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NORTHERN PULP NOVA SCOTIA

Fish Habitat Survey

Focus Report – Replacement Effluent Treatment Facility

Appendix Focus Report Item 7.1 Freshwater Fish and Fish Habitat

As required by item 7.1 of the Terms of Reference (ToR) for the Focus Report (Nova Scotia Environment (NSE) 2019), freshwater fish and fish habitat baseline surveys were conducted to reflect the revised project, as identified in the Focus Report Project Overview. The results of fish habitat surveys are presented in this section.

7.1.1 Freshwater Fish and Fish Habitat Survey Methodology

The fish and fish habitat surveys were conducted as an update to the existing environment as described in the Environmental Assessment Registration Document (EARD, Northern Pulp Nova Scotia (NPNS) 2019) based on the revised project description. The EARD work informed the 2019 fish habitat study design. Work completed for the EARD included a review of existing data for potential freshwater habitat and expected fish species and their life stages present within the local assessment area, review of the potential for fish Species At Risk (SAR) and priority species (i.e., S-ranks ranging from S1 (extremely rare) to S3 (uncommon) based on Atlantic Canada Conservation Data Centre (AC CDC 2018) rankings, as well as the preliminary December 2018 reconnaissance. AC CDC ranks were reviewed for this assessment as of August 2019 (AC CDC 2019).

Fish habitat evaluation was undertaken along the 2019 proposed re-aligned pipeline route on June 3, 2019 and June 18 – 24, 2019. Additional visits to the watercourses were conducted in May and July 2019. Identified watercourses within the boundaries of the Northern Pulp Nova Scotia (NPNS) property and along Highway 106 within the NSTIR right-of-way (ROW), were assessed both upstream and downstream of the proposed works. Field transects typically covered from 30 to 50 m and, at a minimum, the survey transect on the east side of Highway 106 (along the proposed re-aligned pipeline route) covered the complete ROW width. Field investigations were dependent on property access restrictions. Transects were extended to the extent they were required to adequately assess potential fish habitat based on the watercourse characteristics observed.

The watercourses within the Effluent Treatment Facility (ETF) project area were also reassessed in 2019. As with summer 2018 assessments at the ETF footprint, the methodology for all the watercourses followed habitat data collection as adapted from the "Reconnaissance (1:20,000) Fish and Fish Habitat Inventory for British Columbia: Standards and Procedures" (British Columbia Resource Inventory Committee 2001) and in accordance with federal Fisheries and Oceans Canada (DFO) protocols. Investigations included the visual examination of fish habitat descriptors.

The data collected included the following parameters:

- Substrate (types and percentages);
- In-stream cover (types and percentages);
- Wetted and channel width (where applicable);
- Approximate water depth (including pools);
- Watercourse character/morphology (e.g., pool, riffle, run);

- Unique watercourse characteristics (e.g., bars, islands, pattern);
- Bank vegetation;
- Qualitative flow;
- Watershed consideration such as identification of potential flow source/receiving water; and,
- Photographs and Universal Transverse Mercator (UTM) locations.

In addition, select in-situ water chemistry data was collected using water quality meters (YSI model 556 multi-meter for field pH, temperature, conductivity, and dissolved oxygen). Surface water analytical samples (general inorganic chemistry, metals, and Total Suspended Solids (TSS)) were collected in late May and early June 2019.

Presence/absence of fish species is based on watercourse characteristics, known fish species in the area based on available DFO/provincial fisheries data, and professional judgement with regard to habitat suitability. As discussed with DFO (pers. comm. Mark McLean) in the meeting held on May 29, 2019 with the Environmental Assessment Branch of Nova Scotia Environment, fish are assumed to be present based on habitat characteristics. Supplementary presence/absence surveys (e.g., electrofishing, minnow traps based on appropriate conditions and under DFO permit) were undertaken as an additional supporting line of evidence.

A qualitative assessment was made on potential fish habitat for overwintering, rearing, and spawning. The quality of spawning habitat was based on water flow, water quality, and the extent and coverage of suitable substrates. The quality of rearing habitat was based on the types and amount of in-stream cover (e.g., vegetation, undercut banks, large woody debris, and large substrate), and water flow. Overwintering habitat quality was based on the presence or absence of deep pools or ponds (≥ 50 cm) and the potential for year-round water flow. The potential for fish presence year-round was based on the water quality measurements (e.g., dissolved oxygen and pH); habitat quality at the time of the assessment; quality of anticipated overwintering and spring/summer habitat; and the upstream and downstream connectivity to other fish-bearing watercourses or waterbodies.

7.1.2 Review of Watercourses

Watercourses encountered at the proposed ETF property and along the proposed re-aligned pipeline route are shown in Figure A7.1-1. Freshwater watercourses encountered are small, intermittent to permanent drainages, ranging from less than a meter to over 10 m in width. Typical freshwater watercourse depths range from 0.05 m to over 1 m (the deeper watercourses were often in wetland areas). Many of the watercourses are associated with wetland habitat (Refer to Focus Report Section 5.1, and noted on Figures A7.1-1a and b).

Figure A7.1-2 illustrates the larger watersheds and potential flow paths as derived from Depth-to-Water Table mapping. Watercourses within the local assessment area near the ETF footprint area flow directly into Pictou Harbour. Watercourses along the approximate pipeline footprint area include those flowing directly to:

- The Pictou Harbour estuary (WC01 to WC03, WC05, WC06 and an additional small drainage WC18 observed in June 2019);
- The Caribou Harbour of the Northumberland Strait (WC15 and WC16);
- Freshwater sub-watershed Haliburton Brook flowing to the West River estuary portion of the Pictou Harbour (WC07 to WC11); and
- Freshwater sub-watershed Mill Brook flowing to the Northumberland Strait (WC12 to WC14, and WC17 flowing into WC13).

WC04 is the Pictou Harbour estuary and is described in Focus Report Section 7.2.

Table A7.1-1A summarizes potential for fish habitat within freshwater watercourses at the ETF project site and along the proposed re-aligned pipeline route based on desktop and fall 2018 reconnaissance. Subsequent descriptions are provided for those watercourses where fish habitat potential was identified in the summer of 2019. Table A7.1.1B summarizes the watercourses that were identified as intersecting with the proposed project area and deemed not to be fish habitat with rationale for not requiring further habitat assessment and photographs.



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- | | | |
|--|---|----------------|
| Approximate Project Footprint Area* | Secondary Watersheds (NSE Watershed Dataset) (SD= Shore Drainage) | Wetland ID |
| Watercourse | Wetland | Watercourse ID |
| Watercourse Assessed as Potential Fish Habitat | | |

Watercourses in the Proposed ETF Area
 Figure A7.1-1A



MAP DRAWING INFORMATION:
 DATA PROVIDED BY Northern Pulp Nova Scotia,
 NSDNR, GeoNova, NSDNR, ESRI

MAP CREATED BY: SCM
 MAP CHECKED BY: SLD
 MAP PROJECTION: NAD 1983 UTM Zone 20N



*Precise Project Footprint to be determined following completion of detailed design



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- Approximate Project Footprint Area*
- Secondary Watersheds (NSE Watershed Dataset) (SD= Shore Drainage)
- Watercourse
- Wetland
- Watercourse Assessed as Potential Fish Habitat

- WL# Wetland ID
- WC# Watercourse ID

**Watercourses along the Proposed Project
 Figure A7.1- 1B**



MAP DRAWING INFORMATION:
 DATA PROVIDED BY Northern Pulp Nova Scotia,
 NSDNR, GeoNova, NSDNR, ESRI

MAP CREATED BY: SCM
 MAP CHECKED BY: SLD
 MAP PROJECTION: NAD 1983 UTM Zone 20N



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**Watersheds and Depth-to-Water-Table
 Derived Flow Paths
 Figure A7.1- 2**



- █ Approximate Project Footprint Area*
- █ Watercourse
- █ Contour (5m)

- Secondary Watersheds (NSE Watershed Dataset) (SD= Shore Drainage)
- Wetland

- WL# Wetland ID
- WC# Watercourse ID

Flow Accumulation Channels

- 0 - 0.10 m
- 0.11 - 0.50 m



MAP DRAWING INFORMATION:
 DATA PROVIDED BY Northern Pulp Nova Scotia,
 NSDNR, GeoNova, NSDNR, ESRI

MAP CREATED BY: SCM
 MAP CHECKED BY: SLD
 MAP PROJECTION: NAD 1983 UTM Zone 20N







*Precise Project Footprint to be determined following completion of detailed design

Table A7.1-1A: Watercourses at the ETF Area and along the Re-aligned Pipeline Route

ID and Name	Character	Targeted for 2019 Field Investigation*
Flows directly to Pictou Harbour Estuary		
WC01, Unnamed Tributary to East River/Pictou Harbour Estuary	Intermittent flow drainage channel varying from an agricultural and road ditch in the upper reaches to steep ravine (likely partially manmade) in the lower reaches. At the intersection with East River estuary, a large barrier beach and driftwood obstruction prevents fish access except at times of extreme flow.	No - Not fish habitat and investigated in 2018
WC02, Unnamed Tributary to East River/ Pictou Harbour Estuary	Small semi-permanent drainage channel with intermittent flow originating from WL-2. Collects drainage from NPNS facility and parking lot as well as WL-2.	Yes
WC18, Drainage to East River/Pictou Harbour Estuary	Intermittent surface drainage, not a defined watercourse.	No - Not fish habitat and not crossed
WC03, Unnamed Tributary to East River/Pictou Harbour Estuary	Ditched upstream of proposed re-aligned pipeline area; intermittent to tidal in downstream portion. Routing adjustments in 2019 resulted in avoidance of this watercourse. Connected with Pictou Harbour.	Yes
WC05, Unnamed Tributary to Pictou Harbour	Intermittent/ditch upstream; culvert under Highway 106 to wetland drainage. Routing adjustments in 2019 resulted in avoidance of this watercourse.	No -Not fish habitat and not crossed
WC06, Unnamed Tributary to Pictou Harbour	Intermittent; receives ditch drainage and WL-4 drainage.	No - Not fish habitat
Flows to Haliburton Brook (indirectly to West River/Pictou Harbour Estuary)		
WC07, Unnamed Tributary to Haliburton Brook	Ephemeral to intermittent; drainage associated with roundabout, mostly ditching. Central pond some potential for habitat.	Yes
WC08, Unnamed Tributary to Haliburton Brook	Small permanent watercourse with riffle/run/pool flow.	Yes
WC09, Unnamed Tributary to Haliburton Brook	Small to moderate permanent watercourse with riffle/run/pool flow.	Yes
WC10, Unnamed Tributary to Haliburton Brook	Intermittent; receives drainage from WL-8.	Yes
WC11, Unnamed Tributary to Haliburton Brook	Drainage channel. Small to large permanent (wetland channel, but low flow).	Yes
Flows to Mill Brook (indirectly to Northumberland Strait)		
WC12, Mill Brook	Small (upstream) to large (downstream) permanent watercourse channel through a wetland.	Yes
WC13 and 13B, Unnamed Tributary to Mill Brook	Intermittent upstream but large ponded wetland flow downstream. WC13B is intermittent wetland drainage.	Yes
WC17, Unnamed Tributary to Mill Brook	Small flow draining wetland and crossing Hwy 106 to WL-13.	Yes
WC14, Unnamed Tributary to Mill Brook	Intermittent to permanent backwater flooding between two wetlands.	Yes
Flows to Northumberland Strait		
WC15, Unnamed Tributary to Caribou Harbour	Intermittent, potentially ditched.	Yes
WC16, Unnamed Tributary to Caribou Harbour	Intermittent, steep with culvert potentially blocking fish access. Discharge is directly into Caribou Harbour.	Yes

WC04, Pictou Harbour is a Marine Habitat and covered in Section 8.12 "Marine Fish and Fish Habitat" of the EARD
+ based on 2018 Review

Table A7.1-1B: Rational for Watercourses that interact with the ETF Area and Re-aligned Pipeline Route that were not Identified to Provide Potential Fish Habitat at the Project Location (Based on 2018-2019 Assessments).

