WATER SUSTAINABILITY ACT, SECTION 11 APPLICATION

Highway 1: 264 Street to Townline Road

January 2023 | FINAL Revision A

Submitted to: MoTI

MoTI Project # No. 6020-006
Prepared by McElhanney Limited and Associated Environmental Consultants Inc.

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ACRONYMS LIST

ALR	Agricultural Land Reserve
AQP	Appropriately Qualified Professional
AE	Associated Engineering Limited
BC	British Columbia
BMPs	Best Management Practices
BOS	Bus on Shoulder
CB	Catch Basin
CDC	Conservation Data Centre
CEMP	Construction Environmental Management Plan
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSP	Corrugated Steel Pipe
CH	Critical Habitat
DFO	Fisheries and Oceans Canada
ECCC	Environment and Climate Change Canada
Efishing	Electrofishing
ESC	Erosion and Sediment Control
EAA	Extended Assessment Area
EV	Electric Vehicle
FLNRORD	Ministry of Forests, Lands, and Natural Resource Operations and Rural Development
FVISS	Fraser Valley Invasive Species Society
GIS	Geographic Information System
GA	General Arrangements
HADD	Harmful Alteration, Disruption and Destruction
HW	Headwater Depth
HOV	High Occupancy Vehicle
IAPP	Invasive Alien Plant Program
KWL	Kerr Wood Leidal
LAA	Local Assessment Area
LWD	Large Woody Debris
MOECCS	Ministry of Environment & Climate Change Strategy
MoF	Ministry of Forests
MoTI	Ministry of Transportation and Infrastructure
MUP	Multi Use Pathway
OCIO	Office of the Chief Information Officer
POE	Pathway of Effect
RIC	Resources Inventory Committee
RISC	Resource Information Standards Committee
RAA	Regional Assessment Area
RSBC	Revised Statutes of British Columbia
RAPR	Riparian Areas Protection Regulation
SARA	Species at Risk Act
SGSB	Select Granular Sub-Base
SRES	Salmon River Enhancement Society
SWSP	Smooth Walled Steel Pipe
TCH	Trans-Canada Highway, a.k.a. Highway 1
UBC	University of British Columbia
WARS	Wildlife Accident Reporting System
ROW	Right of Way
WPTRT	Western Painted Turtle Recovery Team
WSA	Water Sustainability Act
WSP	Wetland Stewardship Partnership

EXECUTIVE SUMMARY

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Highway 1 is the primary east-west corridor serving and connecting the Lower Mainland to the rest of BC. As the population of the Fraser Valley has grown, the traffic on the corridor has increased substantially. MoTI's proposed Project is part of the Fraser Valley Highway 1 Corridor Improvement Program, and is designed to support the movement of people, goods, and services in BC. The Project proposes expansion of 13 km of Highway 1 from 2 to 4 lanes in each direction, from 264 Street in the Township of Langley to Townline Road, in the City of Abbotsford. This widening will expand primarily into the median.

These upgrades will increase the current capacity, to reduce frequent congestion affecting safety and reliability of Highway 1. Notably, the Project will provide increased capacity through a focus on High Occupancy Vehicle (HOV)/ride sharing, transit, active transportation (walking and cycling) and electric vehicles. Additionally, the Project includes infrastructure upgrades throughout to meet today's highway design requirements, including reconstructed interchange, a mobility hub/transit exchange, upgrades to truck parking, selective application of sound walls, new guide signs, lighting, upgrades to crossing roadway bridges, multi-use paths, larger capacity drainage, and improvements to fish passage.

This *Water Sustainability Act* (WSA) Change Approval application has been prepared for the Ministry of Forests (MoF). The purpose of this application package is to provide the MoF with the information that is required, consistent with the WSA mandate and the Guidance for Applications or Notifications for Changes in and about a Stream under the *Water Sustainability Act* in in the South Coast Region (GoBC, 2019).

