minimization, and, as a last resort, compensation.

In order to determine the potential impacts that the Project may have on wetlands on the Hartlen Point property, and what measures to implement in order to avoid, minimize, and/or compensate for the loss of wetland functions as a result of the Project, the following main objectives were completed for this study:

- Review background information and identify data gaps.
- Conduct site visits to evaluate existing conditions on the Hartlen Point site.
- Identify potential impacts to wetlands from the proposed construction activities.
- Determine whether avoidance of wetland impacts are possible and, if not, indicate why.
- Identify mitigation measures or options to reduce, minimize, or eliminate the anticipated effects on wetland functions.
- Provide two options for onsite compensation (preferably restoration and enhancement).
- Provide an order of magnitude level opinion of probable cost to complete each compensation option.
- Develop a monitoring plan for the selected compensation option.

LEGEND

DCC Site Boundary

Project Components (Feb 23, 2023)

Fenceline

Facility / Building Footprint

Hartlen Point
Wetland Impact Assessment
and Compensation Options

Project Location

DATE: 2023-03-20	PROJ N°: 211207.00	FIGURE: **1.1**
DRAWN BY: SF	CHECKED BY: LM	APPROVED: JB

NOTES:

0 2,500 5,000 10,000 m

SCALE: 1:200,000 Coordinate System: NAD 1983 UTM Zone 20N Units: Meter

Document Path: Y:\Halifax\Data\Projects\211207.00 Hartlen Point Wetland Impact Assessment and Compensation Options\44 CAD\08 GIS\PROJ\211207.00_HARTLENPOINT_OWLSURVEY.aprx - sfowlkes - 20/Mar/2023

2 Evaluation of Wetland Conditions

2.1 Methodology

The first phase of the study entailed gathering information on wetland and overall habitat conditions on site by completing a desktop review of available data sources and reconnaissance-level surveys of the Study Area. Information gathered during these exercises was used to determine whether additional information or surveys would be required to fulfill the objectives of this study. Further information on what each of these tasks entailed is provided in Sections 2.1.1 and 2.1.2.

2.1.1 Desktop Review

CBCL reviewed available data sources prior to conducting field work in order to collect preliminary information on the Hartlen Point site, including the number, location, size, type, and ecological functions of wetlands within the Study Area. This information was gathered from the following sources:

- Previous site-specific reports
    - Dillon Consulting Limited (2006). Inventory/Evaluation of Aquatic Habitat on Selected MARLANT Properties. Final Report.
    - Dillon Consulting Limited (2009). Inventory of Breeding/Migratory Birds, Plant Species and Wetland Habitat/Functional Assessment for Proposed High Frequency Surface Wave Radar Hartlen Point - HX070604 – Final Report.
    - Dillon Consulting Limited (2010). Natural Resource Management Plan, Hartlen Point Property – Final.
    - WSP (2018). Natural Resource Management Plan, Hartlen Point.
    - Stantec (2020a). Geotechnical Letter Report – Proposed Development, Hartlen Point, Shearwater, NS.
    - Stantec (2020b). Final Concept Report. Irving Shipbuilding Inc- Land Based Test Capability.
- Site-specific GIS data provided by DCC/DND
- LiDAR
- Pictometry oblique imagery
- Recent satellite and aerial imagery via Google Earth Pro
- Historical aerial imagery from Environmental Risk Information Services (ERIS) and the NS Geomatics Centre Geographic Information Services

2.1.2 Site Visit

CBCL completed a reconnaissance-level survey on March 8, 2021. The purpose of the survey was to gain a better understanding of wetland and overall habitat conditions on site. Wetlands delineated by WSP in 2017 were visited and assessed for evidence of disturbance or anthropogenic impacts that could potentially be reversed. Areas of wetland that had not been previously reported were georeferenced, when found. Wetland classifications identified by WSP (2018) were reviewed based on the categories outlined in the Canadian Wetland Classification System (National Wetlands Working Group, 1997).

On May 17, 2021, CBCL completed a second site visit to refine the wetland boundaries for HP-2 and evaluate wetland conditions nearer the appropriate seasonal window (generally June 1 to September 30). CWS confirmed that wetland delineation in mid-May is acceptable given the spring phenology in 2021. Ground-level delineation of wetland habitat within the proposed Project footprint was performed as per the protocols outlined in the US Army Corps of Engineers Wetland Delineation Manual (Environmental Laboratory, 1987). The wetland boundary was delineated based on the presence of three wetland parameters: hydrophytic vegetation; hydric soils; and wetland hydrology. The wetland boundary was georeferenced using a hand-held global positioning system (GPS) with 3 to 5 m accuracy. The locations of wetland inflows, outflows, invasive species, and site features that could affect hydrology (e.g., culverts, watercourses) of wetlands were also georeferenced.

During the May 2021 site visit, CBCL also conducted surveys in HP-2, when in suitable habitat, for vascular plant species of conservation concern (SoCC) previously recorded by WSP (2018) in wetlands on site. These SoCC included Satiny Willow (*Salix pellita*) and Seabeach Ragwort (*Senecio pseudoarnica*).

A third site visit was completed on October 7, 2021, to collect further information on topography, elevations along the gravel access road, and hydrologic conditions of wetlands HP-5 and HP-6.

2.1.3 Identification of Data Gaps

Information collected during the previous environmental studies conducted at Hartlen Point and the site visits completed by CBCL in 2021 was reviewed in order to identify data gaps and determine whether additional information was needed to fulfill the study objectives.

2.2 Results

2.2.1 Desktop Review

2.2.1.1 Wetland Classification, Size, and Location

A total of 17 wetlands were identified and delineated in the Study Area during previous studies. The classification, size (ha), and coordinates for each wetland, as previously reported by others, are summarized in Table 2.1.

Table 2.1: Wetlands Previously Identified on the Hartlen Point Property.

Wetland ID	Type	Size	Coordinates at Wetland Centre (UTM)	
			EASTING	NORTHING
HP-1	Basin Bog	11.08	464225.6909	4938528.792
HP-2	Tidal Bay Marsh Complex	6.52	464712.9237	4938631.051
HP-3	Tall Shrub Swamp	1.04 (onsite)*	463807.6331	4938423.526
HP-4	Treed Forested Swamp	1.78 (onsite)*	464210.6528	4938973.918
HP-5	Basin Bog	3.84	464523.4443	4938080.658
HP-6	Slope Marsh	2.17 (+0.53 ha)**	464706.9085	4937939.3
HP-7A	Bog Wetland Pocket	0.05	464362.6238	4937741.314
HP-7B	Bog Wetland Pocket	0.06	464424.5364	4937676.226
HP-7C	Bog Wetland Pocket	0.24	464370.5613	4937503.189
HP-7D	Bog Wetland Pocket	0.211	464191.9672	4937469.057
HP-8	Basin Marsh	0.60	464699.9682	4939151.811
HP-9A	Slope Marsh	2.65	463973.9501	4937873.341
HP-9B	Slope Marsh	0.60	463597.1827	4938159.092
HP-10	Bog Wetland Pocket	0.02	464650.5494	4937729.933
HP11	Bog Wetland Pocket	0.05	464616.5768	4937714.376
HP12	Bog Wetland Pocket	0.04	464414.7468	4937759.041
HP13	Bog Wetland Pocket	0.03	464483.0095	4937598.703

*Area does not include the portion of the wetland that extends beyond the property boundary.
**WSP (2018) reported an area of 2.17 ha for HP-6. HP-6 also contains an additional 0.53 ha within a fenced area that was not previously reported.

2.2.1.2 Wetland Functions

In 2017, WSP functionally assessed the wetlands they delineated using the Adamus (2016) Wetland Ecosystems Services Protocol for Atlantic Canada (WESP-AC) Version 1.1 (WSP, 2018). The non-tidal WESP-AC was used to assess HP-5, HP-6, and the non-tidal portion of HP-2. The tidal version was used to assess wetland functions for the salt marsh component of HP-2. Since the tidal portion of HP-2 is not anticipated to be impacted by the Project, only WESP-AC functions scores for HP-5, HP-6, and the non-tidal portion of HP-2 are summarized in Table 2.2.

Table 2.2: WESP-AC Ratings for Non-tidal Wetlands (WSP, 2018)

Functions	Definition	Potential Benefit	Wetland Function Ratings		
			HP-2 (Shrub Swamp Portion)	HP-5 (Basin Bog)	HP-6 (Slope Marsh)
Hydrologic Functions					
Water Storage & Delay (WS)	The effectiveness for storing runoff or delaying the downslope movement of surface water for long or short periods.	Flood control and maintaining ecological systems.	Moderate	Higher	Moderate
Stream Flow Support (SFS)	The effectiveness for contributing water to streams, especially during the driest part of a growing season.	Supporting fish and other aquatic life.	Lower	Lower	Lower
Water Quality Maintenance Functions					
Water Cooling (WC)	The effectiveness for maintaining or reducing temperature of downslope waters.	Supporting cold water fish and other aquatic life.	Lower	Lower	Lower
Sediment Retention & Stabilization (SR)	The effectiveness for intercepting and filtering suspended inorganic sediments thus allowing their deposition; reducing current velocity; resisting erosion; and stabilising underlying sediments or soil.	Maintaining quality of receiving waters and protecting shoreline structures from erosion.	Higher	Higher	Higher
Phosphorus Retention (PR)	The effectiveness for retaining phosphorus for long periods (>1 growing season).	Maintaining quality of receiving waters.	Moderate	Moderate	Higher
Nitrate Removal & Retention (NR)	The effectiveness for retaining particulate nitrate and converting soluble nitrate and ammonium to nitrogen gas while generating little or no nitrous oxide (a potent greenhouse gas).	Maintaining quality of receiving waters.	Moderate	Higher	Higher

Table 2.2: WESP-AC Ratings for Non-tidal Wetlands (WSP, 2018)

Functions	Definition	Potential Benefit	Wetland Function Ratings		
			HP-2 (Shrub Swamp Portion)	HP-5 (Basin Bog)	HP-6 (Slope Marsh)
Carbon Sequestration (CS)	The effectiveness of a wetland both for retaining incoming particulate and dissolved carbon, and converting carbon dioxide gas to organic matter (particulate or dissolved) through photosynthesis. The effectiveness to then retain that organic matter on a net annual basis for long periods while emitting little or no methane (a potent "greenhouse gas").	Maintaining quality of receiving waters.	Higher	Higher	Lower
Organic Nutrient Export (OE)	The effectiveness for producing and subsequently exporting organic nutrients (mainly carbon), either particulate or dissolved. It does not include exports of carbon in gaseous form or as animal matter.	Supporting food chains in receiving waters.	Higher	Lower	Lower
Ecological (Habitat) Functions					
Anadromous Fish Habitat (FA)	The capacity to support an abundance and diversity of native anadromous fish for functions other than spawning.	Supporting recreational and ecological values.	Lower	Lower	Lower
Resident Fish Habitat (FR)	The capacity to support an abundance and diversity of native non-anadromous fish.	Supporting recreational and ecological values.	Lower	Lower	Lower
Aquatic Invertebrate Habitat (INV)	The capacity to support an abundance and diversity of invertebrate animals which spend all or part of their life cycle underwater, on the water service, or in moist soil.	Supporting salmon and other aquatic life; and maintaining regional biodiversity.	Higher	Higher	Moderate

Table 2.2: WESP-AC Ratings for Non-tidal Wetlands (WSP, 2018)

Functions	Definition	Potential Benefit	Wetland Function Ratings		
			HP-2 (Shrub Swamp Portion)	HP-5 (Basin Bog)	HP-6 (Slope Marsh)
Amphibian & Turtle Habitat (AM)	The capacity to support or contribute to an abundance and diversity of native amphibians (e.g., frogs, toads, salamanders) and turtles.	Maintaining regional biodiversity.	Moderate	Lower	Moderate
Waterbird Feeding Habitat (WBF)	The capacity to support an abundance and diversity of waterbirds that migrate or winter but do not breed in the region.	Supporting hunting and ecological values; and maintaining regional biodiversity.	Lower	Lower	Moderate
Waterbird Nesting Habitat (WBN)	The capacity to support an abundance and diversity of waterbirds that nest in the region.	Maintaining regional biodiversity.	Lower	Lower	Moderate
Songbird, Raptor, & Mammal Habitat (SBM)	The capacity to support an abundance and diversity of native songbird, raptor, and mammal species and functional groups, especially those that are most dependent on wetlands or water.	Maintaining regional biodiversity.	Moderate	Moderate	Higher
Pollinator Habitat (POL)	The capacity to support a diversity of native vascular and non-vascular species and functional groups, especially those that are most dependent on wetlands and water.	Maintaining regional biodiversity and food chains.	Moderate	Moderate	Higher
Native Plant Habitat (PH)	The capacity to support pollinating insects and birds.	Maintaining regional biodiversity and food chains.	Higher	Higher	Moderate

2.2.2 Site Visit

The locations of wetlands on site reported by Dillon (2009, 2010), WSP (2018), as well as those confirmed within or near the Project footprint by CBCL in 2021, are mapped in Figure 2.1.