Reason Watercourse Deemed Not Fish Habitat at the Project Location	Photos
<p>WC01</p> <ul style="list-style-type: none"> • There is a pile of debris and at the mouth of WC01 prevents anadromous access. • A hanging culvert makes passage unlikely for fish. • The upstream areas of the watercourse are ditched for site drainage. • Upstream is dry seasonally. 	 <p style="text-align: center;">June 12, 2018 June 3, 2019</p>
<p>WC18</p> <ul style="list-style-type: none"> • Steep, seepy drainage from the NPNS site. • Choked with wooden debris and very shallow • Photos: June 3, 2019 	
<p>WC05</p> <ul style="list-style-type: none"> • Steep bank and a perched culvert likely prevent fish access. • Photos: June 4, 2019 • Pipeline does not cross. 	
<p>WC06</p> <ul style="list-style-type: none"> • A perched culvert that conveys WC06 under the 'rails to trails' Jitney Trail and into the Pictou Harbour is a potential barrier preventing anadromous fish from getting up WC06 • A steep, but short set of falls that would prevent some fish species from accessing WC06. • Photos: Dec 3, 2018 	
<p>WC16</p> <ul style="list-style-type: none"> • See Section 7.3 Below 	

7.1.3 Fish Habitat Survey Results

Each of the watercourses which were identified as providing potential freshwater fish habitat is discussed further in this section below. Photographs of each watercourse are provided in the respective Photo Plates in Section 7.1.4. Table A7.1-2 provides the physical habitat data. Table A7.1-3 provides the associated metered in-situ water chemistry. Table A7.1-4 provides select water chemistry data from the May 2019 laboratory analyses. Table A7.1-5 provides the fish capture data from June 2019.

Unnamed Tributary to East River (WC02)

WC02 is a small, semi-permanent watercourse that originates in a wetland (WL-2), but also receives storm drainage from a concrete culvert that collects flow from the pressure relief drain on the raw water intake pipe to the mill. This flow is intermittent and occurs only about 5-6 times per year. Historically, this watercourse drained the NPNS car wash area. WC02 also receives a channelized drainage input and underdrain culverts from the parking area located on the north side of the NPNS facility. This narrow, incised channel was assessed as fish habitat (October 2017 and June 2018).

WC02 was at a mid-level water stage at the time of the June 2018 and June 2019 assessments. The channel pattern both within WL-2 and downstream of the storm water discharge from the NPNS facility was observed as sinuous. The morphology of this watercourse consists primarily of runs and small pools; however, much of the channel is encroached on by emergent vegetation such as cattails (*Typha* spp.), rushes (*Juncus* spp.), and blue flag iris (*Iris versicolor*). The substrate is dominated by gravels (70%) with some sand and fines. Patches of boulders and cobbles occur throughout and the amount of fines increase upstream as the watercourse approaches the storm water and wetland discharges. Both the left and right banks are composed primarily of fines and alternated from sloped to undercut (note: right and left bank designations are based on upstream facing perspective). In-stream cover is provided by abundant in-stream and over-hanging vegetation, as well as a moderate amount of bank-undercutting. The average channel and wetted widths in the storm water discharge area was generally less than 1 m. Average measured water depth was approximately 0.1 m; pool depth was 0.3 m in June 2018 and June 2019. WC02's immediate surroundings consist of open grassland with riparian vegetation consisting mostly of herbaceous species such as sedges (*Carex* spp.) and grasses, with cattails, soft rush (*Juncus effusus*), blue flag iris, and goldenrods (*Solidago* spp.) throughout. Nearby woody species are sparse, but speckled alder (*Alnus incana*), sweet gale (*Myrica gale*), willows (*Salix* spp.), and roses (*Rosa* spp.) are present in the area and increase in coverage within WL-2. Shade (cover) provided by both herbaceous and woody vegetation was estimated at approximately 50%.

The aquatic habitat of WC02 had limited potential for brook trout (*Salvelinus fontinalis*) spawning, with low but sufficient flow, access to upstream habitat and access to the marine environment. Although a corrugated metal culvert with a backwater detention feature is present, it does not currently prevent access to the watercourse from the marine environment at high tide. Within the upper reaches of WL-2, potential rearing habitat was present, owing to good cover and back eddies observed. Overwintering habitat was lacking due to insufficient depth. Storm water flow may reduce freezing conditions. Electrofishing in June 2019 captured ninespine stickleback (*Pungitius pungitius*). Stickleback habitat is anticipated throughout the watercourse.

In June 2019, aluminum and iron in WC02 were above the CCME Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life (FWAL). The total chromium concentration was above the hexavalent chromium guideline but below the trivalent chromium guideline, which is more likely to be the dominant form present.

Unnamed Tributary to Pictou Harbour (WC03)

WC03 is an unnamed tributary to the Pictou Harbour. WC03 has a defined channel and is comprised of an ephemerally flowing ditch along the east side of Highway 106 draining an upstream ponded area and receiving drainage from the NPNS property, a short channel within the wooded area between the NPNS property and Highway 106, and a tidally influenced channel at East River/Pictou Harbour estuary. When flowing, water flows northeast along a steep channelled watercourse which runs down slope towards the Pictou Harbour collecting debris and suspended sediments. The upstream ponded area adjacent to Highway 106 has potential for fish habitat based on size and depth (over 300 m long and over 1 m deep). However, the long cattail-dominated ditch (over 500 m) along with the steep section within the wooded area limits fish passage. It is expected that fish access the lower portion of WC03 during high tides and/or periods of high flow.

WC03 was at a moderate-level water stage at the time of the June 2019 field visit. The morphology of this watercourse consisted primarily of small runs and riffles. Substrate appeared to be composed of small cobbles and fines with a high fines component. Iron flocculent was noted throughout the bottom of the freshwater portion of the watercourse. The banks were generally composed of fines (silts and sand) and are sloped upstream of the tidal section. The ditched portion is dominated by dense cattail development. As the watercourse enters the treed area, the cattail density decreases, but other herbaceous plants increase within shallow areas (e.g., horsetails – *Equisetum* sp., grasses)

Table A7.1-2: Habitat assessment data June 2019

WC #	WC02	WC02	WC03	WC07	WC08	WC08	WC08	WC09	WC09	WC09	WC10	WC10	WC11	WC11	WC12	
Transect #:	1	1	1	1	1	2	3	2	2b	1	1	2	1	2	1	
Date	18-Jun-19	24-Jun-19	30-Jul-19	21-Jun-19	21-Jun-19	21-Jun-19	21-Jun-19	21-Jun-19	21-Jun-19	21-Jun-19	21-Jun-19	21-Jun-19	24-Jun-19	24-Jun-19	24-Jun-19	
Transect Location:	Downstream	Upstream of culvert to marine environment	From Hwy 106 ditch to Pictou Harbour	Downstream of culvert at roundabout, upstream of pond	Upstream, downstream of culvert on Pine Tree Road	300 m Downstream of transect 1	Downstream of Rte 6	Transect 2b joins watercourse 9 upstream of culvert	Upstream of culvert	Upstream of culvert	Upstream, just below culvert in highway ditch	Downstream	Downstream of culvert	Upstream of culvert	Downstream of culvert, wetland pond	
Habitat Type	Pool	Run	Run, Riffle	Run	Run	Riffle	Riffle	Run	Riffle	Riffle	Pool	Run	Wetland pond	Wetland pond, beaver pond	Other	
Substrate Type (% of wetted surface area)																
Bedrock (ledge):	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boulder (> 460 mm):	10	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
Rock (180 - 460 mm):	20	10	0	0	0	5	20	5	5	5	10	0	0	0	0	0
Cobble (54 - 179 mm):	0	0	50	0	20	5	30	10	35	40	20	0	0	0	0	0
Gravel (2.6 - 53 mm):	30	70	0	0	30	20	20	40	30	30	10	20	0	0	0	0
Sand (0.06 - 2.5 mm):	40	10	0	0	30	60	20	35	25	15	10	50	0	0	0	0
Fines (0.0005 - 0.05 mm):	0	10	50	100	20	10	10	10	5	10	40	30	100	100	100	100
% Instream Cover By Type (based on Wetted Area)																
% Turbulence	5	0	0	0	0	5	0	0	5	5	0	0	0	0	0	0
% Instream vegetation	5	5	5	0	0	5	5	5	0	5	0	10	5	10	15	15
% Instream Small woody debris	2	0	10	0	10	0	5	5	0	10	20	0	5	10	10	10
% Undercut Banks	5	0	0	0	0	0	5	5	5	5	0	0	0	0	0	0
% Other				15% garbage												
Dimensions (m)																
Wet Width (m):	5	0.7	0.8-1.5	1.2	3.4	0.39	0.9	1.1	1.7	2.4	2.5	1.9	8	6	5.5	5.5
Bankfull Width (m):	6	0.85	1.5	4.4	4.4	3.3	1.8	1.2	2.2	4.9	10	10	25	10	22	22
Wet Depth 1/4 (m):	0.25	0.1	0.05	0.14	0.05	0.12	0.04	0.1	0.11	0.1	0.1	0.1	0.5	0.4	0.33	0.33
Wet Depth 1/2 (m):	0.28	0.15	0.1	0.27	0.08	0.24	0.1	0.09	0.09	0.09	0.33	0.07	1.5	0.9	0.6	0.6
Wet Depth 3/4 (m):	0.3	0.14	0.15	0.29	0.05	0.09	0.06	0.05	0.05	0.04	0.15	0.05	0.5	0.3	0.33	0.33
Max Wet Depth (m):	0.5	0.28	0.15	0.29	0.23	0.24	0.12	0.11	0.15	0.17	0.43	0.15	2	1.2	0.7	0.7
Bankfull Depth Left (m):	2	0.3	0.05	2.5	0.6	0.45	0.45	0.36	0.7	0.6	4	0.4	0.5	1	0.5	0.5
Bankfull Depth Right (m):	2	0.301	0.05	0.8	0.52	0.55	0.7	0.24	0.45	0.5	0.3	0.3	0.5	0.5	0.5	0.5
Channel Type:	Main	Main	Main	Main	Main	Main	Main	Split	Main	Main	Main	Main	Main	Main	Main	Main
% Embeddness:	20-35%	34-50%	>50%	>50%	34-50%	<20%	34-50%	2_20-35%	>50%	34-50%	34-50%	34-50%	34-50%	>50%	>50%	>50%
% Bank Vegetation																
% Bare - Left Bank	10	0	10	0	0	0	0	5	0	0	5	0	0	0	0	0
% Grasses - Left Bank	10	50	35	50	15	25	30	20	40	35	40	20	30	35	45	45
% Shrubs - Left Bank	20	0	0	0	30	20	20	10	5	15	5	30	15	5	5	5
% Trees - Left Bank	10	0	5	0	5	5	0	15	5	0	0	5	10	0	0	0
% Bare - Right Bank	10	0	5	0	0	5	5	0	0	0	5	0	0	0	0	0
% Grasses - Right Bank	40	50	40	50	25	25	25	40	40	40	35	40	25	35	45	45
% Shrubs - Right Bank	0	0	0	0	10	20	15	10	10	0	5	10	20	5	5	5
% Trees - Right Bank	0	0	5	0	15	0	5	0	0	10	5	0	5	10	0	0
% Overhead Canopy	21-40%	0	21-40%	0	21-40%	<1-20%	21-40%	21-40%	21-40%	41-70%	<1-20%	<1-20%	0	<1-20%	0	0