A multidisciplinary team, from McElhanney, AE and ISL Engineering, has worked together to produce required engineering designs and environmental review to support this application. With assistance from Triton Environmental Consultants Limited (Triton), the Project team has completed an inventory of the environmental values and aquatic habitat within the Project area and out to 50 m beyond the Highway 1 corridor.

Drainage design has been guided by the objective of maintaining flows in existing streams. Diversions have been avoided. Where ditches or streams need to be realigned, their source or input waters are returned to the same downstream output locations. There are several median to ditch culverts that are being removed, which puts more flow in the median, but returns flow to those ditches downstream.

Culvert capacities have been increased to meet current guidelines with climate change allowance. Where fish bearing, culverts have been designed with velocity control (flatter grades) and in some cases baffles to provide for passage of the various species of fish at their different life stages.

Four watersheds lie within the Project including, from west to east: Salmon River, West Creek, Nathan Creek and Fishtrap Creek. These each contain fish-bearing and non-fish bearing streams, which interact with the alignment. Class A watercourses are inhabited year-round or have potential for year-round fish presence given reasonable access enhancements, Class A(O) watercourses are inhabited by (or potentially inhabited by) fish during the overwintering period, and Class B are watercourses that supply food and nutrients to downstream fish populations but are non-fish bearing. Class C watercourses are isolated from fish use, but support amphibians and other wildlife.

Two fish species at risk, Salish sucker (*Catostomus* sp.) and Nooksack dace (*Rhinichthys cataractae – Chehalis* lineage), are present in the Project area and have critical habitat in the surrounding regions. Nooksack Dace are present in the Fishtrap Creek watershed, including Enns Brook. No critical habitat for Nooksack dace occurs within the Project area, but potential for occurrence exists (DFO, 2022). Salish sucker are present in Fishtrap Creek, including East Fishtrap Creek and Enns Brook. Critical habitat for Salish sucker occurs in East Fishtrap Creek for a short segment of the channel within the Project area south of Livingston Avenue.

Two wildlife species at risk have been confirmed present in the Project area: Oregon forestsnail (*Allogona townsendiana*) and northern red-legged frog (*Rana aurora*). Mapped critical habitat for painted turtle overlaps all four of the watersheds in the Project area. Many of the watercourses in the Project area provide moderate to high suitability habitat for pacific water shrew.

Once design is finalized and permits are received, Project construction will begin. Construction works are proposed to begin in the fall of 2023. Early construction works planned include tree clearing, utility relocations, grubbing, preload, retaining walls, temporary access and staging areas, expanding the Bradner Rest Area, and construction of the offsite environmental offsets. During the main Project phasing, construction activities that interface most substantially with fish habitat include the installation of Fishtrap Creek Bridges, which will daylight habitat for aquatic species at risk, and culvert installations. Eight primary highway crossing culverts are proposed on fish-bearing watercourses; these have been designed to be passable for all life stages of resident fish. Various features may be utilized to ensure fish passability including culvert embedment, backwatering, outlet pools and downstream riffles, self-draining riffles, and baffles. Other planned construction works include storm sewer, catch basin and spillway, ditch, pond and sound wall installations. Proposed permanent and temporary infrastructure has been defined and drawings are provided for reference.

Impacts which were not reduced or eliminated through design will be mitigated during construction using best management practices (BMPs). However, some permanent impacts to aquatic habitat will occur and will be compensated through offsetting. Currently the Project design results in net impacts to aquatic habitat include a cumulative gain of 1,593 m^2 for Class A and 1,193 m^2 for Class B, as well as a loss of 191 m^2 of Class A(O) habitat. Net impacts to riparian habitat result in a net gain overall, including a gain of 1 m^2 for Class A, 3,390 m^2 for Class A(O), and 11,505 m^2 for Class B riparian habitats. Offsets are being completed onsite where possible, however, several offsite locations are proposed, and work for these is planned to be completed under early project works. Isolated wetlands impacted by design have been compensated for with the creation of new features – further details are found in the project habitat balance.