Wetland classifications and boundaries were confirmed by CBCL in 2021 to be generally consistent with those reported by WSP (2018), with the exception of HP-2. CBCL noted a discrepancy in wetland boundaries during the March 2021 site visit in that the salt marsh portion appeared to be larger and the shrub swamp portion smaller than previously mapped by WSP (2018). As a result of this finding, CBCL re-delineated the boundary of HP-2 in May of 2021. The area for HP-2 was recalculated and found to cover approximately 4 ha in area (Figure 2.1), approximately 2 ha smaller than reported by WSP (2018). The smaller area is attributed to a portion of HP-2 that was classified as a tall shrub swamp by WSP (2018) but was determined to be a cobble beach by CBCL in 2021. The revised wetland boundaries for HP-2 are mapped in Figure 2.1.

Several small pocket wetlands identified by Dillon in 2008 (Dillon, 2009), but not reported by WSP (2018), were confirmed to be wetland habitat by CBCL during the site reconnaissance survey conducted in 2021. These pocket wetlands are mapped in Figure 2.1.

CBCL noted during the background review and site visit that HP-1, the large bog located in the centre of the property, does not appear to have previously been delineated in the field. However, the mapped boundaries (see Appendix A – Figure 2) appear to be consistent with the conditions observed during the 2021 site visit.

Several previously unidentified small wetland areas were noted by CBCL during the site reconnaissance. These areas were mostly small vernal pools and cattail ponds. The locations of these areas are shown in Figure 2.1.

2.2.2.1 Description of HP-2

HP-2 is a wetland complex with both tidal and non-tidal components that has developed in and around Hartlen Cove (Figure 2.1). In 2021, CBCL determined that HP-2 covers approximately 4 ha in area. The coastal marsh component, which covers approximately 2.5 ha, grades into an approximately 1.5 ha non-tidal, tall shrub swamp as the elevation increases.

The tidal portion of HP-2 is a salt marsh that has developed within Hartlen Cove (Appendix A, Photo 1). The salt marsh, which is larger than mapped by WSP (2018), forms a narrow fringe along the north coast of Harlen Cove. The mouth to Hartlen Cove is situated on a very exposed coastline, and the smaller size noted by WSP (2018) may have been a result of storm damage, from which it has since been recovering.

The vascular plant community observed within the salt marsh was fairly typical of small Nova Scotia salt marshes and was dominated by Smooth Cordgrass (*Sporobolus alterniflorus*) in the lower marsh and Saltmeadow Cordgrass (*Sporobolus pumilus*) in the higher marsh. Other common salt marsh species observed during the early season surveys in 2021 and/or reported by WSP (2018) included Seaside Goldenrod (*Solidago sempervirens*), Black Grass Rush (*Juncus gerardii*), Baltic rush (*Juncus balticus),* Sea Glasswort (*Salicornia maritima*), and Common Silverweed (*Potentilla anserina*). An area dominated by Narrow-leaved Cattail (*Typha angustifolia*) with some Freshwater Cordgrass (*Sporobolus michauxianus*) was present between the salt marsh and tall shrub swamp. No shrubs or trees were observed within the tidal portion of HP-2.

The tall shrub swamp component of HP-2 occurs inland of the salt marsh and extends around the western shore of Hartlen Cove. The tall shrub swamp was determined in 2021 to cover approximately 1.5 ha in area, of which 0.091 ha occurs within the proposed Project footprint. A few areas of standing water were observed within this portion of HP-2, as depicted in Appendix B, Photo 2. Species noted included shrubs such as Meadowsweet (*Spiraea alba*), Speckled Alder (*Alnus incana*), Serviceberry *(Amelanchier laevis*, sp.), Grey Birch (*Betula populifolia*), and Red Maple (*Acer rubrum*). A few trees were present, mainly White Spruce (*Picea glauca*) and Red Maple. Ground vegetation included Marsh Straw Sedge (*Carex hormathodes*), Spotted Touch-me-not (*Impatiens capensis*), as well as several grasses and sedges (*Carex* spp.) that were not yet identifiable due to the survey timing.

Wetland HP-2 was reported by WSP (2018) to support two plant SoCC: Satiny Willow and Seabeach Ragwort. CBCL did not observe Satiny Willow during the 2021 field survey. CBCL did observe Seabeach Ragwort along the shore but not within the boundaries of HP-2.

2.2.2.2 Description of HP-5

HP-5 is a basin bog situated north of the access road (Figure 2.1) and covers an area of 3.84 ha. This wetland appears to receive runoff from the surrounding uplands and drains, at times, over the gravel access road and downstream into HP-6, particularly during periods of high rainfall events (Appendix B, Photo 3).

HP-5 is dominated by low shrubby ericaceous vegetation. Few trees were present and those that were present included scattered Black Spruce (*Picea mariana*) and Eastern Larch (*Larix laricina*). Frequently occurring species observed in HP-5 included Leatherleaf (*Chamaehaphne calyculata*), Dwarf Huckleberry (*Gaylussacic begeloviana*), Sweet Gale (*Myrica gale)*, Rhodora (*Rhododendron canadense*), Labrador Tea (*Ledum groenlandicum*), and Lambkill (*Kalmia angustifolia*).

Herbaceous vegetation noted in HP-5 by CBCL included Tussock Cottongrass (*Eriophorum vaginatum*), Northern Pitcher Plant (*Sarracenia purpurea*), and Smooth Rush (*Juncus effusus*). WSP (2018) also reported Northern Bog Goldenrod (*Soligao uliginoisa*), Bog Aster (*Oclemena nemoralis*), and White Beakrush (*Rhychospora alba*), which would be expected in this habitat type but were not yet sufficiently developed to be identifiable in May of 2021. Sphagnum moss and surface water were abundant in HP-5 during the 2021 site visits.

2.2.2.3 Description of HP-6

HP-6 is a slope marsh that drains to the shore along the eastern property boundary and into the Atlantic Ocean. WSP (2018) noted that HP-6 is approximately 2.17 ha in area, although this area includes only the portion of the wetland that was accessible and delineated. Using aerial imagery, CBCL estimated that HP-6 contains an additional 0.53 ha that is fenced in and, subsequently, inaccessible. HP-6 is dominated by grass species, which were not identifiable to species during site visits conducted in March and May 2021 (Appendix A, Photo 4). Small amounts of Speckled Alder were observed in HP-6 in 2021. CBCL also noted a strip of invasive Japanese Knotweed (*Reynoutria japonica*) bordering the edge of HP-6 and the south side of the gravel access road (Appendix B, Photo 4). In 2017, WSP also observed Swamp Candle (*Lysimachia terrestris*) and noted that grasses, specifically Redtop (*Agrostis gigantea*), dominated HP-6 (WSP, 2018).

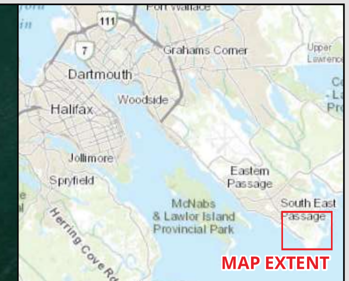
2.2.3 Identification of Data Gaps

The wetland assessments conducted by WSP (2018) identified more wetland habitat than was previously identified by Dillon (2009), particularly within the tidal and non-tidal portions of HP-2. CBCL noted some discrepancies between the WSP (2018) mapped boundary of HP-2 and that observed in the field during the site visit conducted in March 2021. Since this discrepancy would influence the total wetland area of HP-2 needed for the current study, CBCL re-delineated HP-2 boundaries in May of 2021.

CBCL also noted that the full area of HP-6 is not available, as a portion of this wetland falls within a fenced area that is inaccessible and, therefore, could not be delineated by previous consultants. WSP (2018) reported the area for only the portion that they were able to delineate. CBCL estimated the entire size of HP-6 via aerial imagery and the WSP (2018) delineation results.

CBCL noted several additional discrepancies or data gaps during the literature review, although none impacted the objectives of the current study. Several small pocket wetlands reported by Dillon (2009) were not reported by WSP (2018). Two of these pocket wetlands were visited by CBCL during the March 2021 reconnaissance-level survey and confirmed to support wetland vegetation. Additionally, the boundaries of Wetland HP-1 have not been reassessed since initially mapped by Dillon (2006), presumably using aerial imagery.

In reviewing the functional assessment results reported by WSP (2018), CBCL noted that Wetland HP-9a and HP-9b were listed as Wetlands HP-7e and HP-7 in the report.



Project Components (Feb 23, 2023)

- Paved Surface
- Fenceline
- Facility / Building Footprint
- Study Area
- Existing Access Road
- Approximate Fence Location
- DND Site Boundary

Wetland Type (CBCL Field Delineated 2021)

- Salt Marsh
- Tall Shrub Swamp

Wetland Type (WSP Field Delineated, 2018)

- Basin Bog
- Forested Swamp
- Slope Marsh
- Small Bog Pockets
- Tall Shrub Swamp

Wetland Type (DCC 2006)

- Basin Bog

WSP Field Delineated Watercourse

CBCL

Hartlen Point
Wetland Impact Assessment and Compensation Options

Wetland Mapping

DATE: 2023-03-20	PROJ N°: 211207	FIGURE: **2.1**
DRAWN BY: SF	CHECKED BY: LM	APPROVED: JB

NOTES:

0 95 190 380 m

SCALE: 1:7,350 Coordinate System: NAD 1983 UTM Zone 20N Units: Meter

Document Path: Y:\Halifax\Data\Projects\211207.00 Hartlen Point Wetland Impact Assessment and Compensation Options\44 CAD\08 GIS\PRO\211207.00 HARTLENPOINT_OWLSURVEY.aprx - sfewkes - 20/Mar/2023

3 Wetland Impacts and Mitigation

3.1 Methodology

3.1.1 Identification of Wetland Impacts

CBCL used information collected during the desktop review and reconnaissance-level surveys conducted by CBCL in 2021 to identify potential adverse impacts to wetlands as a result of the proposed Project. This included information on wetlands provided in Chapter 2 as well as the location of the Project Area and associated infrastructure (see Figures 1.1and 2.1). Specifically, the total area of wetlands that overlap the proposed Project footprint, the important ecological functions that these wetlands provide, and potential direct and indirect impacts to these wetlands were identified. The area directly affected within the Project footprint was estimated quantitatively. The potential loss or alteration of wetland function was assessed qualitatively.

3.1.2 Mitigation of Wetland Impacts

The following hierarchical sequence was used to identify measures to mitigate the potentially adverse impacts to wetlands that may result from the proposed Project:

- Avoidance – Whenever possible, avoid development in or near wetlands and activities that could result in adverse effects to wetlands.
- Minimization – Minimize unavoidable effects by implementing mitigation measures.
- Compensation – Compensation where adverse effects to wetlands is unavoidable in order to offset the loss of wetland area or function.

Further information on wetland compensation is provided in Chapter 4.

3.2 Results

3.2.1 Identification of Wetland Impacts

3.2.1.1 Loss of Wetland Habitat

CBCL identified three wetlands (HP-2, HP-5, and HP-6) that overlap the proposed Project Area (Figure 2.1). HP-2 consists of tidal salt marsh and shrub swamp components. A portion of the swamp overlaps the proposed LBTF security fencing. Portions of HP-5 and HP-6 fall within the proposed footprint for the upgraded access road.

Based on the location of the Project Area and associated infrastructure shown in Figure 2.1, the proposed Project is anticipated to result in the direct loss of approximately 1,488 m^2 (approximately 0.15 ha) of wetland habitat. The anticipated loss in area of each HP-2, HP-5, and HP-6 is outlined in Table 3.1 and is discussed in the following subsections. The estimated wetland loss presented in this report is anticipated to be a worst-case scenario.