Table A7.1-2: Habitat assessment data June 2019

WC #	WC12	WC13	WC13	WC14	WC14	WC15	WC15	WC15	WC16D	WC16D	WC17	WC17
Transect #:	2	1	2	1	2	1	2	3	1	2	1	2
Date	24-Jun-19	24-Jun-19	24-Jun-19	20-Jun-19	20-Jun-19	20-Jun-19	20-Jun-19	20-Jun-19	20-Jun-19	20-Jun-19	20-Jun-19	20-Jun-19
Transect Location:	Upstream of culvert	Upstream of culvert	Downstream of culvert	Upstream of culvert	Downstream of culvert	Downstream	Downstream	Upstream	Downstream (at tidal mixing area) convergence pool	Below culvert	Downstream	Upstream of culvert
Habitat Type	Run/pool or stagnant water remnant of beaver activity in wetland	Other	Pool	Pool	Pool	Pool	Riffle	Riffle	Pool	Riffle	Riffle	Run
Substrate Type (% of wetted surface area)												
Bedrock (ledge):	0	0	0	0	0	0	0	0	0	0	0	0
Boulder (> 460 mm):	0	0	0	0	0	0	0	0	10	0	0	0
Rock (180 - 460 mm):	0	0	20	0	0	0	5	0	5	10	5	0
Cobble (54 - 179 mm):	0	0	20	0	0	0	0	0	0	25	25	5
Gravel (2.6 - 53 mm):	0	0	20	0	0	0	0	50	10	40	40	5
Sand (0.06 - 2.5 mm):	0	0	10	0	0	0	0	40	75	20	20	20
Fines (0.0005 - 0.05 mm):	100	100	30	100	100	100	95	10	0	5	10	70
% Instream Cover By Type (based on Wetted Area)												
% Turbulence	0	0	5	0	0	0	5	0	5	10	0	0
% Instream vegetation	15	30	0	10	5	5	5	15	30	0	0	0
% Instream Small woody debris	15	5	0	20	15	5	10	0	10	0	5	5
% Undercut Banks	0	0	0	0	0	0	0	0	0	0	0	0
% Other					5% (Wooden bridge)				5% (fishing debris)	%5 culvert section on bank		
Dimensions (m)												
Wet Width (m):	1.1	4.5	3.1	10	6.5	5.5	1.8	0.55	2.2	1.5	1.1	1.5
Bankfull Width (m):	20	22	5	15	7.5	6	2.5	1.2	2.5	3.9	1.6	2.4
Wet Depth 1/4 (m):	0.21	0.45	0.38	0.27	0.2	0.1	0.08	0.04	0.3	0.07	8	0.12
Wet Depth 1/2 (m):	0.21	1.25	0.52	0.3	0.22	0.12	0.11	0.04	0.38	0.04	0.4	0.14
Wet Depth 3/4 (m):	0.19	0.5	0.4	0.3	0.25	0.24	0.11	0.05	0.35	0.07	0.9	0.09
Max Wet Depth (m):	0.41	1.5	0.52	0.35	0.32	0.25	0.11	0.08	0.46	0.23	0.14	0.25
Bankfull Depth Left (m):	0.3	0.2	0.7	0.15	0.5	0.2	0.8	0.2	0.7	0.9	0.33	1.6
Bankfull Depth Right (m):	0.3	0.2	0.7	0.15	0.2	0.36	0.3	0.22	2	1.3	0.4	1.7
Channel Type:	Split	Main	Main	Main	Main	Main	Main	Bogan	Main	Main	Main	Main
% Embeddness:	>50%	>50%	34-50%	>50%	>50%	>50%	>50%	<20%	20-35%	20-35%	20-35%	>50%
% Bank Vegetation												
% Bare - Left Bank	0	0	0	0	0	0	0	40	45	10	30	10
% Grasses - Left Bank	45	0	10	0	15	50	25	0	5	0	5	15
% Shrubs - Left Bank	5	0	40	45	35	0	20	0	0	35	0	0
% Trees - Left Bank	0	0	0	5	0	0	5	10	0	5	15	25
% Bare - Right Bank	0	0	0	0	0	0	5	30	30	5	5	5
% Grasses - Right Bank	45	0	10	15	30	45	10	10	15	5	15	15
% Shrubs - Right Bank	5	0	40	35	20	5	20	0	5	35	0	0
% Trees - Right Bank	0	0	0	0	0	0	15	10	0	5	30	30
% Overhead Canopy	0	0	41-70%	<1-20%	21-40%	<1-20%	41-70%	21-40%	<1-20%	21-40%	21-40%	21-40%

Table A7.1- 3: Metered in-situ Water Quality and Site Observations, June 2019

Watercourse Number	WC02	WC07	WC08	WC09	WC 10 upstream	WC 11	WC12	WC13	WC 14	WC 15	WC 16	WC17
Date:	21-Jun-19	20-Jun-19	20-Jun-19	20-Jun-19	20-Jun-19	21-Jun-19	21-Jun-19	21-Jun-19	19-Jun-19	19-Jun-19	19-Jun-19	20-Jun-19
Conductivity (mS/cm)	0.486	3.06	0.972	0.117	0.054	0.095	0.138	0.077	0.275	0.179	277	0.101
TDS (g/L)	0.35	2.626	0.775	0.056	0.04	0.069	0.105	0.057	0.206	0.126	215	0.079
pH	6.9	7.0	6.8	6.6	4.2	5.7	6.5	6.2	6.3	6.8	7.4	6.0
Dissolved Oxygen (mg/L)	0	2.68	0.28	6.38	3.71	6.67	0.91	5.34	note 1	1.39	8.91	5.38
Dissolved Oxygen (%)	0	24.8	3.6	66.1	36.8	69	9.9	56.8	note 1	1.59	91.4	55.3
ORP (mV)	142.5	100.6	106.6	125.7	169.1	141.9	152.7	106.5	78.9	101.4	55.1	144.1
Water Temperature (°C)	14.8	12.2	15.8	18.2	18.3	19.4	16.5	18.4	17.4	21.0	16.9	16.0
Weather:	Overcast	Overcast	Sunny	Sunny	Sunny	Rain	Rain	Rain	Sunny	Sunny	Sunny	Sunny
Air Temperature (°C)	14	18	18	27	27	14	14	14	24	22	20	0
Water Level:	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Water Clarity:	Fair	Fair	Poor	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Good	Fair
1) meter malfunction, recalibrated prior to collecting other data												