Impacts to the two species at risk present in the Project area will be adequately compensated for to protect the species. After efforts to avoid impacts to critical habitat are implemented, we anticipate a temporary construction-related effect to 20 m^2 of instream habitat and 171 m^2 of riparian habitat within the critical Salish sucker habitat at the Fishtrap Creek crossing of Highway 1. Impacts to critical habitat will be related to and inherently offset by the daylighting of the two highway-spanning culverts at this location, resulting in the creation of 1,140 m^2 of open channel instream habitat and 1,971 m^2 of riparian habitat underneath the new bridge and in the median/ROW. This new habitat will be in-line and immediately downgradient of mapped critical habitat.

Impacts to fish habitat can occur during multiple Project phases; however, environmental impacts have been avoided and minimized by design and mitigations. Project activities known to impact fish and fish habitat are excavation and grading, vegetation clearing, use of industrial equipment, placement or removal of structures in water, addition or removal of aquatic vegetation, and limiting fish passage. Measures to mitigate potential impacts are proposed. Some of the most critical mitigation measures include the development and implementation of a construction environmental management plan, environmental monitoring, erosion and sediment control structures, site restoration and habitat offsetting. Impacts to the local environment during construction will be mitigated and minimized through the use of Best Management Practices (BMPs).

Habitat loss associated with vegetation clearing and sensory disturbance associated with construction are the primary impacts to wildlife anticipated. Impacts to wildlife and wildlife habitat are expected to be adequately mitigated through the implementation of standard BMPs, site-specific mitigation plans, pre-construction surveys and salvages and site restoration.

Offsetting is a critical part of mitigating impacts for the project. Offsetting equivalency ratios have been applied to the project with a ratio based on riparian vegetation habitat quality for impacted habitats as well as for on offsite and onsite habitat rehabilitation areas. A ratio of 0.3:1 was assigned to areas dominated by invasive species, a 0.5:1 ratio to areas dominated by native shrubs, and a 1:1 ratio for areas dominated by native forest. Due to the inherent complexity with a project of this size and magnitude, it is anticipated that designs may be modified with time and may be field fit to ensure effectiveness.

Residual effects are minimal after the implementation of the mitigation and offsetting measures. With respect to the Project-wide habitat balance, the onsite and offsite habitat enhancements proposed throughout the alignment will yield net surpluses of aquatic habitat across all habitat classes. There will be losses in some locations and gains in other locations. Based on the net balance of habitat across the project, residual effects to fishery productivity will likely be limited to temporal lags in habitat form and function post construction. Such uncertainty may be mitigated through mindful approaches in the implementation of offsetting. This may include early construction of offsets, ahead of impacts, utilization of larger tree stock in riparian area plantings, and timing of works to benefit sensitive life history stages of fish.

PART I PROJECT OVERVIEW

I.1 INTRODUCTION AND CONTEXT

The Ministry of Transportation and Infrastructure (MoTI) is widening Highway 1 between 264 Street and Townline Road (the Project) to six lanes, plus bus on shoulder and climbing lanes, as a part of the Fraser Valley Highway 1 Corridor Improvement Program. The Project will increase the capacity of the existing four-lane highway by widening both east-bound and west-bound roadways and connecting interchanges; intersections and ramps. The widenings will extend the existing roadways toward the existing open median, requiring limited widening outside of the existing right-of-way.

The purpose of this Change Approval package is to provide the Ministry of Forests (MoF) with information that is consistent with the *Water Sustainability Regulations* (SBC, 201b, c. 15) in relation to changes in and about a stream described herein. The primary objective of this application was to meet the requirements outlined in the User's Guide for submitting a "Change Approval for Works in and about a Stream" (GoBC, 2022b).

The works described in this document are based on recently completed 100% Functional Design Drawings (referred to as "design drawings" henceforth). This means that the design is inherently "stable" and substantive changes to the Project footprint are not anticipated in future design iterations. Other design details, such as those for major culvert crossings of Highway 1, were expedited to a higher degree of completion to aid regulatory review.