Table 3.1: Summary of Wetland Areas and Areas of Direct Loss

Wetland ID	Wetland Size		Direct Habitat Loss		% of Total Wetland Impacted
	ha	m^2	ha	m^2	
HP-2	4.02	40,200	0.091	905	2.25
HP-5	3.84	38,400	0.053	527	1.37
HP-6	2.17	21,700	0.006	56	0.003

HP-2

Project activities anticipated to result in the direct loss of wetland habitat in HP-2 include clearing, grubbing, and potentially excavation in the northeast Project Area. These activities, if they cannot be avoided, are anticipated to result in the loss 905 m^2 (0.091 ha) of HP-2. The portion of HP-2 that overlaps the Project Area is classified as a tall shrub swamp. Approximately 6% of the shrub swamp component of HP-2, or approximately 2% of the entire wetland, may be directly altered as a result of the Project. However, DND is reviewing options to reduce the size of the Project Area to avoid HP-2 to the extent possible.

None of the tidal portion of HP-2 occurs within the proposed Project footprint and, therefore, the Project is not anticipated to result in the direct loss of salt marsh habitat.

HP-5

The shrub bog identified as HP-5 covers a total area of approximately 3.84 ha (38,400 m^2). A portion of HP-5 is anticipated to be altered during the realignment and construction of a new portion of the access road. This section is estimated to comprise 527 m^2 (1.37 ha) of HP-5, representing approximately 1% of the entire wetland.

HP-6

HP-6, a slope marsh, covers a total area of approximately 2.17 ha (21,700 m^2). A narrow section of HP-6, i.e., 56 m^2 (<1%) of the entire wetland may be altered during upgrades to the access road.

3.2.1.2 Loss of Wetland Functions

The direct loss of wetland habitat in HP-5, HP-6, and the nontidal portion of HP-2 is anticipated to result in the loss of wetland functions. Of particular importance are wetland functions that scored Higher relative to reference wetlands in Nova Scotia, although wetland functions that received a Moderate rating may also be reduced. While it is not possible to quantify the degree to which each of these functions may be reduced, wetland functions with Higher and Moderate ratings and that may, to some extent, be lowered as a result of the proposed Project, include the following:

- Water Storage & Delay (WS)
- Carbon Sequestration (CS)
- Songbird, Raptor, & Mammal Habitat (SBM)
- Pollinator Habitat (POL)
- Native Plant Habitat (PH)

WS and CS may be reduced to some extent in all three wetlands due to the removal of wetland organics and vegetation, particularly HP-5 (basin bog) which scored Higher for these functions. The removal of trees and shrubs may result in a reduced ability for wetlands to provide habitat for songbirds, raptors, and mammals. SBM, POL, and PH functions are also anticipated to be reduced through the removal of herbaceous vegetation. HP-6 scored Higher for SBM and POL functions; however, the loss of these functions in HP-6 is anticipated to be minimal based on the current design, as <1% of this wetland is anticipated to be altered during road upgrades.

3.2.1.3 Indirect Wetland Impacts

Direct impacts to wetlands are alterations that remove or infill a portion or the entirety of a wetland. Such impacts can lead to indirect impacts on the remainder of the wetland or surrounding wetlands. For example, excavating a portion of a wetland may indirectly impact the hydrology of other parts of the wetland, potentially leading to changes in the frequency and duration of inundation or saturation, which can then lead to changes in plant communities and, eventually, species that utilize these communities.

The realignment of the existing access road through HP-5 will require excavation of vegetation and organics and the infill and construction of a new access road. This construction could indirectly impact the hydrology of HP-5 and impede water flow to the portion of HP-5 south of the new access road and potentially reduce the size of the portion to the south over time. To mitigate this potential impact, at minimum, culverts should be installed during road construction to maintain drainage between the northern and southern portions of HP-5.

The loss of wetland functions could affect birds and bats in a variety of ways. Of the SAR/SoCC detected within the Study Area during bird surveys conducted by CBCL in 2021 and 2022, only Barn Swallow (*Hirundo rustica*) and Eastern Wood-pewee (*Contopus virens*) were detected within the Project footprint (CBCL, 2023). Loss of habitat can impact these and other birds and bats via loss of foraging (e.g., Barn Swallow) and breeding (e.g., Eastern Wood-pewee) habitat.

Although no trees with attributes suitable for use as SAR bat maternity roosts were observed in the main Project footprint during a preliminary bat maternity roost habitat assessment conducted by CBCL in July 2021, the forested habitat may be used by non-reproductive bat individuals for roosting (day roosts) during the active period for bats in Nova Scotia (April to October), or for foraging by SAR and non-SAR bats. The loss of habitat could, therefore, indirectly result in the loss of foraging and/or day roosting habitat for bats.

In addition, the loss of native plant and pollinator habitat could lead to decreases in pollinating insects that insectivorous birds and bats rely upon. Loss of water storage and delay capacity in wetlands could lead to changes in vegetative habitats within or near the wetland and a decrease in the wetland's capacity to support insect prey for birds and bats.

3.2.2 Mitigation of Wetland Impacts

3.2.2.1 Avoidance of Wetland Impacts

CBCL considered the possibility of avoidance of HP-2, HP-5, and HP-6 all together. DND has indicated that they are reviewing options to avoid disturbance to wetlands to the extent possible. Such options include reviewing security requirements so as to refine the Project Area and avoid HP-2 if feasible.

3.2.2.2 Minimization of Wetland Impacts

Although the loss of some wetland area and function is unavoidable, impacts to wetland functions identified in subsection 3.2.1.2 can be mitigated or minimized through the implementation of measures outlined Table 3.2.

Table 3.2: Higher and Moderate Wetland Functions that may be Impacted by the Project and Proposed Mitigation and Minimization Options.

Wetland Function	Mitigation and Minimization Options
Water Storage & Delay	▶ Revegetation of disturbed wetland areas and upland areas surrounding the wetland ▶ Onsite stormwater management ▶ Restrict construction activities, such as tree removal/vegetation clearing, to the project footprint. ▶ Restrict parking and laydown areas to areas outside the wetland to avoid unnecessary clearing or disturbance of wetland vegetation.
Carbon Sequestration	▶ Plant trees and native vegetation onsite.

Wetland Function	Mitigation and Minimization Options
Songbird, Raptor, & Mammal Habitat	- Use existing clearings and disturbed areas as much as possible to reduce the potential of removing breeding or foraging habitat. - Maintain existing trees and vegetation to the extent possible.
Pollinator & Native Plant Habitat	- Maintain vegetation to the extent possible. - Use native vegetation and plants that attract pollinators for reseeding and planting. - Check equipment and vehicles for plant or soil materials prior to entering wetlands to avoid the spread of invasive or non-native species. - Clean equipment after working in an area containing invasive species (e.g., Japanese Knotweed), such as along the road between HP-5 and HP-6) before entering a new area - Clean equipment away from vegetated areas to avoid the spread of invasive species.

Additional effects to wetlands, or associated ecological features, during construction can be minimized through implementation of best management practices, environmental protection measures, effective erosion and sediment control measures, and spill prevention and response measures (e.g., storage of hazardous materials and refuelling of equipment at least 30 m from a wetland).

4 Wetland Compensation

Since some loss of wetland area and function is unavoidable, compensation may be a means to achieve the FPWC's goal of no net loss of wetland function on federal lands. It is generally preferred that functional losses be restored onsite. If not possible, however, it is recommended that functional losses are restored in an area as close to the site as possible or at least within the same ecosystem/watershed (Cox and Grose, 2000). DND's preference is to compensate for wetland loss on the Hartlen Point property and requested that CBCL identify two conceptual options for onsite compensation (preferably restoration or enhancement). The methodology used to develop the compensation options and the results of this exercise are described in Sections 4.1 and 4.2.

4.1 Methodology

CBCL identified several types of compensation projects completed on federal lands in NS and Atlantic Canada through a combination of desktop research and consultation with CWS. CBCL researched and reviewed relevant recent wetland compensation projects completed in NS to identify compensation options consistent with those proposed for other projects in Atlantic Canada, with a principal focus on projects on Federal Lands. The intent of this review was to establish a general benchmark of recent and successful compensation projects approved by CWS and relevant to the current project. CBCL engaged in initial consultation with CWS to obtain information on the types of wetland compensation projects completed on federal lands in the region. Site specific information with respect to this project or other projects on federal lands was not disclosed by either party.

Successful offsetting projects and restoration efforts employed elsewhere in Atlantic Canada were then compared with existing site conditions on the Hartlen Point property. Information on existing site conditions was collected during the desktop review, examination of site topography and drainage patterns, reconnaissance-level surveys conducted by CBCL, and collaboration between CBCL biologists and engineers.

A letter report outlining each of the preliminary concept onsite compensation options was then submitted to DCC/DND, which was then submitted to ECCC/CWS for review. A meeting between DCC/DND, ECCC/CWS, and CBCL was held to discuss the various options presented, which option CWS considered most feasible and sufficient to compensate for the loss of wetland functions, and the compensation ratio that would be applied to the Project. The conceptual design for the selected compensation option was further developed and is discussed further in Chapter 6.

4.2 Results

4.2.1 Types of Wetland Compensation

There are four main types of wetland compensation. These includes the following:

- Restoration
- Enhancement
- Creation
- Expansion

Wetland restoration is defined as the act of restoring degraded wetland habitat and functions to natural or historical conditions. This is usually the preferred method of wetland compensation as it is often the most cost-efficient option when conditions are suitable and restoration can often be achieved by restoring a wetland's water supply, either from the original source or by redirecting water from elsewhere (Kentula, 1997). Wetland restoration/re-establishment occurs in the same area where wetland habitat was previously present.

Wetland enhancement can be defined as the modification of an existing wetland, to improve specific functions. Wetland enhancement projects occur in the original wetland location, with the original wetland altered in some manner to enhance a specific function or value, such as sedimentation retention, flood control, or wildlife support (Lewis et al., 1989; Gwin et al., 1999).

Examples of wetland enhancement activities include an increase in water depth (hydrologic regime), duration of water presence (hydroperiod), or a change in plant community from the one originally present. Wetland enhancement activities often occur at the expense of other wetland functions, so potential project outcomes must be carefully considered prior to implementation (USDA, 2008).

Wetland expansion is the act of increasing the size of an existing wetland by expanding it into adjacent areas. Technically this is a type of wetland enhancement, as it impacts an existing wetland. This generally requires an increase in water input, and/or some modification of topography within the existing wetland to allow expansion (USDA, 2008).

Wetland creation is the construction of wetland habitat where it did not previously exist. This requires the provision of wetland hydrology to a site that was not originally wetland habitat. These projects tend to be more expensive and require more management requirements than other types of wetland compensation. Wetland creations are usually intended to support a small number of functions, such as providing wildlife habitat or improving surface water runoff quality (i.e., stormwater retention ponds). Note that created wetlands are different from constructed wetlands which are usually intended to treat or ameliorate waters or soils (USDA, 2008).

4.2.2 Types of Compensation Projects in NS

Initial consultation with CWS indicated that types of wetland compensation projects that have previously been completed on federal lands within the province include the following:

- Improvements to hydrology (enhancement)
- Invasive Species Management Plan (enhancement/restoration)
- Creation of stormwater retention ponds (creation)

4.2.2.1 Wetland Enhancement – Improvements to Hydrology

Hydrology is the key parameter in wetland establishment, as it controls the formation, persistence, size, and function of wetlands (Carter, 1997). Wetlands are subject to the main hydrologic cycle components: precipitation, surface-water flow, ground-water flow, and evapotranspiration. The source of the water supplying a wetland (precipitation, surface water, or ground water) also controls the water chemistry and determines what nutrients are available for plant growth (Carter, 1997). As summarized by Carter (1997), the hydrologic and water-quality functions of wetlands are controlled by the following wetland characteristics:

- Landscape position (elevation in the drainage basin relative to other wetlands, lakes, and streams)
- Topographic location (depressions, flood plains, slopes)
- Presence or absence of vegetation
- Type of vegetation
- Type of soil
- The relative amounts of water flowing in and water flowing out of the wetland
- Local climate
- The hydrogeologic framework
- The geochemistry of surface and ground water

In terms of deliberating impacting wetland hydrology for the better, some of these characteristics are more easily manipulated or modified than others. The relative amounts of water flowing in and out of the wetland, as well as the types of soil and vegetation present are likely the most amenable to modification. Wetland water inflow/outflow can be modified by increasing surface water runoff into the wetland or by installing water control structures to decrease outflow. Wetland soils can be modified by the addition of organic matter, which then impacts the types of vegetation that can occur, which can also impact wetland hydrology. Wetland vegetation communities can be altered by the addition of new species via seeding or transplanting, or by removal of species via selective removal. Efforts to alter wetland hydrology should have clearly defined objectives and a definition of success, as the alteration of one aspect of a wetland often results in alteration to other aspects, which may or may not be desirable. For example, increasing the water level in a wetland can result in changes in the vascular plant communities present, as some existing species may not be tolerant of the increased water supply, while other new species may colonize newly created suitable habitat.