Table A7.1-4: Surface Water Analytical Data, May-June, 2019

	Units/ Date	CME WQG Freshwater	CME WQG Marine	WC02	WC02 Dup C	WC03 *	WC03B	WC07-U East	WC07-U West	WC07-Pond	WC07-D	WC08-U	WC08-D	WC09-U	WC09-Mid	WC09-D	WC09-D Dup B	WC09B-U	WC09B-D	WC10-U	WC10-D	WC11-U	WC11-D	
				03-Jun-19	03-Jun-19	03-Jun-19	03-Jun-19	04-Jun-19	04-Jun-19	04-Jun-19	04-Jun-19	04-Jun-19	03-Jun-19	03-Jun-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19
Laboratory Results																								
Hardness (CaCO3)	mg/L	---	---	24	24	1600	150	-	-	250	170	77	69	17	-	18	17	-	-	4.4	4.8	8	14	
Calculated TDS	mg/L	---	---	70	68	6800	450	-	-	1100	590	210	210	45	-	49	51	-	-	13	16	27	63	
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	---	---	20	21	130	160	-	-	110	94	64	64	11	-	10	11	-	-	<1.0	<1.0	<1.0	6.8	
Carb. Alkalinity (calc. as CaCO3)	mg/L	---	---	<1.0	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	<1.0	
Alkalinity	mg/L	---	---	21	21	130	160	-	-	110	95	64	65	11	-	10	11	-	-	<5.0	<5.0	<5.0	6.8	
Dissolved Chloride (Cl-)	mg/L	120	---	18	18	3300	160	-	-	550	300	83	88	18	-	20	20	-	-	5.5	7.4	13	31	
Colour	TCU	variable ²	variable ²	27	26	53	150	-	-	22	31	85	53	230	-	220	240	-	-	260	260	270	260	
Nitrate (N)	mg/L	2.94	45.25	0.25	0.23	<0.050	<0.050	-	-	0.079	0.083	<0.050	<0.050	<0.050	-	<0.050	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	
Nitrite (N)	mg/L	0.06	---	<0.010	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	-	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	
Nitrate + Nitrite (N)	mg/L	---	---	0.25	0.23	<0.050	<0.050	-	-	0.079	0.083	<0.050	<0.050	<0.050	-	<0.050	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	
Ammonia (N)	mg/L	variable ²	---	<0.050	<0.050	<0.050	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	<0.050	-	<0.050	<0.050	-	-	<0.050	<0.050	<0.050	<0.050	
Total Organic Carbon (C)	mg/L	---	---	4.3	4.1	13	19	-	-	7.8	8.2	14	10	22	-	22	22	-	-	25	25	25	25	
Orthophosphate (P)	mg/L	---	---	0.01	<0.010	<0.010	0.12	-	-	<0.010	<0.010	<0.010	<0.010	0.012	-	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	
pH	pH	6.5-9	7.0-8.7	7.45	7.48	7.49	7.62	-	-	7.72	7.46	7.36	7.75	6.54	-	6.58	6.71	-	-	5.40	5.12	5.84	6.08	
Reactive Silica (SiO2)	mg/L	---	---	2.9	3.1	5.1	6.7	-	-	3.6	4.9	4.4	4.8	1.8	-	2.1	4.9	-	-	1.7	1.6	0.98	1.4	
Total Suspended Solids	mg/L	variable ¹	variable ¹	4	4.6	16	6	4.2	<1.0	6	<1.0	3	1.6	2.6	2.2	1.2	2.0	1.2	2.6	2.4	<1.0	4	3	
Dissolved Sulphate (SO4)	mg/L	---	---	11	9.6	470	18	-	-	40	12	4.3	4.3	<2.0	-	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	
Turbidity	NTU	variable ¹	variable ¹	9.1	10	6.1	5	-	-	4	0.38	1.9	0.9	1.1	-	1	1	-	-	0.35	0.52	1.7	1.2	
Conductivity	µS/cm	---	---	120	120	11000	830	-	-	2100	1200	390	410	78	-	86	89	-	-	34	38	52	120	
Total Aluminium (Al)	µg/L	5-100 ¹	---	410	260	110	91	-	-	210	10	100	50	260	-	260	230	-	-	270	270	180	190	
Total Antimony (Sb)	µg/L	---	---	<1.0	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	<1.0	
Total Arsenic (As)	µg/L	5	12.5	<1.0	<1.0	<1.0	4.6	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	<1.0	
Total Barium (Ba)	µg/L	---	---	34	34	240	250	-	-	160	140	100	70	36	-	36	33	-	-	12	13	49	67	
Total Beryllium (Be)	µg/L	---	---	<1.0	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	<1.0	
Total Bismuth (Bi)	µg/L	---	---	<2.0	<2.0	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	
Total Boron (B)	µg/L	1,500	---	<50	<50	1100	<50	-	-	<50	<50	<50	<50	<50	-	<50	<50	-	-	<50	<50	<50	<50	
Total Cadmium (Cd)	µg/L	0.04-0.37 ²	0.12	0.015	0.013	0.16	0.02	-	-	3.2	0.046	0.048	0.025	0.021	-	0.022	0.022	-	-	0.021	0.011	0.02	0.032	
Total Calcium (Ca)	µg/L	---	---	7000	6800	140000	53000	-	-	84000	56000	25000	23000	5100	-	5300	5100	-	-	1100	1300	2500	4300	
Total Chromium (Cr)	µg/L	1 ²	1.5 ²	1.3	1.4	<1.0	1.2	-	-	1.5	<1.0	1.3	<1.0	1.7	-	1.4	1.2	-	-	1.8	1.3	1.5	1.7	
Total Cobalt (Co)	µg/L	---	---	<0.40	<0.40	<4.0	1.3	-	-	<0.40	<0.40	0.68	<0.40	<0.40	-	<0.40	<0.40	-	-	<0.40	<0.40	<0.40	<0.40	
Total Copper (Cu)	µg/L	2.4 ³	---	1.3	1.2	<5.0	0.89	-	-	2.7	1.1	1.6	1.7	0.92	-	0.76	0.86	-	-	<0.50	0.52	<0.50	0.77	
Total Iron (Fe)	µg/L	300	---	360	350	2000	4700	-	-	490	54	930	310	670	-	720	670	-	-	490	510	1300	1400	
Total Lead (Pb)	µg/L	1.7 ²	---	<0.50	<0.50	<5.0	<0.50	-	-	0.63	<0.50	0.53	<0.50	0.57	-	0.52	<0.50	-	-	0.61	0.64	<0.50	<0.50	
Total Magnesium (Mg)	µg/L	---	---	1600	1600	290000	4800	-	-	9200	7700	3200	3000	1100	-	1200	1100	-	-	390	410	460	700	
Total Manganese (Mn)	µg/L	---	---	47	47	2100	2600	-	-	1500	170	680	64	120	-	170	150	-	-	55	61	220	250	
Total Mercury (Hg)	µg/L	0.026	0.016	<0.013	<0.013	<0.013	<0.013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total Molybdenum (Mo)	µg/L	73	---	<2.0	<2.0	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	
Total Nickel (Ni)	µg/L	25-150 ²	---	<2.0	<2.0	<2.0	<2.0	-	-	2.5	<2.0	<2.0	<2.0	<2.0	-	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	
Total Phosphorus (P)	µg/L	---	---	<100	<100	<1000	320	-	-	<100	<100	<100	<100	<100	-	<100	<100	-	-	<100	<100	<100	<100	
Total Potassium (K)	µg/L	---	---	760	750	93000	7200	-	-	2600	990	1300	1100	420	-	450	440	-	-	<100	<100	110	190	
Total Selenium (Se)	µg/L	1	---	<1.0	<1.0	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0	-	-	<1.0	<1.0	<1.0	<1.0	
Total Silver (Ag)	µg/L	0.25	7.5 ²	<0.10	<0.10	<1.0	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	-	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	
Total Sodium (Na)	µg/L	---	---	14000	14000	2500000	97000	-	-	320000	160000	48000	48000	11000	-	13000	12000	-	-	3800	5100	8100	20000	
Total Strontium (Sr)	µg/L	---	---	32	31	1800	150	-	-	260	210	110	110	19	-	22	20	-	-	4.8	5.5	9.4	15	
Total Thallium (Tl)	µg/L	0.8	---	<0.10	<0.10	<1.0	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	-	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	
Total Tin (Sn)	µg/L	---	---	<2.0	<2.0	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	
Total Titanium (Ti)	µg/L	---	---	8.4	8.2	<20	3.9	-	-	6.3	<2.0	3	2	3.7	-	3.3	3.5	-	-	<2.0	2.5	2.1	2.6	
Total Uranium (U)	µg/L	15	---	<0.10	<0.10	<1.0	0.12	-	-	0.24	<0.10	<0.10	<0.10	<0.10	-	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	
Total Vanadium (V)	µg/L	---	---	<2.0	<2.0	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	<2.0	-	-	<2.0	<2.0	<2.0	<2.0	
Total Zinc (Zn)	µg/L	7 ²	---	<5.0	<5.0	<5.0	<5.0	-	-	28	<5.0	6.2	<5.0	<5.0	-	<5.0	<5.0	-	-	<5.0	<5.0	<5.0	<5.0	
Field Parameters																								
temperature	°C	---	---	13	-	12.5	16.6	10	21.7	19.4	12.9	17.6	14.9	11.5	9.4	11.3	-	-	10.8	10.6	10.4	10	13	
pH	pH	6.5-9	7.0-8.7	6.6	-	7.6	7.3	7.5	7.7	7.7	7.1	6.9	7.4	5.6	5.0	5.7	-	-	3.4	4.1	3.3	3.3	5.0	5.1