This document provides accounting of aquatic and riparian areas, by watershed, and by class, to provide an understanding of unavoidable habitat impacts across the Project. Many environmental offsets and enhancements have been mindfully selected and engineered to achieve a Project-wide quantitative balance of fish and wildlife habitat.

I.2 PROJECT LOCATION

The Project involves the widening of 13 km of Highway 1 between 264 Street in the Township of Langley and Townline Road in the City of Abbotsford. In addition to the widening, the Project includes the geometric redesign of the Highway 1 interchange at 264 Street. The design is being conducted by two engineering teams and is divided into two segments, one for each team:

- Segment 1 – 264 to Ross Road (Design by ISL Engineering)
- Segment 2 – Ross Road to Townline Road (Design by AE)

The geographic location is from 49.145º N 122.602º W (Glover Road Bridge) to 49.046º N 122.353º W (Peardonville Bridge) near Townline Road along the Trans Canada Highway and immediate connecting roadways, within the Township of Langley and the City of Abbotsford of the Fraser Valley Regional District.

Figure 1 below shows the Project location in relation to the Province and Fraser Valley and illustrates small- and large-scale plans for the Project and associated offsite offsets.

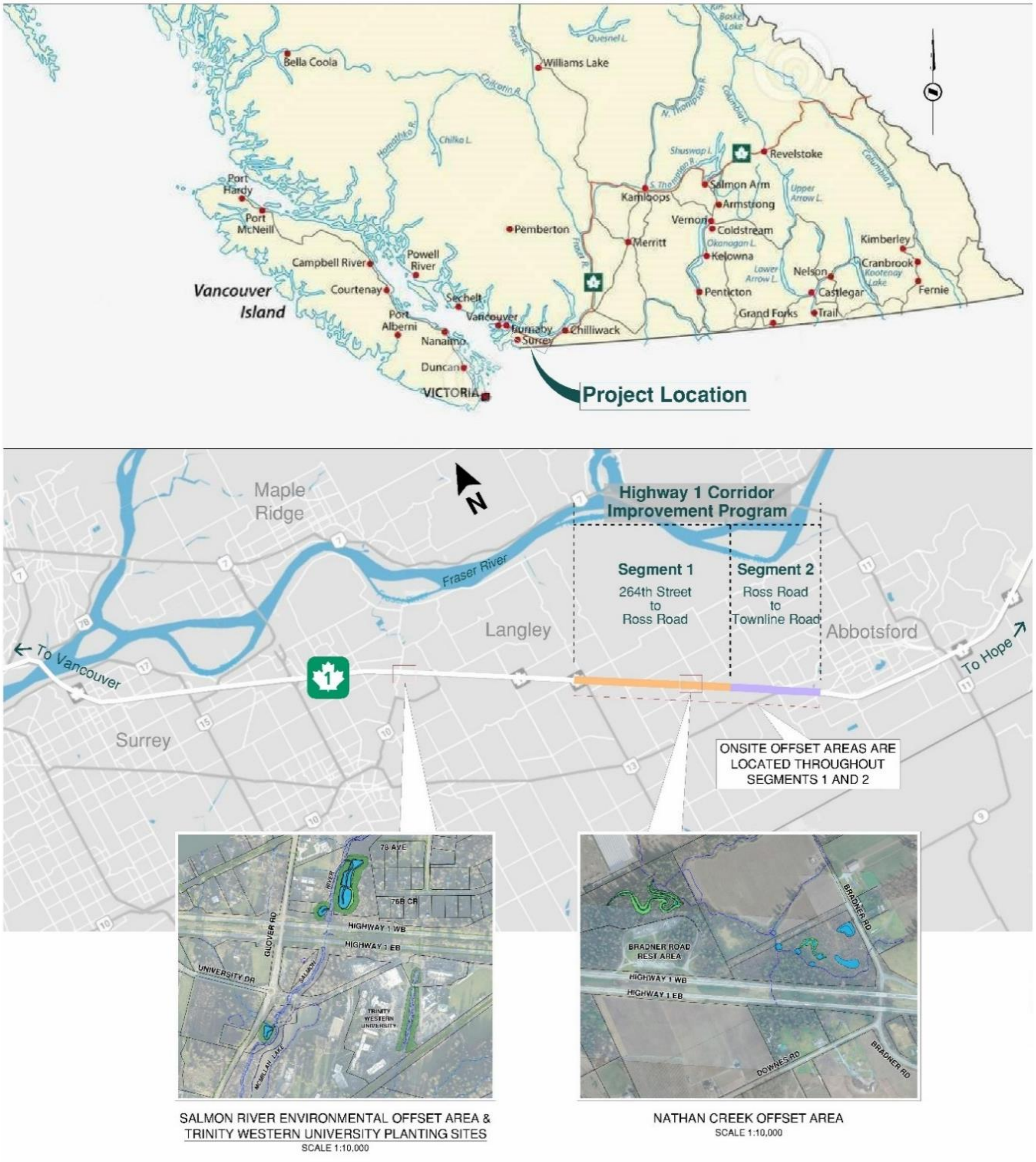

Figure 1. Project Location in relation to the Province and Fraser Valley.

The Project will be completed through the following four watersheds, moving from west to east, as well as three notable sub-catchments:

- Salmon River (includes Coghlan Creek sub-catchment)
- West Creek
- Nathan Creek
- Fishtrap Creek (includes Enns Brook and East Fishtrap Creek sub-catchments)

See ***Figure 2*** for the watershed outlines. Aerial photography-based strip maps, within ***Appendix A***, show the water sources and water bodies affected.

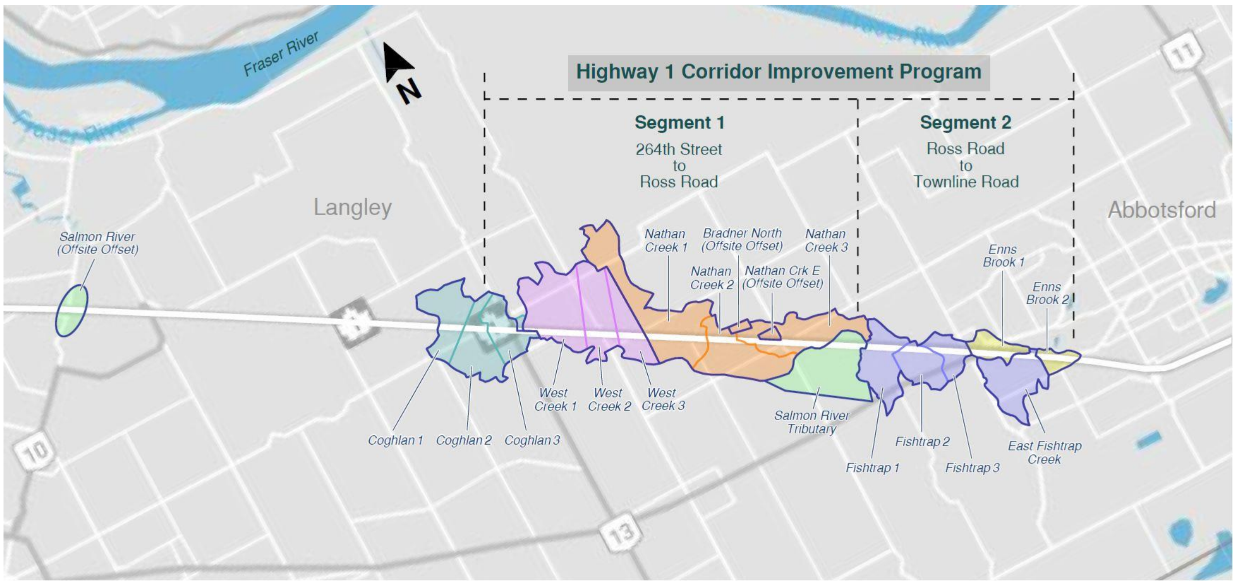

Figure 2. General location map with application site locations.