4.2.2.2 Wetland Enhancement and Restoration – Invasive Species Management Plan

A second type of wetland enhancement that occurs is the removal or management of invasive plant species from wetlands. Some invasive plant species spread rapidly once they recruit to suitable habitat and compete with native species for habitat. They are often less attractive to native fauna species in terms of providing suitable habitat or food, and so can have far-reaching impacts on local ecosystems. Some federal wetland compensation projects in eastern Canada have involved the development and execution of Invasive Species Management Plans. Management of invasive species on a particular site has several components.

Once a species has become established, there are several ways it can be dealt with, with the most applicable method depending on the species, the site and the surrounding environment. Mechanical or hand removal may be effective some species, while spot or large-scale herbicide applications may be required for others. Removal or control efforts for some species may entail long-term removal and monitoring efforts. All management practices should take into account the potential for harm to other aspects of site ecosystems.

While CWS cannot provide project specifics, it is highly likely that some federal wetland compensation projects have developed such plans for Purple Loosestrife (*Lythrum salicaria*). Purple Loosestrife is a tall perennial plant with square stems and showy purple flowers that is currently widespread throughout wetlands in Canada. Purple Loosestrife is native to Eurasia, and is thought to have been introduced to NS in the early 1880s for ornamental and medicinal purposes. This plant is currently creating issues within HRM and elsewhere due to its ability to outcompete native wetland plants, its prolific seed production and resulting large seed bank and the difficulty of eradicating it (HRM, undated). CBCL is unaware of any reports of this species on the Hartlen Point site, however, there are confirmed, recent records (2020) of blooming Purple Loosestrife near Crystal Sands Beach and along Main Road on iNaturalist (an online repository of citizen science species records (www.iNaturalist.org). Both sites are less than 1 km away from the Hartlen Point property. It would be prudent to monitor for this species' occurrence on the Hartlen Point property.

Japanese Knotweed (*Reynoutria japonica*) is another widely established species in HRM (HRM, undated) that has cause considerable damage to local ecosystems. However, Japanese Knotweed does not usually grow in wetlands, occupying a variety of habitats but preferring streambanks and riparian areas. It is notorious for crowding out native species and being very difficult to eradicate once established (HRM, undated). While Japanese Knotweed was observed to be established in several locations on the Hartlen Point property, none was observed in wetland habitat in March 2021.

4.2.2.3 Wetland Creation – Creation of Stormwater Retention Ponds

Wetland creation has been conducted on federal properties in eastern Canada via the creation of stormwater retention ponds. Stormwater retention ponds, or basins, are intended and designed to capture surges of surface runoff and prevent flooding downslope. They are usually designed to retain some of this water permanently and are often colonized by native wetland species, the establishment of which can be helped along by seeding or transplanting. Over time, the establishment of wetland vegetation communities can lead to the development of fish and wildlife habitat. Establishment of native species can be helped along by seeding or transplanting of suitable species. In this way stormwater retention ponds can replace some of the wetland functioning lost by development. However, they can accumulate pollutants due to stormwater runoff input and require regular monitoring and inspection to check water quality, wildlife and vegetation accumulation, as well as the functioning of any mechanical inflow or outflow structures. Stormwater retention ponds also typically require fencing in urban areas, to maximize public safety.

4.2.3 Wetland Compensation Ratios

Wetlands that have been restored, enhanced, or created generally do not provide as many functions as natural wetlands, at least not initially. They are also generally less effective at providing specific wetland functions. To account for this decrease in overall wetland functioning, the amount of compensation required for a given project is usually considerably larger than the amount of wetland habitat or function lost.

Unlike provincial compensation ratios identified in Table 4.1, wetland compensation ratios are not defined at the federal level and are, instead, determined on a case-by-case basis. CWS confirmed that the compensation ratio would be higher than 2:1. During initial site planning, the Project was anticipated to result in the direct alteration of 0.5 ha of wetland habitat. CWS indicated that to compensate for 0.5 ha of wetland impacted, approximately 6 ha of wetland would need to be restored or enhanced. Continued refinement of the Project Area has resulted in avoidance of some wetland habitat and reduced the anticipated area of wetland impact to 0.15 ha.

Table 4.1: NSE Wetland Compensation Ratios

Compensation Type	Compensation Ratio
Restoration	2:1
Enhancement	3:1
Creation	4:1
Expansion	2:1

5 Proposed Compensation Options

CBCL developed four preliminary concepts for onsite compensation options for consideration by DCC/DND and CWS. These compensation options are described in the following sections. The locations of these potential options within the Study Area are depicted in Figure 5.1.

It should be noted that these compensation options were based on initial site plans and the assumption that the existing access road would be left in place. Since the development of these options, a portion of the existing access road was realigned and moved north so that it is further from the coastline to reduce potential erosion issues over the planned operational life of the LBTF.

Should the existing portion of the access road remain in place, the preliminary compensation options presented in this report may still be feasible; however, further hydrological assessment is recommended to confirm feasibility with the addition of an access road to the north.

Should the decommissioned portion of the existing road be removed, the organics and vegetation excavated from HP-5 could be relocated to the footprint of the existing access road, once removed. The removal of the existing access road could, therefore, present an opportunity for both the restoration of hydrology and wetland habitat.

5.1 Option 1: Expansion or Creation of Salt Marsh Habitat

The Hartlen Point property is a coastal site that is bordered by a small cove (Hartlen Cove) containing salt marsh habitat along its eastern boundary and a small cove along its southwestern boundary near the Halifax Harbour confluence. The location of the site and hydrodynamic conditions that characterize these coves may provide an opportunity to expand existing salt marsh habitat comprising a portion of HP-2 or to create new salt marsh habitat in the southernmost cove (Figure 2.1). Ecological functions that may be reduced through the removal of shrub swamp habitat in HP-2 (e.g., aquatic invertebrate habitat; organic nutrient export; carbon sequestration; and sediment retention &

stabilization) could potentially be restored. This option could also provide an opportunity to increase the area and functions of ecologically significant wetland habitat on the property.

5.1.1 Option 1A: Expansion of Existing Salt Marsh Habitat

CBCL has experience in the design of coastal restoration projects using 'living shorelines' and has considered the potential to expand the existing salt marsh within Hartlen Cove. Initially, CBCL examined the possibility of expanding the salt marsh along the eastern shore of Hartlen Cove. Upon initial consideration, it is anticipated that this option may entail extensive civil works that could, potentially, interact with the golf course to the north. The area of salt marsh that could be created in this area is not anticipated to meet the compensation ratio requirements identified in the Statement of Work.

Instead, there is potential to expand the existing salt marsh in Hartlen Cove by infilling the west shore of the small estuary and stabilizing this infill with a breakwater. This option would be dependent on several factors, including, but not limited to, information on the substrate comprising the sea bottom in this area, a bathymetric survey to quantify the amount of infilling needed, and Authorization from Fisheries and Oceans Canada.

5.1.2 Option 1B: Creation of New Salt Marsh Habitat

CBCL has considered the possibility of creating a living shoreline in the cove situated between HP-9A and HP-7D, the location of which is illustrated in the mapping provided in Figure 2.1. It is anticipated that this preliminary concept could result in the creation of approximately 1,500 m^2 of salt marsh habitat. Further analysis would be required to confirm whether this option is, in fact, feasible in this area. It is important to note that this cove is popular for bird watching, and any works completed in this cove may not be well received by the public. One option to alleviate potentially negative feedback would be to install signage educating the public on the ecological benefits of salt marsh habitat, particularly in relation to supporting marine birds.

5.2 Option 2: Creation of Wetland Fringe

The second preliminary concept that CBCL has considered is the creation of wetland habitat, specifically, a wetland fringe around portions of the pond adjacent to HP-3 and along the watercourse (WC5) south of the pond (Figure 2.1).

HP-3 is situated near the northeastern property boundary and extends beyond the property boundary in a northwesterly direction. Immediately southeast of HP-3 is a pond that receives inflow from HP-3 via a culvert under a gravel access road that separates HP-3 from the ponded area. Water drains from the pond into WC5, which flows to the southeast, traversing the southern portion of the golf course before merging with WC4, which travels in a southwesterly direction and drains into WL-9A and eventually off site.

The pond bordering HP-3 is characterized by relatively steep banks (Appendix B, Photo 5). Assuming that water levels of the pond do not fluctuate often, a potential compensation option is to decrease the slope of the banks surrounding the pond and plant plugs or seeds of suitable native wetland plants that thrive in shallow wetland conditions, thereby creating a vegetated wetland fringe around the perimeter of the pond. In addition, there is potential to create wetland habitat along WC5 by either excavating or creating natural berms along WC5. This option could restore functions lost through the removal of wetland habitat in HP-2, HP-5 and HP-6 (e.g., carbon sequestration; native plant habitat; songbird, raptor & mammal habitat; pollinator habitat; and native plant habitat).

There is potential that this option could interact with the golf course and golfers. One potential option to avoid this interaction would be to complete any works surrounding the pond and watercourse during the off-season. There is also potential that this option could be utilized for other ponds on the property as well, in which case it would be beneficial to identify how the various ponds on the property are relied upon for stormwater management, and if there are any areas of the golf course that experience issues with runoff where efforts should be focused.

5.3 Option 3: Expansion of HP-2

The third option proposed by CBCL entails the enhancement of wetland habitat by expanding a portion of the tall shrub swamp component of HP-2. As shown in Figure 2.1, a portion of the shrub swamp falls within the Project Area and may be directly lost as a result of the Project if avoidance of this wetland is not possible.

5.3.1 Option 3A: Expansion of Area North of Project Footprint

An area immediately north of the project footprint (Appendix B, Photo 6) appears to have served as a disposal ground for fill that was removed during the creation of the golf course, as several long, treed berms are situated perpendicular to the shore. The area appears to receive runoff from the golf course, and the vegetation is a borderline wetland community. CBCL considered the possibility of modifying the topography and managing hydrology in this area in order to promote the development of wetland habitat. This could potentially be accomplished by excavating the narrow strip so that the elevation is lower than that of HP-2 and water then drains from HP-2 into the area of lower elevation. The difference in elevation between this upland area and HP-2 appears to be upwards of 17 m, which is anticipated to require extensive modification to topography to implement Option 3A.

5.3.2 Option 3B: Expansion of HP-2 Along Southwest Border

Due to the logistical constraints associated with Option 3A, CBCL proposes that the expansion of HP-2 would be more feasible along its southwestern boundary where there is less variation in elevation. This would entail modifying the topographic relief of upland habitat within approximately 10 m of the wetland edge as illustrated in Figure 2.1.

5.4 Option 4: Establishing Hydrologic Connectivity Between HP-5 and HP-6

The fourth compensation option proposed by CBCL entails enhancements to HP-5 (basin bog) and HP-6 (slope marsh) through the establishment of hydrologic connectivity between the two wetlands (Figure 2.1). Both wetlands are located near the eastern property boundary and are bisected by an approximately 2 m wide gravel access road that lacks a culvert.

Due to the lack of a culvert, water currently flows over the road from HP 5 into HP-6 (Appendix B, Photo 7) during high water/storm events, and eventually drains to the shore. Rock and clear fill have been dumped in washed out areas along the road to make it more passable to vehicles. CBCL is proposing to establish a hydrologic connection between these wetlands through the installation of a culvert under the gravel road. This could potentially improve hydrologic functions, such as water storage and delay, and subsequently, potentially minimize flooding of the road and reduce the likelihood of sedimentation and erosion into these wetlands.

There is potential that the installation of a large culvert could potentially increase flow and lead to dryer bog conditions and a smaller bog area over time. Whether this potential could be mitigated through the installation of a smaller culvert would need to be explored further, and HP-5 may need to be monitored over several years in order to assess changes over time. There is not anticipated to be any changes in size to HP-6 since water already drains through this wetland and offsite.

5.5 Other Options Considered

Additional options that were considered as part of this assessment include the management of invasive species, such as Japanese Knotweed, which was observed on site in locations identified in Figure 5.1. However, the elimination of Japanese Knotweed has often proved unsuccessful, and this option was, therefore, not considered feasible for this site.