Table A7.1-4: Surface Water Analytical Data, May-June, 2019

	Units/ Date	CCME WQG Freshwater	CCME WQG Marine	WC12-U	WC12-D	WC13-U	WC13-D	WC13B-D	WC17-U	WC17-D	WC17-D Dup A	WC14-U	WC14-D	WC15-U	WC15-D	WC16-D	Notes
				27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	27-May-19	04-Jun-19	
Laboratory Results																	Canadian Ministers of the Environment (CCME) Water Quality Guidelines (WQG) for the Protection of Aquatic Life, Freshwater and Marine
Hardness (CaCO3)	mg/L	---	---	23	23	14	15	19	14	14	15	9.3	11	6	22	43	All samples were compared to the freshwater WQGs and WC2, WC3, WC5, and WC16 have been additionally compared to the marine WQGs.
Calculated TDS	mg/L	---	---	41	43	26	30	30	30	37	38	75	100	16	78	130	Field parameters collected with YSI Professional Plus Handheld multimeter
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	---	---	21	22	9.1	8.4	24	9.1	8.6	9.6	10	14	<1.0	15	39	
Carb. Alkalinity (calc. as CaCO3)	mg/L	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Alkalinity	mg/L	---	---	21	22	9.1	8.4	24	9.1	8.6	9.6	10	14	<5.0	15	39	
Dissolved Chloride (Cl-)	mg/L	120	---	9.6	11	8.2	11	31	10	15	15	28	41	6.3	33	49	
Colour	TCU	variable ^b	variable ^b	68	67	210	200	46	130	140	150	140	89	390	290	130	
Nitrate (N)	mg/L	2.94	45.25	0.053	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	
Nitrite (N)	mg/L	0.06	---	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	
Nitrate + Nitrite (N)	mg/L	---	---	0.053	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	
Ammonia (N)	mg/L	variable ^d	---	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.06	
Total Organic Carbon (C)	mg/L	---	---	10	10	20	20	9.5	18	17	17	16	13	30	22	14	Highlight: exceedance to the CCME FWAL WQG
Orthophosphate (P)	mg/L	---	---	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.021	<0.010	<0.010	<0.010	<0.010	Bold: an exceedance to the marine WQG
pH	pH	6.5-9	7.0-8.7	7.03	6.95	6.39	6.28	7.04	6.20	6.34	6.36	6.35	6.68	5.31	6.74	7.37	No Obs. Flow - the estimated flow rate was imperceptible
Reactive Silica (SiO2)	mg/L	---	---	2.4	2.5	1.5	1	4.6	1.5	1.7	2.2	3.2	3.9	3	4	4.7	Italics: detection limit exceeds applicable guideline
Total Suspended Solids	mg/L	variable ^e	variable ^e	<1.0	<1.0	1.4	10	<1.0	2.6	<1.0	<1.0	1.8	1	1.4	2.6	1.8	a) based on hardness
Dissolved Sulphate (SO4)	mg/L	---	---	<2.0	<2.0	<2.0	<2.0	7.3	<2.0	<2.0	<2.0	9.4	11	<2.0	2.4	6.8	b) The guidelines for trivalent and hexavalent chromium are 8.9 and 1.0 µg/L, respectively for freshwater long term exposure and 56 and 1.5 µg/L, respectively for marine long term exposure (FWAL 1997). Total chromium is reported by the lab and compared to the more stringent guidelines (1.0 µg/L and 1.5 µg/L for freshwater and marine, respectively).
Turbidity	NTU	variable ^e	variable ^e	1.1	0.33	0.39	1.8	1.2	0.38	0.19	0.97	0.87	0.81	1.1	1.6	1.6	c) based on a short term exposure scenario
Conductivity	µS/cm	---	---	67	78	48	54	140	51	68	68	130	170	38	140	240	d) Field pH and temperature dependant
Total Aluminium (Al)	µg/L	5-100 ^f	---	50	47	170	300	110	330	160	160	230	190	420	280	140	e) The mean absorbance of filtered water samples at 456 nm shall not be significantly higher than the seasonally adjusted expected value for the system under consideration (CCME, 1999).
Total Antimony (Sb)	µg/L	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	f) For clear flow, maximum increase in TSS of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d). For high flow, maximum increase in TSS of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is ≥ 250 mg/L (CCME, 1999).
Total Arsenic (As)	µg/L	5	12.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	g) For clear flow, maximum increase in turbidity of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period). For high flow or turbid waters, maximum increase in turbidity of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Should not increase more than 10% of background levels when background is > 80 NTUs.
Total Barium (Ba)	µg/L	---	---	80	77	46	51	76	37	30	31	20	22	12	45	59	h) The guideline shown is for dissolved zinc, based on a long term exposure scenario and is for surface water of 50 mg/L hardness, pH of 7.5 and 0.5 mg/L DOC. Please see Guideline Technical Document for conversion information (CCME 2018).
Total Beryllium (Be)	µg/L	---	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	i) based on pH
Total Bismuth (Bi)	µg/L	---	---	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
Total Boron (B)	µg/L	1,500	---	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	
Total Cadmium (Cd)	µg/L	0.04-0.37 ^g	0.12	<0.010	<0.010	<0.010	0.014	0.014	0.014	<0.010	<0.010	0.018	0.016	0.029	0.039	0.033	
Total Calcium (Ca)	µg/L	---	---	6800	6700	3500	3800	5000	3500	3600	3600	2700	3400	1300	6500	13000	
Total Chromium (Cr)	µg/L	1 ^h	1.5 ^h	1.1	1.3	1.3	1.3	1.4	1.3	1.1	1.5	1.6	1.3	1.1	1.5	1.2	
Total Cobalt (Co)	µg/L	---	---	<0.40	<0.40	<0.40	<0.40	<0.40	0.45	<0.40	<0.40	<0.40	<0.40	<0.40	1.4	<0.40	
Total Copper (Cu)	µg/L	2.4 ^h	---	<0.50	0.53	<0.50	0.76	1.7	0.78	0.63	<0.50	2.5	2.2	0.57	1.6	1.2	
Total Iron (Fe)	µg/L	300	---	200	180	380	640	350	1200	360	350	560	480	490	1000	740	
Total Lead (Pb)	µg/L	1.7 ^h	---	<0.50	<0.50	<0.50	<0.50	<0.50	0.72	<0.50	<0.50	<0.50	<0.50	1.1	0.9	<0.50	
Total Magnesium (Mg)	µg/L	---	---	1500	1400	1200	1300	1600	1300	1300	1300	640	650	640	1400	2600	
Total Manganese (Mn)	µg/L	---	---	46	40	53	99	470	100	38	40	47	160	81	900	900	
Total Mercury (Hg)	µg/L	0.026	0.016	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total Molybdenum (Mo)	µg/L	73	---	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
Total Nickel (Ni)	µg/L	25-150 ^h	---	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
Total Phosphorus (P)	µg/L	---	---	<100	<100	<100	<100	<100	110	<100	<100	<100	<100	<100	<100	<100	
Total Potassium (K)	µg/L	---	---	310	330	400	430	640	440	420	400	670	570	190	640	910	
Total Selenium (Se)	µg/L	1	---	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Total Silver (Ag)	µg/L	0.25	7.5 ^h	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Total Sodium (Na)	µg/L	---	---	7200	7800	5500	7200	24000	6300	9300	9200	24000	30000	3500	19000	28000	
Total Strontium (Sr)	µg/L	---	---	19	19	11	11	15	12	12	12	6.7	8.4	5.7	18	31	
Total Thallium (Tl)	µg/L	0.8	---	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Total Tin (Sn)	µg/L	---	---	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
Total Titanium (Ti)	µg/L	---	---	<2.0	<2.0	2.4	5.2	2.1	5.8	2.4	<2.0	2.7	2.2	4.9	3.5	<2.0	
Total Uranium (U)	µg/L	15	---	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Total Vanadium (V)	µg/L	---	---	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
Total Zinc (Zn)	µg/L	7 ^h	---	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
Field Parameters																	
temperature	°C	---	---	10.3	10.7	11.7	11.7	7.8	10.7	10.7	-	11	11.1	11.2	19.3	15.3	
pH		6.5-9	7.0-8.7	5.3	5.9	5.3	5.2	5.8	5.2	5.2	-	5.7	6.1	4.0	6.5	6.6	
Conductivity	µS/cm	---	---	59	63	41	46	111	42	57	-	104	146	32	142	207	
Dissolved Oxygen	mg/L	---	---	8.3	8.0	5.2	6.7	8.9	5.5	8.1	-	6.2	8.5	5.8	6.0	9.4	
Estimated Flow Rate	m/sec	---	---	0.36	No Obs. Flow	0.24	0.40	0.11	0.08	0.13	-	No Obs. Flow	0.02	0.11	0.03	0.2	

Table A7.1- 5 Fish Captured June 2019

Site	Method	Effort	Fish Captured	Fork Length (mm)	Mass (g)	Date	Notes
WC02 upstream of culvert	Electrofishing	108 sec	ninespine stickleback (8 fish)	<2mm	0.83	24-Jun-19	batch weight of 8 fish obtained
WC07 Pond	Electrofishing	80 sec	no fish	NA	NA	21-Jun-19	High aquatic vegetation with stagnant water. Noted movement in water. Presumed to be tadpoles.
WC08 (multiple locations)	Electrofishing	300 sec	no fish	NA	NA	21-Jun-19	-
WC09 from culvert crossing to t1	Electrofishing	485 sec	brook trout (young of year)	36	0.45	19-Jun-19	-
			brook trout	123	23.47		
			common white sucker	59	1.93		
			common white sucker	56	1.62		
			common white sucker	63	2.32		
			dace species (possibly black nose)	62	3.25		
			common white sucker	62	2.88		
			common white sucker	52	1.37		
			common white sucker	52	5.8		
			Shiner species (possibly black nose)	72	2.44		
			common white sucker	56	2.09		
			common white sucker	54	2.2		
WC10 upstream		50 sec	no fish	NA	NA	20-Jun-19	tadpoles
WC10 downstream	Electrofishing	45 sec	no fish	NA	NA	20-Jun-19	-
WC11	Minnow Trap	8hr 40 min	no fish	NA	NA	20-21-Jun-19	-
WC12	Minnow Trap	13 hours, 40 min	no fish	NA	NA	20-21-Jun-19	-
WC13 Culvert Plunge Pool	Electrofishing	220 sec	ninespine stickleback	46	0.54	20-21-Jun-19	-
			ninespine stickleback	47	0.71		
			ninespine stickleback	21	3.61		
WC15 at culvert	Electrofishing	118 Sec	no fish	NA	NA	19-Jun-19	Next to highway and wetland. No fish observed. Organic substrate.
WC16 at culvert	Electrofishing	130 sec	ninespine stickleback	NA	NA	19-Jun-19	Benthics at transect 1 include anthropods and beetles. Transect 1 has rip rap/armour stone on river bank. Aquatic vegetation is mainly seaweed washed in from Caribou Harbour.
WC17	Electrofishing	278 sec	fourspine stickleback	49	1.01	19-Jun-19	-
			ninespine stickleback	45	0.72		
			ninespine stickleback	48	0.77		

Notes: NA not applicable

The average channel and wetted widths in the storm water discharge area is in the order of 2-3 m. Average measured water depth was less than 0.1 m until the tidal area, at which point, depth increases to over 1 m as it enters the harbour.

Fish habitat is not present within the freshwater section of WC03. However, fish species within the East River/Pictou Harbour estuary that have potential to use the tidally-influenced area include brook trout and various stickleback species (Possibly also gaspereau/alewife/herring (*Alosa* spp), striped bass, silversides, and other estuarine fish). Due to the conductivity levels of the area with potential for habitat, electrofishing could not be conducted.

Within the tidal section, the CCME FWAL for chloride, iron, and aluminum do not apply. However, chloride and iron exceedances of the CCME FWAL were noted in the ditch upstream in June 2019. The total chromium concentration was above the hexavalent chromium guideline, but below the trivalent chromium guideline.

Unnamed Tributary to Haliburton Brook (WC07)

WC07 is an unnamed tributary to the Haliburton Brook. The watercourse is small and intermittent and has been highly disturbed by development of the Pictou Roundabout, including multiple drainage culvert crossings. Upstream of the roundabout, the majority of the watercourse is ditched within an open wetland area. Within the centre of the roundabout, an engineered pond exists. Flowing westward and downstream of the roundabout, further ditching occurs for about 200 m, at which point the watercourse enters a shrub wetland area and has a somewhat defined channel. Approximately 400 m downstream (to the west) of entering the shrub and forest, the watercourse enters Haliburton Brook.

At the time of the June 2019 survey the watercourse was at a moderate flow level. Watercourse morphology may be identified as a run, but it is generally ditched within the developed roundabout area. Watercourse width varied from less than a metre to approximately 4 m bankfull. The central engineered pond was about 30 m in diameter. Water depth was generally less than 0.3 m, but increased to 0.75 m depth in the central pond. Flow within the pond was limited and the water appeared stagnant during the summer 2019 surveys. Substrate was dominated by fines. Cattails and grasses encroached on the watercourse throughout the area. Aquatic macrophytes were extensive in the pond. Electrofishing was attempted within the pond, but only tadpoles were observed and no fish were captured. Electrofishing within the ditch area also resulted in no captured fish. Given the limited access, limited flow, substrate dominated by fines and low dissolved oxygen levels, fish are not anticipated to occur within the ditched portion of this watercourse. At a minimum, seasonal fish habitat is anticipated for brook trout (and small forage fish) approximately 400 m downstream of the roundabout.

CCME FWAL exceedances in June 2019 included chlorides (consistent with the roadside location), metals including aluminum, cadmium, chromium, iron, and zinc (which are believed to be generally reflective of the sediment present).

Unnamed Tributary to Haliburton Brook (WC08)

WC08 is a small, semi-permanent watercourse that appears to originate in a forested area east of Pine Tree Road, near the Pictou Roundabout. Flowing east to west, WC08 is conveyed under Pine Tree Road, Highway 106 and Route 6 via concrete culverts before finally emptying into Haliburton Brook, over 600 m downstream of Highway 106.

WC08 was at a moderate-level water stage at the time of the assessment in June 2019 and primarily exhibited a sinuous channel pattern consisting primarily of short riffle-run sequences. Small pools were present throughout.

Upstream of Pine Tree Road, flow was very low and stagnant with a flow path wide (over 3 m) and shallow (less than 0.1 m). The substrate was dominated by fines. Grasses dominated the bank cover and overhead cover was up to 40%. Dissolved oxygen was low at this location.

Between Highway 106 and Route 6, the substrate included cobble (5%), gravels (20%), sand (60%) and fines (10%). Stream width decreased to under 1 m and depth 0.1-0.25 m. Canopy cover was less than 20% and included both shrubs and grasses.

Downstream of Route 6, fish habitat characteristics improved and riffle habitat increased. The substrate included rock (20%), cobble (30%), gravel (20%), sand (20%), and fines (10%). Both banks were present and composed primarily of fines. Some bank-undercutting was observed. In-stream cover was abundant, consisting of small woody debris. Bank cover included herbaceous ferns and grass and overhead cover was up to 40% comprised of mixed wood forest.