I.2.1 Application Sites

Proposed works have been divided into 19 sites by watershed sub-catchment, proposed type of works and offsite offsets to facilitate submission into FrontCounter BC. ***Figure 2*** is a general location map showing each of the application sites with their location / site IDs. Detailed works descriptions, project footprint, site-specific mitigation measures, and corresponding maps and photos are provided in ***Appendix B***.

I.3 BACKGROUND AND RATIONALE

Highway 1 is the primary east-west corridor serving and connecting the Lower Mainland to the rest of BC. The existing section between 264 Street in Langley and Townline Road in Abbotsford is generally a four-lane freeway constructed in the early- to mid-1960s. Over the years, the traffic on this corridor has increased substantially, as the population in the Fraser Valley has grown. This has created frequent congestion and queuing on the highway, particularly during peak periods. The provincial government identified that widening Highway 1 between Langley and Abbotsford, as part of the Fraser Valley Highway 1 Corridor Improvement Program, would support the movement of people, goods, and services in BC and improve highway mobility, safety and reliability. Notably, this project has a focus on mode shift and does not increase the number of general-purpose lanes. As such, the project encourages capacity increases through High

Occupancy Vehicle (HOV) / ride sharing, transit, active transportation (walking and cycling), and electric vehicles. ***Figure 3*** is a photo of typical traffic conditions and existing laning.

Figure 3. Typical photo of the Trans Canada Highway within the project area.

In addition to adding HOV lanes, there are infrastructure upgrades throughout, to meet today's highway design requirements. These include a reconstructed 264th interchange with a mobility hub/transit exchange, upgrades to truck parking, selective application of sound walls, new guide signs, lighting, upgrades to crossing roadway bridges, multi-use paths, larger capacity drainage, improvements to fish passage, and expansion of the Bradner Rest Area.

I.4 ROLES AND RESPONSIBILITIES

There is a broad multi-disciplinary team assembled for this Project. Design for the Project is split between three primary firms and their respective sub-disciplines. Design contacts are listed in ***Table 1*** are as follows:

- *ISL Engineering* – 264th to Ross Road
- Associated Engineering (BC) Ltd. (AE) - Ross Road to Townline Road
- *McElhanney Ltd*. - offsite offsets

Table 1. Responsible parties for civil engineering and drainage design leads.

Company	Contact	Role	Responsible Design Professionals
ISL Engineering and Land Services Ltd.	A: 201-3999 Henning Drive, Burnaby, BC V5C 6P9 P: 604-629-2696	264th to Ross Road	Neal Cormack, P.Eng, ENV SP Steve Clark, P.Eng
Associated Engineering (BC) Ltd.	A: 500-2889 E 12th Avenue, Vancouver BC, V5M 4T5 P: 604-293-1411	Ross Road to Townline Road	Priscilla Tsang, M.Eng, P.Eng Eric Finney, P.Eng
McElhanney Ltd.	A: 200 – 858 Beatty Street, Vancouver, BC V6B 1C1 P: 604-683-8521	Offsite Offsets	Kevin Leggett, P.Eng Jack McKee, MESc., ENV SP, P.Eng

Construction is a future activity through a tendering process and is not yet awarded. There will be smaller tenders for early works to prepare the site and pre-build offsets.

Environmental responsibilities and their respective qualified professionals are outlined in *Error! Reference source not found.*. These parties are responsible for field aspects and preparation of the respective sections of this report. See also the professionals signature table in the ***Part VII.1*** Closures, which lists their contributions in the review of environmentally valuable resources and the project impacts.

Table 2. Responsible parties for environmental overview and design.