MAP EXTENT

- Proposed Culvert
- Proposed Breakwater
- Proposed Area Of Excavation
- Proposed Recontouring Of Slopes
- Proposed Infilling
- Proposed Extension
- Cat tail pond
- Dam
- Culvert
- Drainage Outflow and Direction
- Knotweed (Invasive)
- Seabeach Groundsel (S3)
- WSP Field Delineated Watercourse

Project Components (Feb 23, 2023)
- Paved Surface
- Fenceline
- Facility / Building Footprint
- Existing Access Road
- Wetlands (Dillon, 2008)
- Approximate Fence Location
- Study Area
- DCC Site Boundary

Wetland Type (CBCL Field Delineated, 2021)
- Salt Marsh
- Tall Shrub Swamp

Wetland Type (WSP Field Delineated, 2018)
- Basin Bog
- Forested Swamp
- Slope Marsh
- Small Bog Pockets
- Tall Shrub Swamp

Wetland Type (DCC 2006)
- Basin Bog

CBCL

Wetland Compensation Options within the Study Area

DATE: 2023-03-17	PROJ N°: 211207	FIGURE: 5.1
DRAWN BY: SF	CHECKED BY: LM	APPROVED: JB

NOTES:

0 95 190 380 m

SCALE: 1:7,350 Coordinate System: NAD 1983 UTM Zone 20N Units: Meter

6 Selected Compensation Option

During consultation with CWS, CWS indicated that Wetland Compensation Option 4, specifically, the restoration of historical hydrology and minimizing future impacts of the road to adjacent wetlands through the avoidance of erosion and sedimentation should be an acceptable level of compensation for the proposed Project.

To further develop this preliminary concept compensation option, CBCL completed a hydrologic and hydraulic analysis of the site in order to determine the sizing and location of culverts required to maintain existing hydrologic conditions and restore historical hydrologic conditions. The methodology and results of these assessments are described in Sections 6.1 and 6.2.

6.1 Hydrologic Conductivity Assessment

6.1.1 Existing Conditions

Wetlands HP-5 and HP-6 drain a total area of approximately 12 hectares (ha). As shown in Figure 6.1, the watershed draining towards HP-5 is bounded by a gravel access road, Shore Road, and golfing grounds. HP-6 receives flows from HP-5 when these overtop the gravel access road at the two low points shown in Figure 6.1. HP-6 also receives flows from its surrounding watershed, shown in pink in Figure 6.1. Runoff continues to drain unrestricted through HP-6 towards the shoreline. The flow paths shown in Figure 6.1 were calculated through a slope analysis of the 1-m Digital Elevation Model (DEM) using 2019 provincial Light Detection and Ranging (Lidar) data.

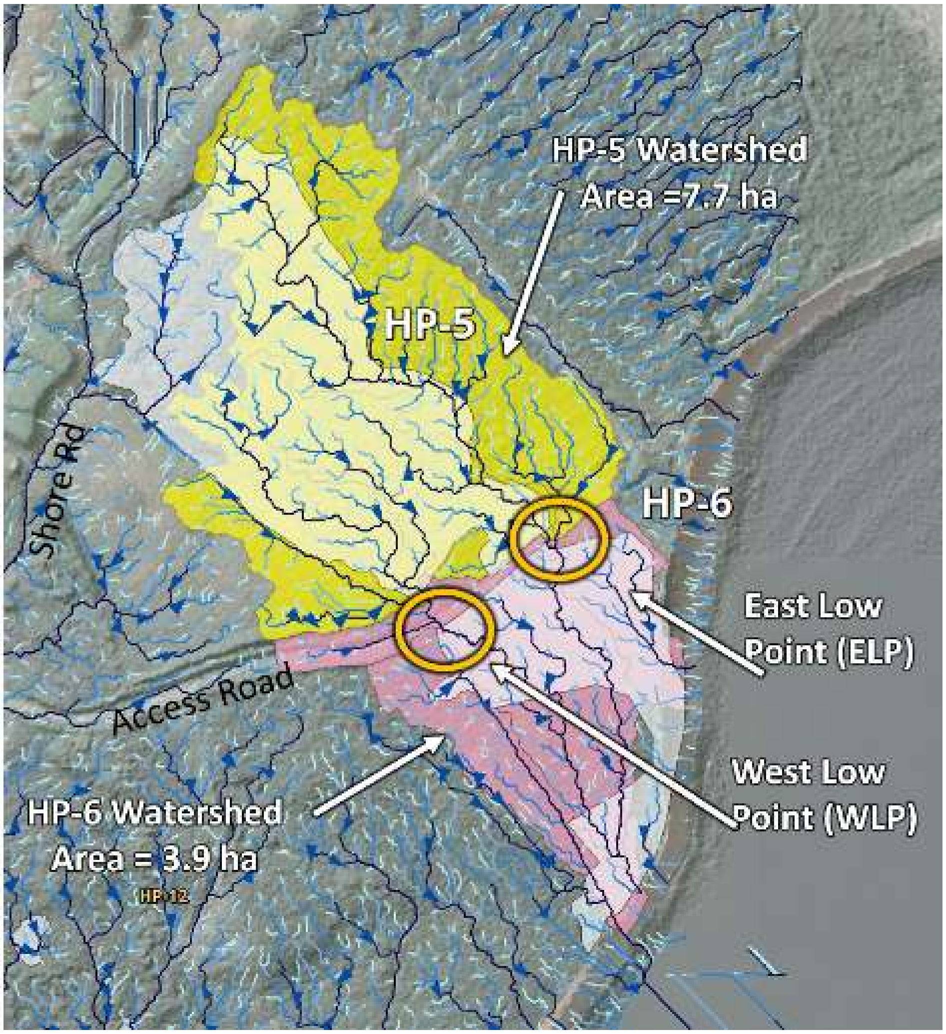


Figure 6.1: Watersheds Draining to Wetlands HP-5 and HP-6 under Existing Conditions.

A topographic profile delineated along the flow pathway through the East Low Point (ELP) shown on Figure 6.2, indicates that the road is approximately 0.20 m higher than the wetland elevation. The upstream (or upgradient) section of HP-5 features a steep slope where the drainage is only partly restricted by the gravel access road. As depicted in Figure 6.2, the gravel access road through wetlands HP-5 and HP-6 leads to only limited water backup or pooling in HP-5. Except for very low runoff flows, most of the stormwater flowing through HP-5 may travel unrestricted to HP-6. Smaller rainfall events and subsequent runoff is likely to pond throughout HP-5 in the small depressions created by the natural irregular shape of the terrain. Evidence of this flow pattern can be observed in the site photograph shown in Figure 6.2. This suggests that the installation of culverts at the existing ELP and West Low Point (WLP) along the gravel access road may result in limited changes to the existing wetland conditions (e.g., vegetation type, hydrology, functions) observed in HP-5 and limited enhancement to HP-6.

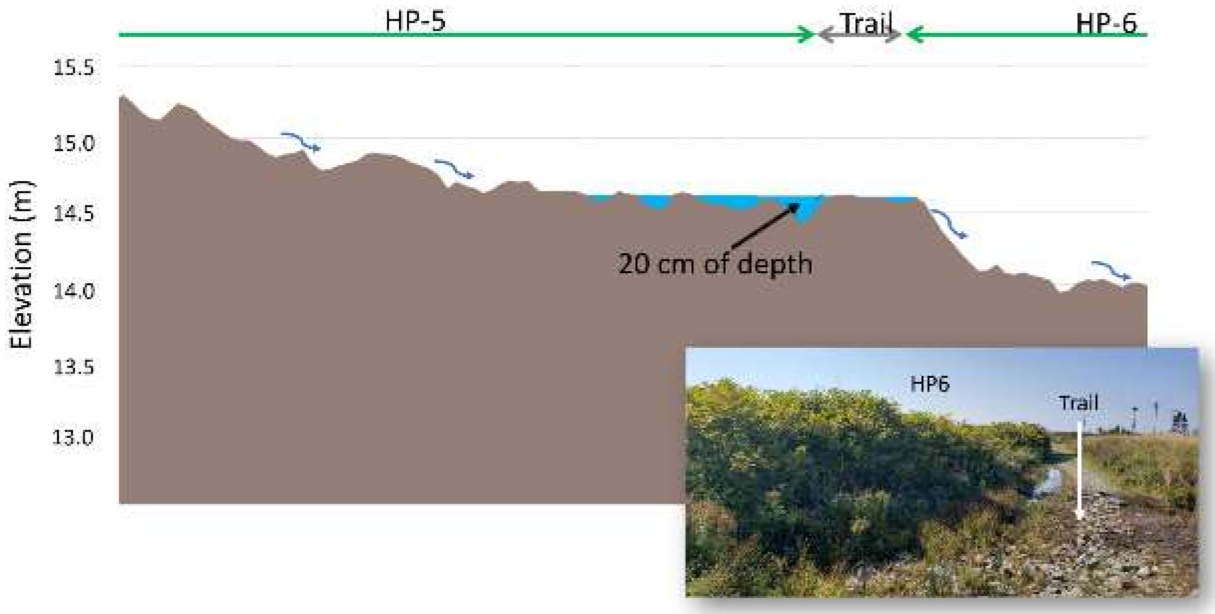


Figure 6.2: Topographic Profile along the East Low Point of the Gravel Access Road.

6.1.2 Conditions Prior to Site Development

An analysis of the existing topography and the estimated flow paths suggests that the 6.5 ha area located north-northeast of Shore Road (shown in Figure 6.3) may have drained towards HP-5 before the golf course was developed. The topography and flow paths shown in Figure 6.3 suggest that runoff flows from this area were diverted southwesterly along the south face of Shore Road during development. Because the size of this potentially diverted area is close to the size of the watershed currently draining directly to HP-5, this suspected diversion may have resulted in substantial changes to the type and function of wetland HP-5. Therefore, efforts to restore hydrology in HP-5 to pre-development conditions may require the restoration of the flow paths identified in Figure 6.3.

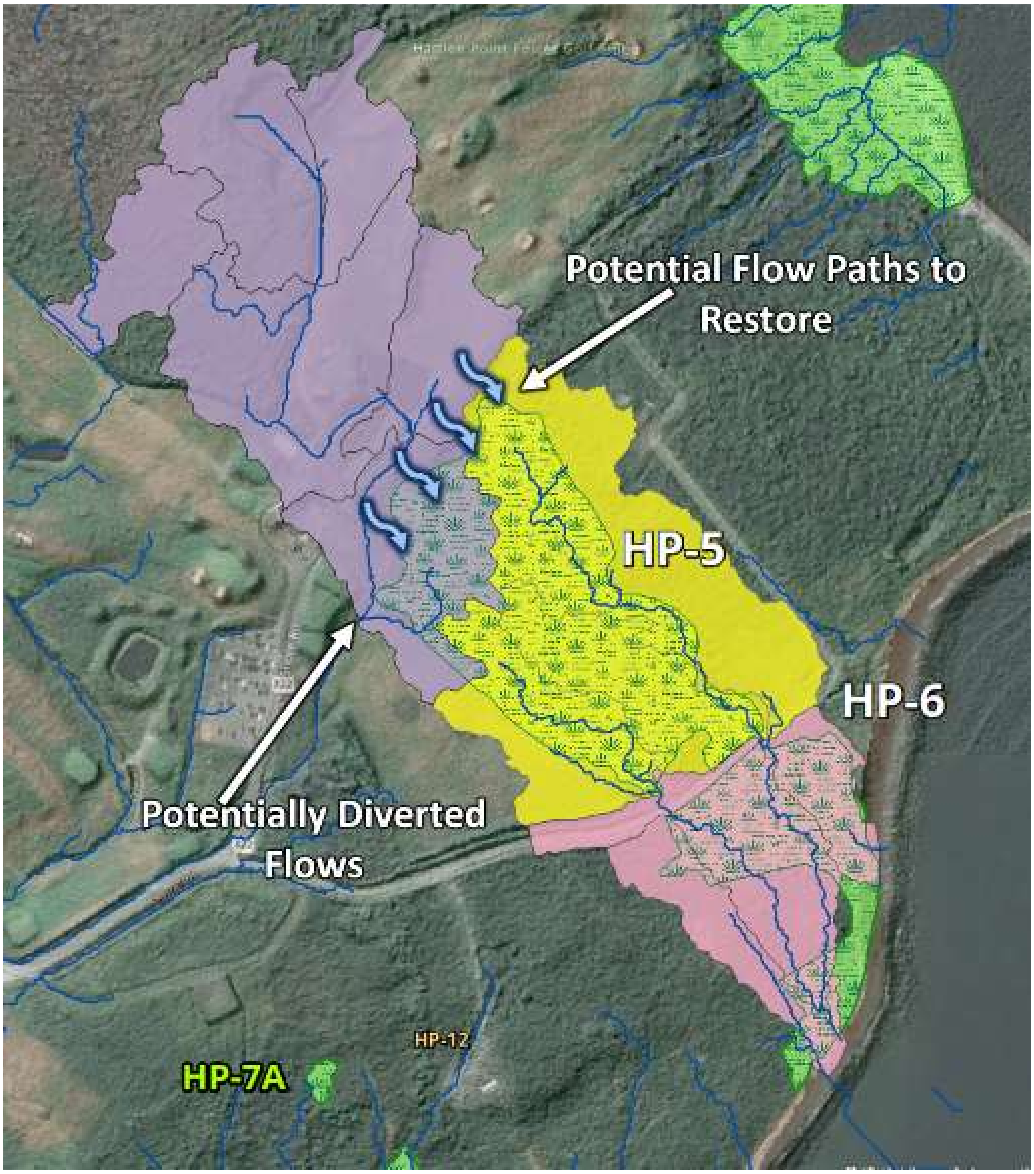


Figure 6.3: Current Location of Flow Paths Potentially Diverted During Site Development and the Location of Potential Flow Paths for Restoration.