Electrofishing throughout this watercourse did not capture any fish. Habitat for salmonids was poor until at least 400 m downstream of Route 6. Seasonal habitat for forage fish is likely present when flows permit. Few deep pools were identified as summer or winter refuge.

Iron was above the CCME FWAL when sampled in June 2019. The total chromium concentration was above the hexavalent chromium guideline but below the trivalent chromium guideline, which is more likely to be the dominant form present.

Unnamed Tributary to Haliburton Brook (WC09)

WC09 is a permanent watercourse that originates in wetlands over 1 km upstream of the ROW, flows through WL-7, then is conveyed under Highway 106 by a set of two concrete culverts. Downstream of Highway 106, the watercourse meanders through a fringing graminoid and alder wetland before it confluences with the main stem of Haliburton Brook to the southwest. Haliburton Brook widens into a ponded area over 700 m downstream of Highway 106.

WC09 was at a moderate-level water stage at the time of the June 2019 field visit. The channel pattern observed was sinuous in sections and straight in other sections. Width varied from 1 to 5 m and depth ranged from 0.1 to 0.3 m. The morphology of this watercourse consisted primarily of riffle/run. Substrate in the riffle sections were dominated by cobble (35-40%), gravel (30%), and sand (15-25%), with some rock (5%) and fines (5-10%). Substrate in the run sections were also dominated by gravel

(40%) and sand (30%), with some rock (5%), cobble (10%), and fines (10%). Banks were well defined and in-stream cover was provided by abundant in-stream and over-hanging vegetation, as well as a moderate amount of bank-undercutting.

Electrofishing downstream of Highway 106 captured numerous fish: two brook trout, eight common sucker (*Catostomus commersoni*), and two minnow species (dace, *Couesius* sp. and shiner, *Notemigonus* sp.). Overall, habitat for brook trout was good and included rearing and spawning habitat, but no significant pools were observed. Atlantic salmon (*Salmo salar*) juvenile rearing habitat is unlikely but poor habitat is present within the Highway 106 ROW. Potential habitat for other fish species included American eel (*Anguilla rostrata*) adult foraging habitat. It is unknown if obstructions to anadromous fish passage are present downstream, but if passage is possible, potential fish that may travel up the watercourse could include gaspereau/blueback herring (*Alosa pseudoharengus* and *A. aestivalis*) and smelt (*Osmerus mordax*).

The laboratory and field reported pH was below the applicable CCME FWAL recommended range in May 2019 and June 2019. In addition, aluminum and iron and were above the recommended CCME FWAL. The total chromium concentration was above the hexavalent chromium guideline but below the trivalent chromium guideline, which is more likely to be the dominant form present.

Unnamed Tributary to Haliburton Brook (WC10)

WC10 is a small intermittent watercourse that originates in the large wetland (WL-8/WL-9) located to the north of Highway 106, and conveyed under Highway 106 by a corrugated metal culvert to WL-8 and travels over 200 m downstream before joining Haliburton Brook (WC09).

WC10 was at a moderate-level water stage at the time of the June 2019 field visit. Watercourse width varied from 2 m where channelized, to 10 m within wetland areas. Water depth varied from 0.1 m to 0.4 m. The channel pattern observed was sinuous. The morphology of this watercourse consisted primarily of run/flat associated with wetland and short runs and small pools. Substrate appeared to primarily consist of cobbles; however, due to the high water riffles (including as a result of beaver debris) visibility of substrate was limited. A large ponded area (i.e., pool) at the culvert outlet occurred downstream of the Highway 106 crossing. Substrate was dominated by sand (50%) and fines (30-40%), with a higher fines component in the culvert pool and minor boulder (<10%), rock (<10%) and cobble (<20%). Bank vegetation reflected the surrounding wetland shrub and grass/sedge cover type, providing up to 20% overhead cover. Minor amounts of in-stream vegetation was present.

Only tadpoles were observed during electrofishing and no fish were captured within the upstream or downstream portion of the Highway 106 ROW in June 2019. Poor potential for seasonal for habitat brook trout and for forage species, such as minnows, was present.

The laboratory and field reported pH was below the applicable CCME FWAL recommended range in May 2019 and June 2019. In addition, aluminum and iron and were above the recommended CCME FWAL. The total chromium concentration was above the hexavalent chromium guideline but below the trivalent chromium guideline, which is more likely to be the dominant form present.

Unnamed Tributary to Haliburton Brook (WC11)

WC11 was at a moderate-level water stage at the time of the June 2019 field visit. This watercourse flows via a culvert beneath Highway 106. This is an intermediate sized, permanent wetland channel with an apparent slow flow (based on field observations). WC11 appears to flow from WL-10 westward towards WL-9 and then continues further to the southeast to join with WC10/Haliburton Brook. Within WL-10, a permanently flooded birch tree dominated fen, the watercourse lines the road ditch. Immediately west of Highway 106, WC11 consists of a large channel within a shrub swamp (WL-9). A beaver lodge was noted on the west side of the highway and it is expected that beaver activity likely contributes to the flood level within the wetland.

Watercourse width during the June 2019 field visit varied from 6 m to 8 m in the channel and up to 25 m within the floodplain. Watercourse depth also varied from 0.5 m to over 2 m where flooded. The morphology of this watercourse consisted primarily of run associated with wetlands, which in places was deep enough to constitute a pool. Substrate was dominated by fines throughout. Bank vegetation reflected the surrounding wetland shrub and grass/sedge cover type. Overhead cover was up to 20%. Minor amounts of in-stream vegetation was present.

No fish were captured or observed in WC11 and only tadpoles were caught during an 8 hour minnow trap set in June 2019. Habitat present for brook trout is considered unlikely within the ROW, but may be seasonal. Access from downstream areas was poor due to the shallow, braided nature of wetland flow paths. Furthermore, both the pH and dissolved oxygen were low, reflecting the stagnant, bog-like wetland conditions. Lastly, a high sediment load was noted in the substrate. However, habitat within the ROW may be suitable for forage fish and eels.

The laboratory and field reported pH was below the applicable CCME FWAL recommended range in May and June 2019. In addition, aluminum and iron were above the recommended CCME FWAL. The total chromium concentration was above the hexavalent guideline but not the trivalent guideline more likely to be the dominant form present.

Mill Brook (WC12)

Mill Brook (WC12) runs from southeast to northwest and is permanent watercourse in the vicinity of Highway 106. Mill Brook receives drainage from wetlands, forests, and urban land, and eventually discharges to Caribou Harbour over 2 km to the northwest. Mill Brook receives drainage from a wetland to the south and the channel flows northwest and crosses Highway 106 via a concrete culvert and flows into a cattail marsh before confluence with WC13. A beaver dam historically occurred downstream of the highway which impounded that area historically. A beaver lodge was observed during the field survey.

WC12 was at a moderate-level water stage at the time of the June 2019 field visit. Channel pattern observed was sinuous. Watercourse width varied from 1 m to 5 m in the channel and up to 25 m within the floodplain. Watercourse depth also varied from 0.5 m to nearly 2 m within the ponded area west of the highway. The morphology of this watercourse consisted primarily of runs associated with wetlands, which in places was deep enough to constitute a pool. Substrate was dominated by fines throughout.

Bank vegetation reflected the surrounding wetland shrub and grass/sedge cover type. Minor amounts of in-stream vegetation was present.

No fish were captured during a 13-hour minnow trap set in June 2019. Habitat for brook trout is unlikely, but may be seasonal. Access from downstream areas was poor due to the shallow, braided nature of wetland flow paths. Furthermore, the pH was low reflecting bog wetland conditions and substrate had a high sediment load. Habitat was suitable for forage fish and eels.

The field reported pH was below the applicable CCME FWAL recommended range in May 2019 and June 2019. In addition, aluminum was above the recommended CCME FWAL.

Tributary to Mill Brook (WC13)

The Tributary to Mill Brook (WC13) is a ponded area associated with WL-13 that spans Highway 106. Approximately 500 m downstream of the wetland pond, WC13 joins with WC12 (Mill Brook) and, over 2 km downstream, enters Caribou Harbour.

WC13 was at a moderate-level water stage at the time of the June 2019 field visit. No channel pattern was observed within the pond, but the downstream drainage was sinuous. The ponded area was over 150 m wide and generally less than 1 m deep in places. Substrate within the pond was dominated by fines. Extensive aquatic vegetation, predominantly lilies, was present within this shallow pond.

The discharge watercourse downstream of the ponded wetland width varied from 3 m to 5 m in the channel. The morphology of this watercourse consisted primarily of run and a culvert plunge pool. Substrate consisted of rock (20%), cobble (20%), gravel (20%), sand (10%), and fines (30%). Overhead cover included grasses and shrubs and was estimated at up to 70%.

Electrofishing in the plunge pool at the outlet to the wetland (i.e., Highway 106 culvert outlet) captured three ninespine stickleback. Poor habitat was present for brook trout and access from downstream areas was poor due to the shallow, braided nature of wetland flow paths. Habitat was suitable for forage fish and eels.

The field and laboratory reported pH was below the applicable CCME FWAL recommended range in May 2019 and June 2019. In addition, aluminum and iron were above the recommended CCME FWAL. The total chromium concentration was above the hexavalent chromium guideline but below the trivalent chromium guideline, which is more likely to be the dominant form present.

Unnamed Tributary to Mill Brook (WC17)

This small unnamed tributary to Mill Brook (WC17) upstream of Highway 106 receives flow from two sources, one roughly paralleling the highway and one from a wetland to the south. The watercourse crosses the highway in a corrugated metal culvert and then flows approximately 200 m to join with WC13 on the west side of Highway 106. Mill Brook enters Caribou Harbour over 3 km downstream of WC13.

WC17 was at a moderate-level water stage at the time of the June 2019 field reconnaissance. The watercourse upstream of the highway was predominantly a shallow run, while the downstream section was a mixed riffle/run.

Typical watercourse width varied from 1 m to 2 m with depth in riffles less than 0.2 m and depth in the runs typically less than 0.3 m. Riffle substrate was dominated by gravel (40%), with rock (5%), cobble (25%), sand (20%), and fines (10%). In the runs, substrate was predominantly fines (70%) with sand (20%), gravel (5%), and cobble (5%). Overhead cover providing shade (and cover) was ranged between 20-40%.

Electrofishing captured two ninespine stickleback and one fourspine stickleback. Poor habitat was present for brook trout. Limited refuge habitat (pools) and poor cover reduced the quality of habitat. Habitat was suitable for forage fish and eels.

The field and laboratory reported pH was below the applicable CCME FWAL recommended range in May 2019 and June 2019. In addition, aluminum and iron were above the recommended CCME FWAL. The total chromium concentration was above the hexavalent chromium guideline but below the trivalent chromium guideline, which is more likely to be the dominant form present.