Company	Role	Responsible Environmental Professionals
Triton Environmental Consultants Limited	Preliminary environmental review and initial investigation of restoration areas	Dave Schmidt, R.P.Bio. Greg Sykes, R.P.Bio. Jason Leathem, R.P.Bio. Margarete Dettlaff, R.P.Bio. Brent Matsuda, R.P.Bio.
Associated Environmental Consultants Inc.	Detailed environmental review of aquatic resources	Rob Hoogendoorn, R.P.Bio. JP Hervieux, P.Ag. Thomas Smith Jennifer Prive, R.P.Bio.
Associated Environmental Consultants Inc.	Detailed environmental review of wildlife and vegetation resources	Naomi Sands, R.P.Bio. Dave Muhlert, R.B.Tech.
McElhanney Ltd.	Development of the habitat impacts and gains analysis Submission of permitting application, including WSA and DFO submissions Offsite offset design	Patty Burt, R.P.Bio., P.Biol Thomas Fita, R.P.Bio., P.Ag. Emilia Cronin, B.Sc. Courtney Lahue, BIT Gina Le Bel, R.P.Bio. Emily MacInnis, B.Sc. Karina Ernst, A.Ag., BC-CESL Connor Forsdick, ADV DIP GIS Christopher Thiede B.ENV.D, AALA Associate Jori Porter, T.F.T. Steve Hobbs, P.Eng, BCLS, PTOE Jack McKee, MESc., ENV SP, P.Eng. Kevin Leggett, P.Eng.

I.5 REGULATORY CONTEXT

There are multiple permitting requirements and regulatory risks associated with the implementation of the Highway 1 upgrades. In this application the term “permit” refers collectively to all legal instruments including, but not limited to permits, licences, approvals, authorizations, and notifications. The Section below lists applicable permits that are anticipated for implementing this project.

I.5.1 Federal Legislation

I.5.1.1 Fisheries Act

The *Fisheries Act* (RSBC, 1985, c.F-14) (Canada, 1985) and supporting policies aim to protect and manage all fish and fish habitats by providing protection against the death of fish, other than by fishing, and the harmful alteration, disruption, or destruction of their habitat (HADD) (Canada, 1985). The *Fisheries Act* regulates activities that affect fish or fish habitat including permanent alteration or destruction of habitat (Section 35) and deposition of deleterious substances into fish-bearing waters (Section 36).

The Fish and Fish Habitat Protection Provisions oversees and ensures compliance for projects that take place in and around fish habitat under the provisions from the *Fisheries Act* and *Species at Risk Act* (SC, 2002, c.29) (Canada, 2002). To ensure compliance under the *Fisheries Act*, any projects in or near water will require an understanding of the impacts the project will have on fish and fish habitat. A Request for Project Review (RFR) is submitted to DFO, which outlines the existing environmental setting, identifies the impacts the project will have on fish and fish habitat, and suggests measures to avoid and mitigate impacts to fish and fish habitat. Upon review of the RFR, DFO may lead to the issuance of a Letter of Advice, both outlining specific mitigation measures to ensure impacts are minimized or managed in the most sufficient way possible.

As a part of the project's regulatory requirements, an Application for the Issuance of an Authorization under Paragraphs 34.4(2) (b) and 35(2)(b) of the Fisheries Act has been submitted to Fisheries and Oceans Canada (DFO). Legislated timelines for non-emergency Authorizations include a regulatory response to notify the applicant whether application is complete, incomplete or inadequate within 60 calendar days of receipt, and issuance or refusal of Authorization within 90 calendar days from the date of notification that the application is complete. Additionally, the project will require application for fish salvage permits, to allow relocation of fish prior to instream works.

I.5.1.2 Migratory Birds Convention Act (MBCA)

Most bird species in Canada are protected under the *Migratory Birds Convention Act* (MBCA) (SC, 1994, c.22) (Canada, 1994). Birds in Canada are protected under provincial and territorial statute in addition to the federal MBCA. The purpose of the MBCA is to implement the Convention by protecting breeding migratory birds and their nests. MCBA prohibits injury, molestation and destruction of migratory birds and their nests; regulates works that impact the breeding of birds listed as migratory under the Act.

No permits are required pursuant to the Act, but implementation of the final design should follow applicable agency guidance, both for the purpose of maintaining a due diligence defense in the event of litigation and to assure compliance with the Act and any applicable provisions of the Tender documents.