6.1.3 Options for Enhancing Hydraulic Conductivity

The following options could be implemented to restore and/or enhance hydraulic conductivity between HP-5 and HP-6:

- **Option A:** Installation of culverts along the existing low points of the access road.
- **Option B:** Installation of culverts along the existing low points of the access road, in combination with the restoration of flow paths to pre-site development conditions, such that runoff drains from the northeast side of Shore Road into HP-5.

CBCL conducted a hydrologic and hydraulic analysis of extreme flows reaching the access road to size culverts for Options A and B. Concept options for restoring the flow paths from the area north-northeast of Shore Road to pre-development conditions are not discussed in this report.

6.2 Hydrologic Analysis

The hydrologic assessment involves calculations of extreme runoff flows draining towards the HP-5 and HP-6 watersheds. For this purpose, CBCL developed a hydrologic and hydraulic model of the overland drainage system based on a site survey, Lidar information, Agriculture and Agri-Food Canada soil survey data and Environment, as well as ECCC Intensity, Duration and Frequency (IDF) curves. The model was developed using PCSWMM, a modelling program developed by Computational Hydraulics International (CHI) that integrates Version 5 of the Storm Water Management Model (SWMM) with a geographic information system (GIS) engine. SWMM is a combined hydrologic and one-dimensional hydraulic model produced by the United States Environmental Protection Agency to study semi-urban drainage systems. This software can perform unsteady flow calculations to simulate water backup, pooling, and culvert hydraulics.

6.2.1 Watershed Characteristics

The watersheds currently draining towards HP-5 and HP-6 and the watersheds north-northeast of Shore Road (potentially diverted during construction) were delineated based on the Lidar DEM available from the NS database, GeoNOVA. To account for the variability of land cover and slopes in the runoff calculations, the drainage area was divided in a series of smaller sub-catchments as shown in Figure 6.4. The watershed characteristics identified in this assessment are summarized as follows:

- **Slopes:** Slopes within the watershed range between 0.5% and 2%, with the land surface becoming steeper south of Shore Road.
- **Land Cover:** Most of the land cover within the watersheds is vegetated. Land uses associated with golfing activities feature low (maintained) grass, whereas areas of the watersheds surrounding the golf course consist of shrub and forested habitat, with Manning's (n) roughness coefficients ranging between 0.15 and 0.40.
- **Permeability:** Except for the wetland covered surfaces, most of the watershed area is considered permeable.
- **Soils:** According to the Natural Resources Canada (NRC) soil survey, the underlying substrate surrounding the wetlands consists mostly of sandy clay loam soils. The NRC soil survey identifies the substrate underlying HP-5 and HP-6 as peat.

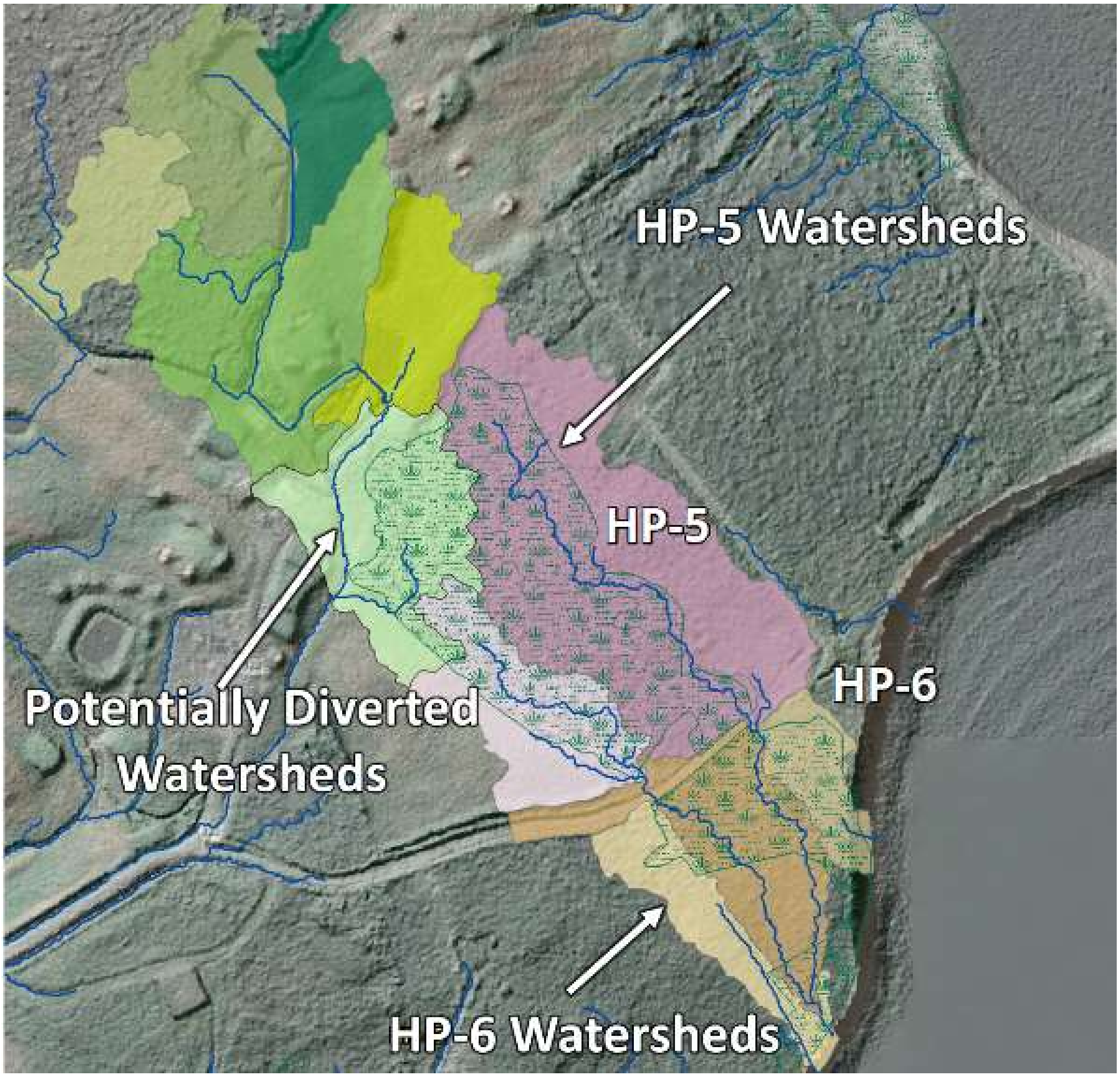


Figure 6.4: Watersheds Draining to HP-5 and HP-6.

Table 6.1 presents the infiltration parameter values associated with sandy clay loam soil types as presented at by Rawls et al. (1983).

Table 6.1: Infiltration Parameters Values for Sandy Clay Loam Soils

Soil Condition	Suction Head (mm)	Hydraulic Conductivity (mm/hr)	Moisture Deficit Ratio
Sandy Clay Loam	219.96	1.524	0.02

6.2.2 Rainfall Analysis

ECCC provides IDF curves for 55 locations throughout Atlantic Canada. The IDF curves show extreme rainfall intensities for a range of durations (from 5 minutes to 24 hours) and return periods (2, 5, 10, 25, 50 and 100 years). These curves are the result of extreme value statistical analyses of 20 years of rainfall intensity records and can be used to calculate synthetic hyetographs (rainfall time series) using methods such as the Chicago Distribution.

Climate Change Considerations: Climate change is expected to severely impact the intensity of rainfall events in the foreseeable future. Therefore, increased severity and frequency in runoff peak flows can be expected. Previous assessments conducted by CBCL in the Halifax area estimate a potential 30% increase between 2070 and 2099. These assessments are based on utilization of the following:

- **Western University Intensity Duration Frequency Climate Change Tool (IDF_CC)** - estimates potential impacts of climate change on IDF curves by downscaling Global Climate Models (GCM) outputs to current IDF curves.
- **Clausius-Clapeyron Equation** - allows for the conversion of temperature output to precipitation due to the tendency of air to hold more water as the temperature increases.

Design Event: This assessment assumes a culvert life cycle of approximately 75 years with climatic conditions projected for the 2070 to 2099 period with a 30% rainfall increase. Based on the NS Environment Watercourse Alteration Standards, the 1 in 100-year flows were selected as the design criteria for the hydraulic capacity of the proposed culverts. Figure 6.5 shows the 1 in 100-year hyetographs calculated using the Chicago Distribution method and the IDF curves for the Shearwater Climate Station. These time series were used as inputs in the hydrologic model of the watershed.

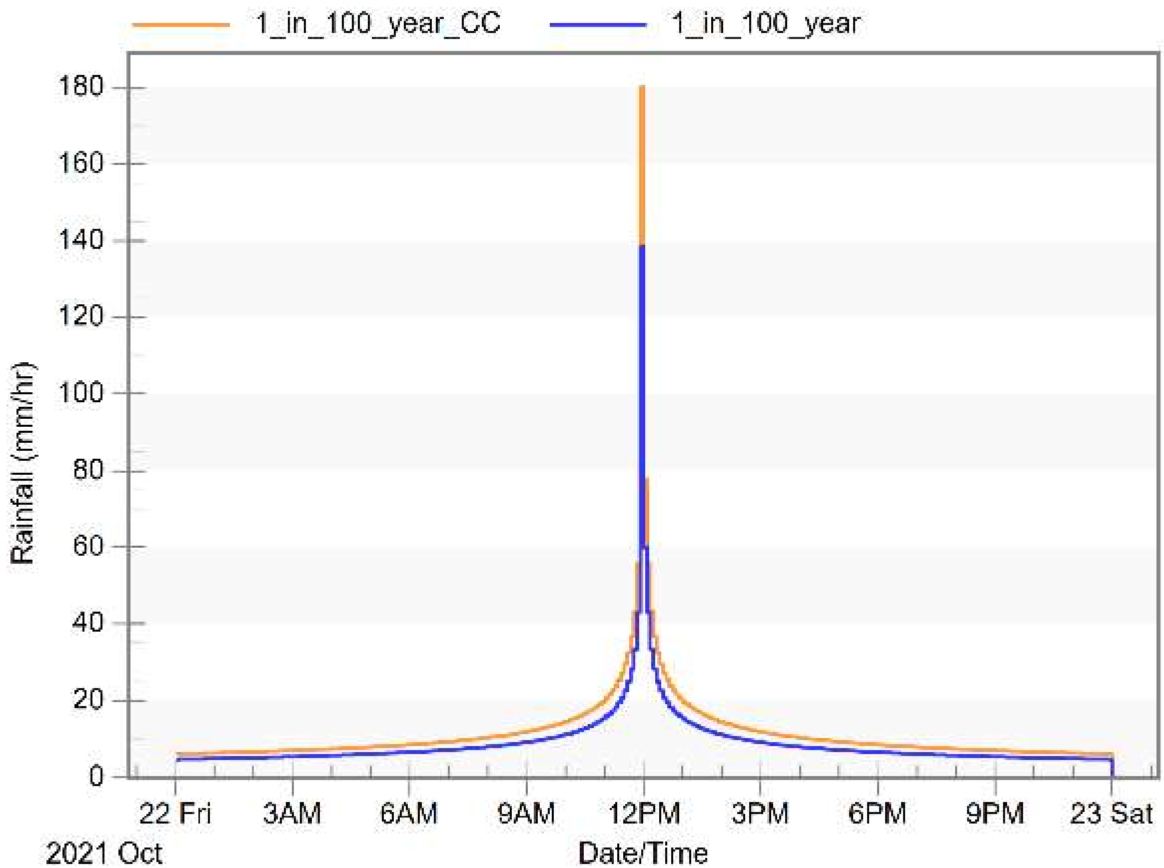


Figure 6.5: 1 in 100-year Rainfall Time Series for Existing and Projected Climatic Conditions.