Unnamed Tributary to Caribou Harbour (WC14)

Watercourse WC14 is a small, intermittent flow along wetland drainage with historical beaver activity. Habitat was dominated by fines and organics with multiple signs of past beaver activity. An all-terrain vehicle (ATV) bridge crossing has also impacted the habitat characteristics of this watercourse. Flow was insufficient to provide fish habitat and a defined channel was not present for most of the area examined, with the exception of stagnant ponded areas. However, it is anticipated that fish habitat is present further downstream.

Unnamed Tributary to Caribou Harbour (WC15)

WC15 is a small, intermittent and partially ditched watercourse. It receives ditch drainage from both the west and east side of Highway 106 and may be headwaters to WC16. Flow from the east side crosses to the west side in a culvert, just south of Three Brooks Road Overpass structure. WC15 was at a moderate-level water stage at the time of the June 2019 field visit. Eventual discharge is over 500 m to the north at the Caribou Harbour.

The approximate width of the watercourse during the June 2019 field visit ranged from <1 m to over 5 m and the average depth was generally < 0.2 m. Stream character included pool and riffle areas. Substrate was dominated by fines and/ or organics, for much of the area observed. In the riffle areas substrate was composed of 50% gravel, 40% sand, and 10% fines. Cover in the ditched section was dominated by emergent vegetation (i.e., rushes and cattails) and mixed conifers and broad leaf vegetation growing on the banks. Overhead cover ranged from <1% in the ditches to over 70% in downstream shrubs.

Electrofishing at the culvert pool did not result in any fish captured. Poor habitat was present for brook trout. Limited refuge habitat (pools) and poor cover reduced the quality of habitat. As access to better

habitat areas is unlikely, it is not anticipated to provide brook trout habitat. Habitat was suitable for forage fish and eels.

The field and laboratory reported pH was below the applicable CCME FWAL recommended range in June 2019. In addition, aluminum, lead, and iron were above the recommended CCME FWAL. The total chromium concentration was above the hexavalent chromium guideline but below the trivalent chromium guideline, which is more likely to be the dominant form present.

Unnamed Tributary to Caribou Harbour (WC16)

WC16 is a small intermittent to semi-permanent watercourse that flows through a forested area in close proximity to Highway 106 (approximately 12 m west of the highway) before discharging directly into Caribou Harbour, immediately adjacent the Northumberland Ferries marine terminal. WC16 emerges directly from a perched culvert approximately 15 m upstream and is very steep. Both the perched culvert and steepness of WC16 represent likely barriers to fish access and passage.

Electrofishing in June 2019 captured one ninespine stickleback within the plunge pool of the perched culvert. The watercourse was dominated by rock/rubble substrates in the reach directly below the culvert. The lower reach received consistent wave action from the ferry activity and tidal influences causing the area to be exposed to erosion and washed up garbage debris.

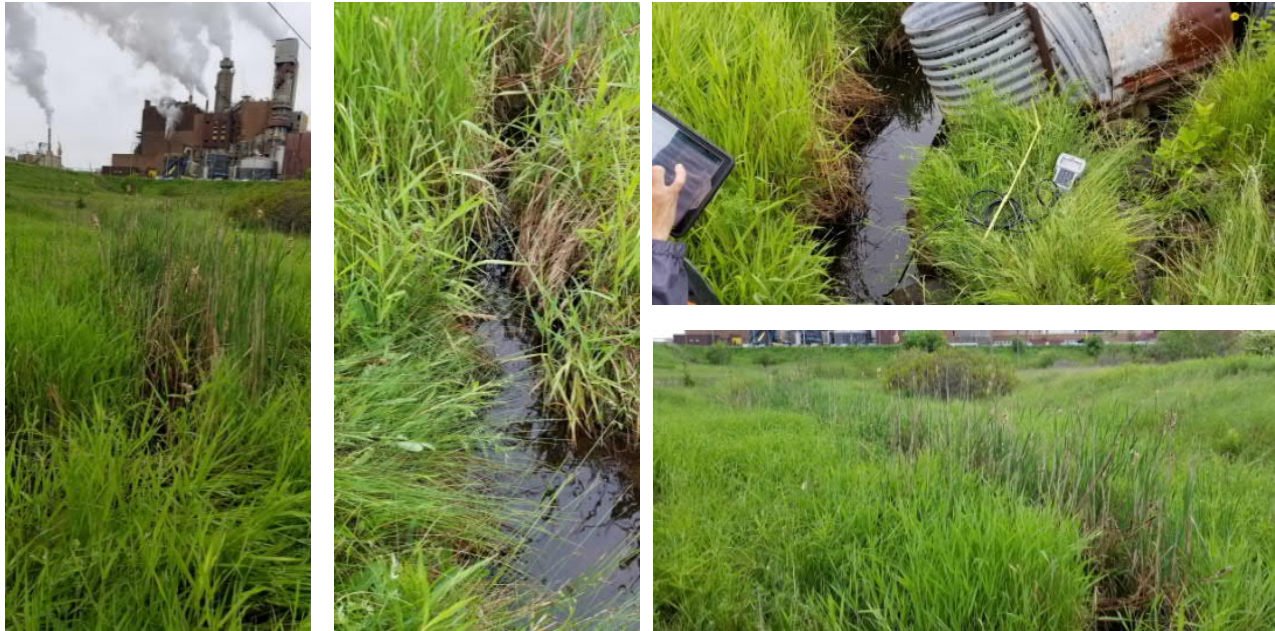
The field and laboratory reported pH was below the applicable CCME FWAL recommended range in June 2019. In addition, aluminum, lead, and iron were above the recommended CCME FWAL. The total chromium concentration was above the hexavalent chromium guideline but below the trivalent chromium guideline, which is more likely to be the dominant form present.

7.1.4 Fish Habitat Photo Plates

The following plates provide typical habitat photographs of the watercourses encountered.

Fish Habitat Photo Plate 1 WC02 – June 2019

Upstream of marine culvert, downstream of Wetland 2



Culvert entering Pictou Harbour and coastal (marine) area



Fish Habitat Photo Plate 2 WC03 – June 2019

Upstream – Ditch adjacent Highway 106 and transition to steep area



Watercourse as enters Pictou Harbour and coastal area (marine)



Fish Habitat Photo Plate 3 WC07 – June 2019

Ditching upstream of the roundabout



Roundabout "Pond"



Ditching upstream and downstream of "Pond"



Shrub wetland downstream of roundabout



Fish Habitat Photo Plate 4 WC08 – June 2019

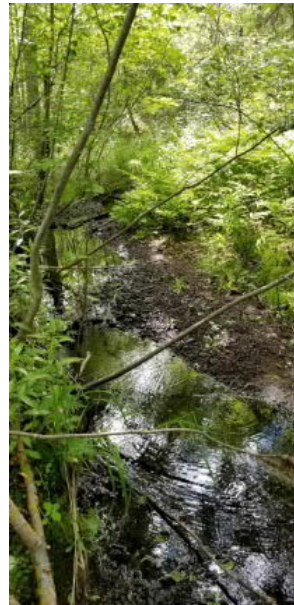
Upstream of Highway 106



Between Highway 106 and Route 6



Downstream of Route 6

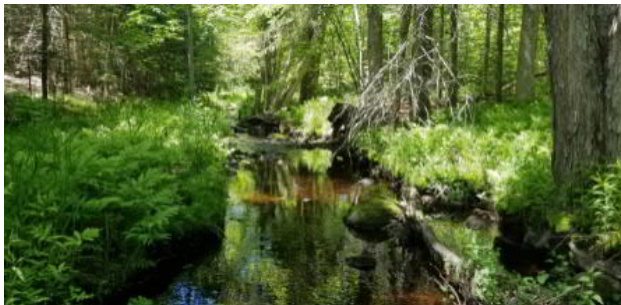


Fish Habitat Photo Plate 5 WC09 – June 2019

Typical riffle/run



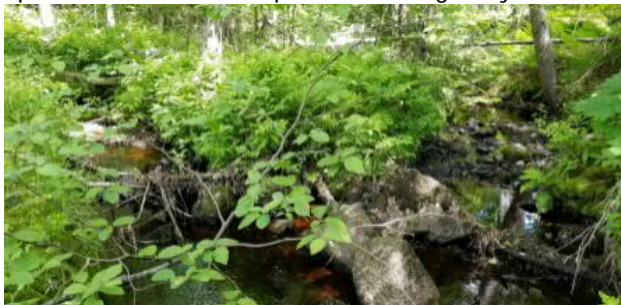
Run Substrate



Split channel located upstream of Highway 106



Highway 106 crossing



Fish Habitat Photo Plate 6 WC10 – June 2019

Upstream of Highway 106



Downstream of Highway 106



Fish Habitat Photo Plate 7 WC11 – June 2019

West (Downstream) Highway 106



Looking across wetland habitat and WC11



East (upstream along Highway 106)



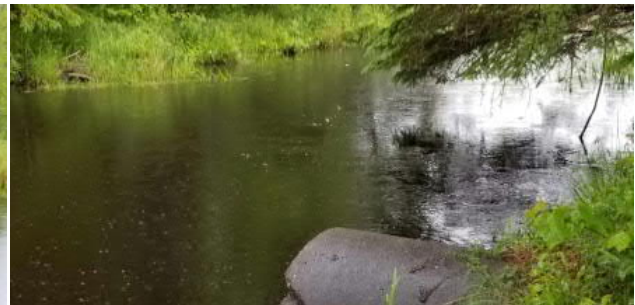
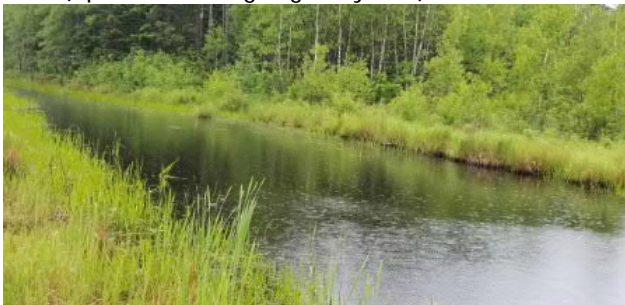
Downstream of Highway 106 crossing



East (upstream along Highway 106)



Downstream of Highway 106 Crossing



Fish Habitat Photo Plate 8 WC12 – June 2019

East (upstream) of Highway 106



West (downstream) of Highway 106



Fish Habitat Photo Plate 9 WC13 – June 2019

East (upstream) of Highway 106



East (upstream) of Highway 106



Wetland outlet and west (downstream) of Highway 106



Wetland outlet and west (downstream) of Highway 106



Fish Habitat Photo Plate 10 WC17 – June 2019

East (upstream) of Highway 106



West (downstream of Highway 106)