6.2.3 Hydrologic Calculation Results

Table 6.2 presents runoff flows calculated at the following locations of interest, as shown in Figure 6.6:

- **Location 1:** East low point along gravel access road (approximate coordinates: 63°26'41.689"W and 44°35'39.92"N).
- **Location 2:** West low point along gravel access road (approximate coordinates 63°26'44.856"W and 44°35'38.132"N).
- **Location 3:** Section of existing drainage channel currently receiving runoff flows that may have drained to HP-5 prior to construction of the Golf course (approximate coordinates 63°26'55.337"W and 44°35'42.55"N). Flows collected at this location could potentially be restored to flow through HP-5.

Table 6.2: Calculated Runoff Flows at the existing low points along the gravel access road and the potential diversion point north of Shore Road.

Location	1 in 100 -year Flow – Existing Conditions (m^3/s)	1 in 100-year Flow Climate Change Scenario (m^3/s)
Location 1	0.655	0.897
Location 2	0.204	0.281
Location 3	1.172	1.629

Flows calculated at Location 1 and Location 2 were used as inputs to size the proposed culverts to maintain hydrologic connectivity between HP-5 and HP-6 by conveying water under the road rather than overtopping and washing out the road (Option A). Flows calculated at Location 3 were used as inputs in the calculation of culvert sizes for a scenario where drainage to wetland HP-5 from the area north-northeast of Shore Road is restored (Option B).

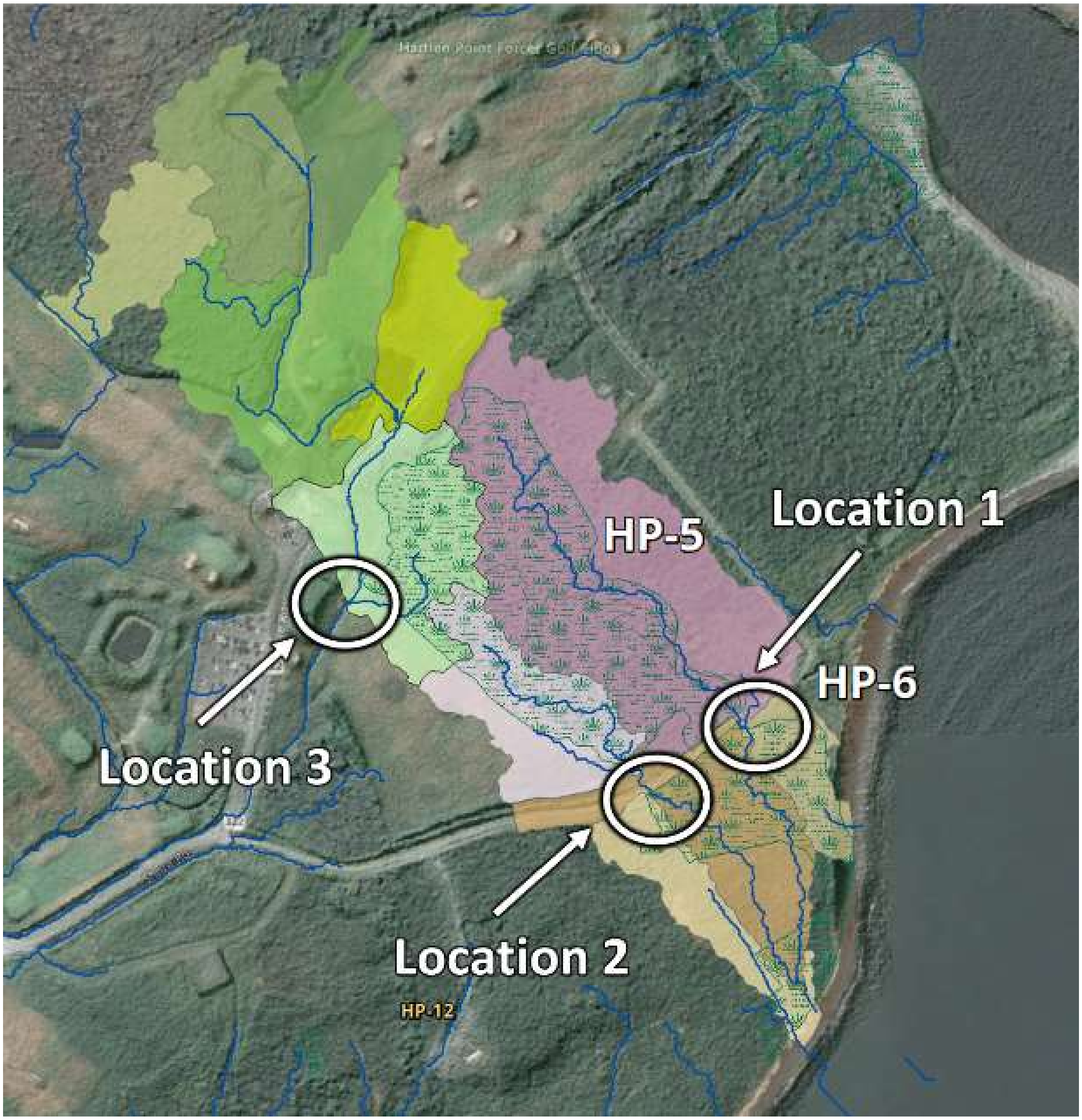


Figure 6.6: Locations at which 1 in 100-year Flows (under Existing and Climate Change Conditions) were Calculated.

6.3 Hydraulic Analysis

The methodology outlined in the Federal Highway Administration Hydraulic Design of Highway Culverts (Schall, 2012) was followed to estimate culvert dimensions based on hydraulic capacity to convey the runoff flows calculated in the hydrologic analysis. This assessment assumes that open-bottom culvert boxes will be installed at the site to allow passage of aquatic species. Table 6.3 presents the calculated sizes for the following two options:

- **Option A:** Enhancing hydrologic conductivity between HP-5 and HP-6 by installing two culverts under the gravel access road that runs through the two wetlands.
- **Option B:** Installation of two culverts under the gravel access road, in conjunction with the restoration of historical flows that currently discharge to Location 3.

Table 6.3: Summary of Culvert Sizing Results

Option	Location	1 in 100-year Flow Existing Conditions			1 in 100-year Flow Climate Change Conditions		
		Design Flow (m^3/s)	Head Water Depth (m)	Culvert Dimensions (height x width)	Design Flow (m^3/s)	Head Water Depth (m)	Culvert Dimensions (height x width)
A	1	0.655	0.63	610 mm x 914 mm	0.897	0.64	610 mm x 1219 mm
	2	0.204	0.37	610 mm x 610 mm	0.281	0.46	610 mm x 610 mm
B	1	1.487	0.78	914 mm x 914 mm	2.061	0.97	914 mm x 1219 mm
	2	0.500	0.52	610 mm x 914 mm	0.700	0.53	610 mm x 1219 mm

Results of the hydraulic assessment indicate that installing a 610 mm x 1219 mm and a 610 mm x 610 mm open-bottom box culvert at Location 1 and Location 2, respectively, will provide the minimum hydraulic capacity required to convey the calculated 1 in 100-year peak flows under the projected climatic change conditions for Option A.

If restoring drainage from the area north-northeast of Shore Road to HP-5 is considered (Option B), larger structures would be required. This is because runoff flows would increase as they would also include those calculated at Location 3. For this scenario, the calculations indicate that installing a 914 mm x 1219 mm and a 610 mm x 1219 mm open-bottom box culvert at Locations 1 and 2, respectively, would provide the minimum hydraulic capacity to accommodate 100-year peak flows under projected climatic change conditions. These results are further summarized in Table 6.4. A concept sketch of the culvert cross section for each Option A and Option B is provided in Figure 6.7.

Table 6.4: Summary of Culvert Sizing and Locations for Option A and Option B

Option A		Option B	
Location 1	Location 2	Location 1	Location 2
610 mm x 1219 mm	610 mm x 610 mm	914 mm x 1219 mm	610 mm x 1219 mm

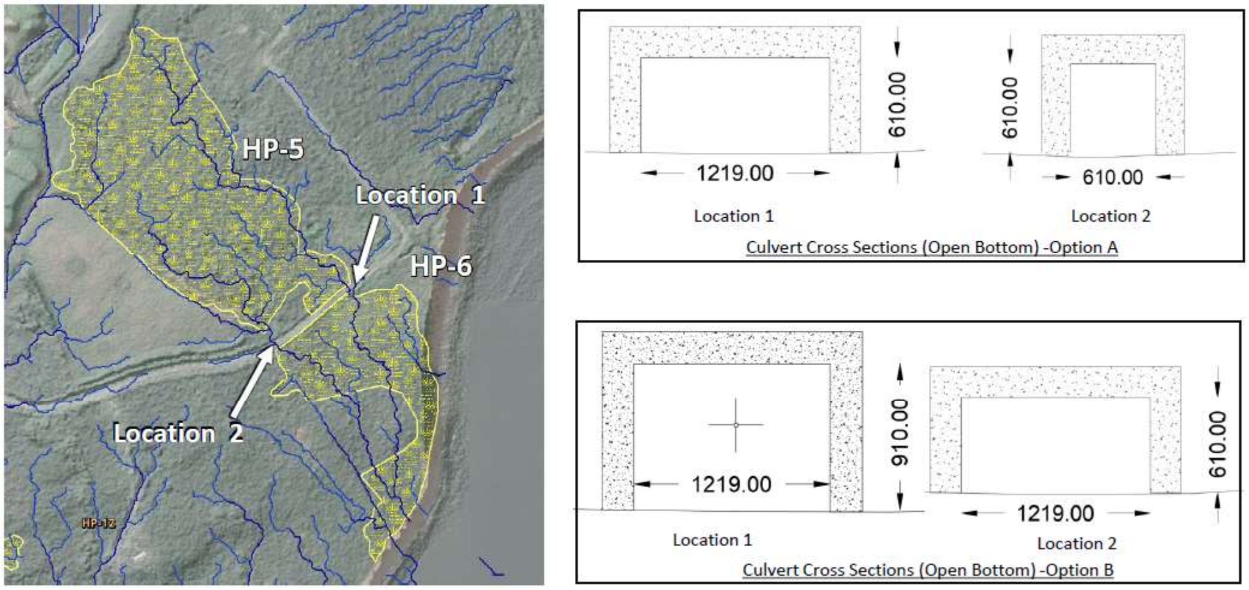


Figure 6.7: Concept Sketches of Culvert Cross Sections for Option A and Option B.

6.4 Proposed Schedule and Estimation of Cost

The selected compensation option entails the installation of culverts during upgrades to the gravel access road during construction. A Concept Level (Class D) cost estimate for the installation of culverts for each Option A and Option B is provided in Appendix C.

As previously identified, concept options for restoring the flow paths from the area north-northeast of Shore Road to pre-development conditions are not discussed in this report and more detailed analysis would be required to assess the extent of site re-grading needed to restore flow path direction. As such, a schedule and Class D cost estimate to complete this work could not be provided at this time.

7 Wetland Monitoring Plan

The wetland monitoring plan proposed for the wetland compensation project will assess general wetland conditions, vegetation communities, and ecological functioning. These aspects are discussed in the following subsections.

7.1 Hydrological Monitoring

Hydrological monitoring in a wetland involves observing and recording water levels across multiple seasons in order to characterize and monitor the hydroperiod (i.e., seasonal pattern of water fluctuation). Hydrological monitoring of HP-5 and HP-6 will ideally capture data during pre- and post-construction periods and across, at minimum, three seasons in order to establish a range of hydrologic conditions.

The community structure of a wetland is dependant on wetland hydrology. This is because the range of plants which form the basis of a wetland have varying water level requirements. If, for example, the water table in HP-5 is lowered following construction, over a period of time vegetation communities could shift from those that require a higher water table (i.e., moss) to those that prefer a lower water table (i.e., shrubs). Monitoring of wetland hydrologic processes is important to not only determine whether existing conditions are maintained during construction but, if changed, how these changes to wetland hydrology influence the community structure of HP-5 and HP-6 over time.

7.1.1 Pre-Construction Monitoring

Hydrological monitoring stations will be established upstream (north) and downstream (south) of each the ELP (Location 1) and WLP (Location 2) along the access road, i.e., the outflows of HP-5 and inflows for HP-6. These stations will be established prior to construction in order to establish baseline conditions.