West (downstream) of Hwy 106



Fish Habitat Photo Plate 11 WC14 – June 2019

East (upstream) of Highway 106



Historical beaver activity



West (downstream) of Highway 106



Fish Habitat Photo Plate 12 WC15

Upstream (west) of along Highway 106



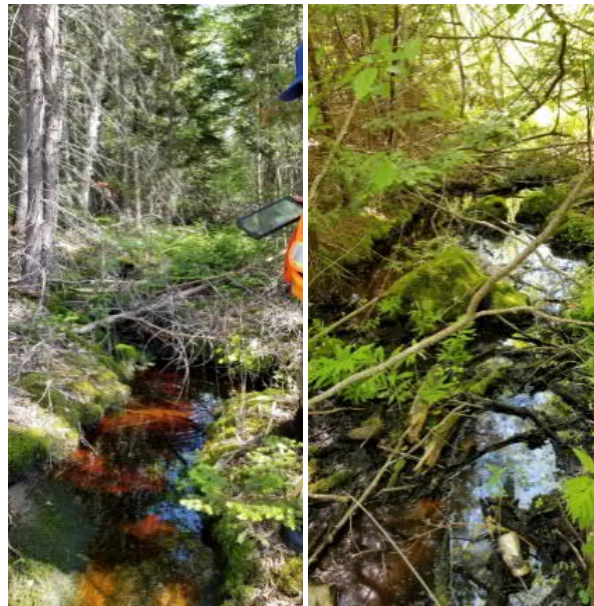
Ditch on east side of Highway 106



Upstream (east) Highway 106

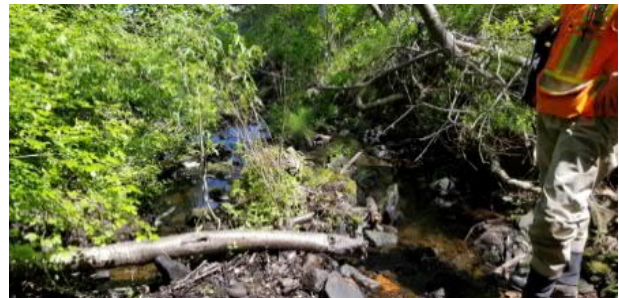
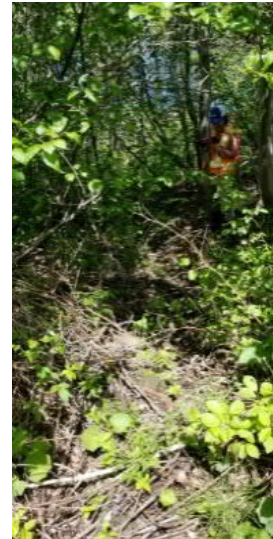


Downstream (west) Highway 106



Fish Habitat Photo Plate 13 WC16

Caribou Harbour to approximately 100 m upstream



7.1.5 Priority Fish

7.1.5.1 Priority Freshwater Fish Species Findings

The only priority fish species found during June 2019 surveys was brook trout.

Brook trout (conservation status rank S3 (uncommon), general status sensitive): Brook trout are anticipated to occur in most permanent watercourses in the area including sea runs to the Pictou Harbour estuary area (MacMillan 2014). Potential brook trout habitat was observed within the ETF footprint or along the proposed re-aligned pipeline route at WC02, WC03, WC07, WC08, WC09, WC10, WC11, WC12, WC13, WC17, and WC15. Spawning habitat was limited within the vicinity of the proposed re-aligned pipeline route.

7.1.5.2 Potential Priority Freshwater Fish

As identified in the EARD, the following priority freshwater/diadromous fish have potential to occur in watercourses crossed by the proposed project:

American eel (Committee on the Status of Endangered Wildlife in Canada – COSEWIC: Threatened; conservation rank: S2 (rare); general status: secure): Adults are known to occur in suitable habitat throughout the local assessment area (Cairns et al. 2012) and are likely to occur in areas of suitable habitat including within the watercourses crossed by the proposed project. Potential watercourses included WC02, WC03, WC07, WC08, WC09, WC10, WC11, WC12, WC13, WC17, and WC15. As eels spawn at sea, freshwater habitat is expected to be used for elvers (young eels) and for adult foraging. Potential for American eels is also identified for marine habitat.

Atlantic salmon (Southern Gulf of St. Lawrence population – COSEWIC: Special Concern; conservation rank: S1 (extremely rare)): Atlantic salmon entering southern Gulf rivers typically have fall runs (with the exception of the Morell River and Margaree Rivers in PEI) (COSEWIC 2010). The East and West Rivers (Pictou) are listed Atlantic salmon rivers with historic low angling catches and assumed populations. From 2006 to 2010, an average of less than 150 releases and 10 grilse kept were reported for the East River; less than 60 releases and 17 grilse kept for the West River; and only less than 7 captures for the entire 1984-2011 period in the Middle River (Breau 2012). A 1996 population estimate for the East River was less than 1,000 fish (O'Neil et al. 2000). Atlantic salmon habitat is not anticipated within the small freshwater watercourses in the immediate vicinity of the project footprint, but salmon are expected to be present on an occasional basis in the vicinity of the Pictou Causeway section of the proposed re-aligned pipeline route and potentially may enter downstream reaches of Haliburton Brook. Prior to heading to spawning areas up river, the salmon spend time within estuary areas including the Pictou Harbour estuary. The timing of acclimation in the estuary and seaward migration of adults is not well known for any of the rivers in the study area. Potential for Atlantic salmon is also identified the marine habitats.

Gaspereau/Blueback Herring: Gaspereau (S3 (uncommon); general status: sensitive) and blueback herring (S4 (widespread); general status: secure) run up rivers within the Gulf of St. Lawrence; however, populations have been reduced by exploitation and passage issues (DFO 2001). Gaspereau/blueback

herring enter freshwater to spawn in the spring (typically June) in lakes and quiet streams. Potential gaspereau/blueback herring habitat was not observed during June 2019 field investigation, other than potential for estuary/marine habitat within Pictou Harbour adjacent to WC04 and potentially downstream on Haliburton Brook.

Pearl dace (S3 (uncommon); general status: sensitive): This minnow species inhabits boggy lakes and streams and is known to occur in Pictou County. Although no specifically identified within the local assessment area, there is potential for this fish to occur if suitable habitat is present. Watercourses with some potential for habitat included WC11, WC12, and WC13.

Striped bass (Southern Gulf of St. Lawrence population – COSEWIC: Endangered; S2S3 (rare to uncommon); general status: may be at risk): Striped bass are reported to use the eastern section of the Northumberland Strait as a migration corridor (COSEWIC 2012). Striped bass adults leave marine habitats typically in June to spawn above head of tide. Striped bass habitat was not observed during in the vicinity of the proposed freshwater portion of the project. However, habitat is present in estuary/marine habitat within Pictou Harbour adjacent to WC04. Striped bass are known to congregate “upstream” of the gate under the Pictou Causeway (WC04) (pers. comm. C. Kennedy).

7.1.6 Summary of Fish Habitat

Potential fish species that may occur in the Pictou area were identified in the EARD. Habitat characteristics of watercourses within the June 2019 survey are summarized in Table A7.1-6, along with identification of potential fish species that may occur based on habitat.

Table A7.1-6: Watercourse Fish Habitat Potential

ID and Name	Potential Fish Habitat at Project Footprint/Crossings	Passage Required? +	Potential Fish Habitat Downstream
WC02, Unnamed Tributary to East River	Fair to good minnow and other forage rearing/feeding/spawning. Poor potential brook trout and American eel feeding.	Yes.	Marine and anadromous species.
WC03, Unnamed Tributary to East River	Fair to good minnow and forage species, brook trout and American eel - primarily feeding potential.	No, natural obstruction. Pipeline avoids crossing.	Marine and anadromous species.
WC07, Unnamed Tributary to Haliburton Brook	Poor minnow and forage species rearing and feeding.	No, upstream of Highway 106 ditching.	Brook trout and minnow/forage/eel habitat.
WC08, Unnamed Tributary to Haliburton Brook	Poor minnow and forage rearing/feeding/spawning. Poor seasonal brook trout and American eel feeding.	Yes.	Brook trout and minnow/forage/eel habitat.
WC09, Unnamed Tributary to Haliburton Brook	Fair to good minnow and forage rearing/feeding/spawning. Fair brook trout and American eel feeding. Poor brook trout spawning/overwintering.	Yes.	Brook trout and minnow/forage/eel habitat. Potential anadromous species including Atlantic salmon and introduced species.
WC10, Unnamed Tributary to Haliburton Brook	Poor minnow and forage rearing/feeding/spawning. Poor seasonal brook trout and American eel feeding.	Yes.	Brook trout and minnow/forage/eel habitat.
WC11, Unnamed Tributary to Haliburton Brook	Poor minnow and forage rearing/feeding/spawning. Poor seasonal brook trout and American eel feeding.	Yes.	Brook trout and minnow/forage/eel habitat.
WC12, Mill Brook	Poor minnow and forage rearing/feeding/spawning. Poor seasonal brook trout and American eel feeding.	Yes.	Brook trout and minnow/forage/eel habitat.
WC13, Unnamed Tributary to Mill Brook	Poor minnow and forage rearing/feeding/spawning. Poor seasonal brook trout and American eel feeding.	Yes.	Brook trout and minnow/forage/eel habitat.
WC17, Unnamed Tributary to Mill Brook	Poor minnow and forage rearing/feeding/spawning. Poor seasonal brook trout and American eel feeding.	Yes.	Brook trout and minnow/forage/eel habitat.
WC15, Unnamed Tributary to Caribou Harbour	Poor minnow and forage rearing/feeding/spawning.	Yes.	Brook trout and minnow/forage/eel habitat.
WC16, Unnamed Tributary to Caribou Harbour	Fair to good (below steep section) minnow and forage rearing/feeding/spawning. Limited potential for American eel.	No, natural obstruction.	Marine and anadromous species.

Notes:

Potential minnow species may include: Common shiner, *Luxilus cornutus*, provincial S5/Secure; Creek chub, *Semotilus atromaculatus*, provincial S5/Secure; Lake chub, *Couesius plumbeus*, provincial S5/Secure; and Northern redbelly dace, *Phoxinus eos*, provincial S5/Secure.

Other forage species may include: banded killifish, *Fundulus diaphanus*, S5, secure; brown bullhead, *Ameiurus nebulosus*, S5, secure; Stickleback (Threespine), *Gasterosteus aculeatus*, provincial S5/Secure; Stickleback (Four spine), *Apeltes quadracus*, provincial S5/Sensitive; Stickleback (nine spine), *Pungitius pungitius*, provincial S5/Secure; White perch, *Morone americana*, provincial S5/Secure; Yellow perch, *Perca flavescens*, provincial S5/Secure; and White sucker, *Catostomus commersonii*, provincial S5/Secure.

Introduced species may include: Brown trout, *Salmo trutta*, provincial SNA/Exotic; Chain pickerel, *Esox niger*, provincial SNA/Exotic; and Smallmouth bass, *Micropterus dolomieu*, provincial SNA/Exotic.

+Passage required indicates whether or not there is a need for flow to be maintained in the watercourses throughout the project lifetime.

7.1.7 References

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https://www.novascotia.ca/nse/ea/Replacement_Effluent_Treatment_Facility_Project/Focus-Report-Terms-of-Reference.pdf

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