At minimum, nested piezometers (one deep and one shallow) and one surface water well will be installed at each of the four locations to capture a range of water variation above and below ground. Each minipiezometer and well will be instrumented with a data logger. The data loggers will be programmed to measure and record continuous water levels and temperature data on an hourly basis. One station will also be instrumented with a barometric pressure and air temperature logger.

At each monitoring station, the following measures will be implemented:

- Photographs of baseline conditions
- Documentation of indicators of wetland hydrology
- Description of the sediment water content (i.e., water covered, saturated, wet, moist, or dry)
- Manual measurements of water levels in the surface water well and minipiezometer using a water level tape
- Check/download water level, barometric pressure, and temperature loggers

If possible, data should ideally be collected for one to three years prior to construction. However, it is recognized that collection of such data over one to three years may not be feasible in this case due to project timelines.

7.1.2 Post-Construction Monitoring

Each year, the loggers will be installed in April and retrieved in November. The hydrological monitoring stations will be visited at least three times per calendar year. During these visits, the same information as was gathered during the initial baseline visit will be collected. Surface water depth and velocity will also be collected on either side of the culverts.

Hydrological monitoring data is anticipated to provide information on the following:

- Fluctuations in water levels and the wetland hydroperiod following construction.
- Seasonal water level and temperature trends.
- Magnitude and direction of groundwater flow either into or out of the monitored plot of each wetland.
- Whether surface water drainage and/or groundwater discharge helps to sustain moisture levels.
- Groundwater interaction with areas of exposed water within each wetland.
- The magnitude of response of surface water and shallow groundwater levels to rain events.

Hourly groundwater levels provide information on pre- and post- construction conditions of wetland hydrology and indications of seasonal and annual trends, as well as changes to these trends over time. Potential changes could include higher or lower absolute groundwater levels, with corresponding changes to the water table and/or vertical exchanges with surface water. Other effects could include increased or subdued seasonal responses to precipitation and air temperature.

A comparison of the surface water and groundwater level at each station will provide an estimate of the local vertical gradient. Vertical gradients can provide an indication of vertical flow between surface water and the shallow subsurface environment. Groundwater levels in a minipiezometer that are higher than the surrounding surface water indicate that groundwater is discharging to the water body. This effect is confirmed if surface water temperatures coincide more closely with groundwater temperatures rather than air temperature. Groundwater levels in a minipiezometer that are lower than the surrounding surface water indicate that surface water may be recharging the shallow groundwater regime. Vertical hydraulic gradients can change in response to rain events and seasonal effects. The degree and nature of surface water-groundwater interaction can serve as an indication of the function of wetlands in this context.

7.2 Establishment of Wetland Photo Monitoring Stations

Wetland photo stations should be established throughout the two wetlands which are part of the Wetland compensation program. These stations should consist of a series of points which are easily accessible, and which allow a broad view of portions of the relevant wetlands. These locations should be photographed during every site visit.

Photographs of each monitoring station will be obtained during every monitoring site visit. The wetland boundary will also be photographed, if apparent. Photographs will be taken from same viewpoint and using same focal length each year. These images will allow a visual assessment of changes in vegetation communities during the Project.

7.3 Vegetation Monitoring

Vegetation monitoring should be conducted in each wetland to be impacted by the wetland compensation activities (HP-5 and HP-6). This should involve both baseline and post-construction collection of vegetation data.

7.3.1 Vegetation Quadrat Monitoring

The vegetation monitoring portion of this wetland monitoring plan involves examining the vegetation within established monitoring quadrats within the wetlands over time. The following subsections outline the proposed approach to baseline and post-construction monitoring, while Section 7.4 outlines the proposed schedule for monitoring activities.

7.3.1.1 Baseline Assessment

Ecological baseline data should be collected from two monitoring locations established within HP-5 and HP-6, for a total of four monitoring locations. At each location, 5 m x 5 m reference plots will be established at two representative locations within the subject wetlands. The data collected from each pre-construction assessment plot should include the following:

- Description of wetland type
- Vegetative strata present (tree layer, shrub layer, herbaceous (ground) vegetation layer)

- Species present
- Wetland indicator status of each species present
- Percent cover value of each species
- Percent cover value of bare soil
- Evidence and percent cover of stressed or wilted vegetation
- Evidence of wetland hydrology
- Photographs of each plot, taken from same viewpoint and using same focal length each year
- UTM coordinates of each plot corner

This assessment should take place in July, when vegetation is well-developed, and prior to the initiation of wetland alteration activities. Photographs of each monitoring station will also be obtained during the baseline survey.

7.3.1.2 Post-Construction Monitoring

The post-construction monitoring portion of this plan will include collection of the same data as was collected for the baseline assessment, at the same time of year to allow annual comparisons. The intention of this program is to detect any changes in the plant community composition arising from construction activities.

Photographs of each monitoring station will also be obtained during the post-construction monitoring monitoring visits. The wetland boundary will also be photographed. Photographs will be taken from same viewpoint and using same focal length each year. These images will allow a visual assessment of changes in vegetation communities post-construction.

7.3.2 General Assessment and Vegetation Community Composition Survey

This portion of the monitoring plan intends to provide an assessment of visible wetland impacts over time, as well as changes in the overall vascular plant community composition. This will allow identification of any non-project impacts to the wetlands, as well as identification of any new species recruiting to the wetlands. The following subsections outline the proposed approach to baseline and post-construction monitoring, while Section 7.4 outlines the proposed schedule for monitoring activities.

7.3.2.1 Baseline Assessment

In addition to the observations to be made at the reference plots, an assessment of general conditions and overall species composition will also be made within HP-5 and HP-6 prior to site disturbance. This will include observations of any hydrological indicators, evidence of existing impacts or disturbance, a well as a full inventory of vascular plant species. The wetland indicator status of each plant species detected will be determined. This survey should occur in July, preferably at the same time as the quadrat monitoring.

Should any SAR or SoCC plants be detected within HP-5 and HP-6 (none are currently known to occur), these will be photographed, counted, and their locations georeferenced.

7.3.2.2 Post-Construction Assessment

Once construction activities have been completed, post-construction assessment of the wetland and the vegetation community present is recommended. This should follow the same methods as were used for the baseline assessment. Identification of the wetland indicator status of vascular plant species in the wetland should allow detection of changes in vegetation community composition related to potential changes in wetland hydrology. This survey will also permit detection of any new non-native plant species establishing within the wetland.

Any SAR or SoCC vascular plants detected during the baseline survey will be reassessed during each post-construction monitoring visit.

7.3.3 Wetland Delineation

It is possible that re-establishing hydrological connectivity between HP-5 and HP-6 could lead to a change in the spatial extent of Wetland 5 over time, as water will be able to drain more easily from this wetland. A comparison of this wetland boundaries over time would therefore be useful in determining whether this has occurred. To assess this possibility, the wetland boundaries delineated and mapped by WSP in 2017 (WSP, 2018) can be used as the baseline boundaries for HP-5 and HP-6. HP-5 and HP-6 should be re-delineated two years after construction has been completed, and again after 5 or 10 years if changes are detected.

7.4 Proposed Monitoring Schedule

The following schedule is proposed for monitoring for the two wetlands (HP-5 and HP-6) identified for enhancement as part of the wetland compensation program for the proposed Project.

If possible, it is recommended that a baseline assessment of HP-5 and HP-6 is completed, at minimum, during the growing season prior to the commencement of construction and include the following tasks:

- Establishment of Photo Monitoring Stations
- Vegetation Quadrat Monitoring
- General Assessment and Vegetation Community Composition Survey

The post-construction monitoring schedule for the proposed Project was developed based on recommendations provided by Al Hanson of CWS during a regulatory meeting on September 2, 2021. The proposed post-construction monitoring schedule and associated tasks for each year are as following:

- Post-Construction Monitoring Year 1:
    - Photography at Photo Monitoring Stations
    - Vegetation Quadrat Monitoring
    - General Assessment and Vegetation Community Composition Survey
- Post-Construction Monitoring Year 2:
    - Photography at Photo Monitoring Stations
    - Vegetation Quadrat Monitoring
    - General Assessment and Vegetation Community Composition Survey
    - Wetland Re-delineation
- Post-Construction Monitoring Year 5:
    - Photography at Photo Monitoring Stations
    - Vegetation Quadrat Monitoring
    - General Assessment and Vegetation Community Composition Survey
    - Wetland Re-delineation (if changes noted in Year 2)
- Post-Construction Monitoring Year 10:
    - Photography at Photo Monitoring Stations
    - Vegetation Quadrat Monitoring
    - General Assessment and Vegetation Community Composition Survey
    - Wetland Re-delineation (Wetland 6 only)
    - Wetland Re-delineation (if changes noted in Years 2 and 5)
- Post-Construction Monitoring Year 20:
    - Photography at Photo Monitoring Stations
    - Vegetation Quadrat Monitoring
    - General Assessment and Vegetation Community Composition Survey

8 Conclusions

The construction of the LBTF at Hartlen Point may result in the direct loss of a maximum of approximately 0.15 ha of wetland habitat and a loss, to some extent, of several wetland functions. CBCL developed four conceptual level onsite options to compensate for the loss of wetland functions on federal lands. These options were prepared based on initial site plans which have since been updated. CWS reviewed the proposed options and advised that approximately 6 ha of wetland would need to be restored or enhanced for 0.5 ha of wetland impacted and that restoring historical hydrologic connectivity between HP-5 and HP-6 (Compensation Option 4) should provide an acceptable level of compensation for the proposed Project. It should be noted that these options are preliminary concepts, and consultation with CWS should be revisited prior to further development and design of any wetland compensation options.

An assessment of hydrologic conductivity between HP-5 and HP-6 under current conditions determined that HP-6 receives flows from HP-5 when water overtops the two low points along the gravel access that separates HP-5 and HP-6. An evaluation of the topography of the area suggests that before the site was developed, the area north-northeast of Shore Road may have drained towards the location of HP-5. The diversion of these flows during site development may have resulted in substantial changes to wetland characteristics, including hydrology, of HP-5.

The installation of culverts under the gravel access road at the two low points identified in this assessment would allow conveyance of flows from HP-5 to HP-6. However, they are unlikely to significantly change the type and functions of wetlands HP-5 and HP-6, but rather are more likely to maintain existing conditions. Restoration of historical hydrologic conditions at HP-5 and HP-6 would likely require both the installation of culverts and restoration of flow paths from the area north-northeast of Shore Road such that it drains towards wetland HP-5. More detailed analysis would be required to assess the extent of site re-grading required to restore historic flow patterns.

This assessment estimates the minimum culvert size requirements to accommodate the 1 in 100-year peak flows under climate change conditions. Sizes are calculated for existing drainage conditions (Option A) and for a scenario where drainage from the area north of Shore Road is restored to HP-5 (Option B). The assessment is also based on the assumption that the existing access road will be used for the project and does not factor in the realignment of the access road to the north.

It is proposed that culvert installation be completed in conjunction with upgrades to the access road. A Class D level cost estimate for the installation of two culverts along the gravel access road for each Option A and Option B is provided in Appendix C.

9 Closure

This report has been prepared for the sole benefit of DCC/DND. The report may not be relied upon by any other person or entity without the express written consent of CBCL and DCC/DND. Any use which a third party makes of this report and any reliance on decisions made based on it, are the responsibility of such third parties. CBCL Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions or actions made based on this report.

The conclusions presented represent the best judgement of the assessors based on the observed site conditions. Due to the nature of the investigation, the assessors cannot warrant against undiscovered environmental conditions or liabilities.

Should additional information become available, CBCL requests that this information be brought to our attention so that we may re-assess the conclusions presented herein.

Respectfully submitted,

CBCL Limited

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APPENDIX A

Photographic Log

Photo 1: **View (Looking Southeast) of Tidal (Salt Marsh) Portion of HP-2.**

Photo 2: **View of standing water (vernal pool) in the non-tidal (tall shrub swamp) portion of HP-2.**

Photo 3: View of HP5 (from access road) and water draining across the access road from HP-5 to HP-6.

Photo 4: View of HP-6 (from access road) and inflow of drainage from HP-5. Also visible is gravel infill from access road and stalks of Japanese knotweed from last season.

Photo 5: Pond located southeast of HP-3 (looking southeast).

Photo 6: Disturbed area with borderline wetland conditions north of Project footprint.

Photo 7: **Overflow of water onto gravel road that bisects HP-5 and HP-6.**

APPENDIX B

Class D Cost Estimate: Culvert Installation


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