Vegetation clearing should occur between August 16 and March 14, which is outside the migratory bird breeding season for that region. If any vegetation (includes grasses and shrubs) needs to be removed during the migratory bird breeding season, then pre-clearing nesting activity surveys conducted by an AQP are required to establish protective buffers around nesting active nests.

I.5.1.3 Species at Risk Act (SARA)

The *Species at Risk Act* (SARA) (SC, 2002, c.29) (Canada, 2002) protects species at risk from becoming extinct or lost from the wild. It covers all wildlife species listed under Schedule 1 as being at risk nationally (and their critical habitats) (Canada, 2002). The purposes of SARA are to prevent wildlife species in Canada from disappearing, to provide for the recovery of wildlife species that are extirpated (no longer exist in the wild in Canada), endangered or threatened because of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened (SC, 2002, c.29).

Generally, SARA only applies to federal lands, except for migratory birds or aquatic species where SARA applies in provincial jurisdictions as well. In addition, SARA provides for the possibility of a Ministerial Order requiring that SARA apply to specific provincial lands. SARA does apply in the Project area as relating to SARA-listed aquatic species. SARA-listed fish could be affected by the Project; therefore, a permit will be required under Section 73, to authorize related impacts to fish individuals and/or their residences.

I.5.2 Provincial Legislation

I.5.2.1 Agricultural Land Reserve – Property Exclusion

The Agricultural Land Reserve (ALR) is a land designation within the province which denotes the priority land use as farming. The Agriculture Land Commission (ALC) has the responsibility to preserve this agricultural land, encourage farming on agricultural land and encourage all levels of government to encourage farming land use within their respective policies and legislations.

Along the highway alignment there is land designated within the ALR, which will need to be acquired for the widening, particularly for environmental offsite offsets. An application will need to be made to the ALC for its non-farm use.

I.5.2.2 Water Sustainability Act

The *Water Sustainability Act* (WSA) (SBC, 2014, c.15) (BC, 2014b) regulates changes in and about a stream (BC, 2014b). It also regulates the use of surface and groundwater. The purpose of the WSA is to ensure the sustainability of fresh, clean water to fulfil the needs of B.C. resident, both current and future. It is the primary law used to manage the diversion of water resources and their use. Under the Regulation, two pathways for regulatory oversight occur. A notification can be submitted if the works are classified as authorized works; this submission comes with a 45-day review period by the MoF. If the works cannot meet the Authorized Works criteria, then an Approval process will be required. Target timelines for approval applications are 140 days.

For projects requiring legal instruments under the WSA, the regulations require considerable documentation of the site impacts environmentally and from a construction and water resources perspective. The outlines for this content are found in:

- Water Sustainability Regulation (WSR)
- Guidance for Applicants or Notifications for Changes in and about a Stream under the Water Sustainability Act in the South Coast Region (SCR) (GoBC, 2019).
- User’s Guide for submitting a “Change Approval for Works in and about a Stream” (GoBC, 2022b).

To assist the reviewer, and to confirm compliance, the following concordance table (***Table* 13**) outlines required content within this application. The left column sets out the regulation source for the content. The right column sets out where that content is located.

Table 3. Concordance table to meet WSA requirements.

Regulation	Description	Application Information Location
Water Sustainability Regulation (WSR) 3(1) (a) South Coast Guidance (SCG) 4.1 Step 7 FrontCounter BC Application Step 7	Applicant Contact Info	Executive Summary
WSR 4 (j) SCG 4.1 Step 3-4 i) FrontCounter BC Application Step 7	Agent	Executive Summary Letter of Agency (attached in FrontCounter)
SCG 4.1 Step 3-1 FrontCounter BC Application Step 3	Fee Exemption Request	Client Number = 28500
SCG 4.1 Step 3-4 c) SCG 5.1.1.2	Associated Permits	Part I.5 Regulatory Context
Multi-Site Applications FrontCounter BC Application Step 3	General Location Map	***Figure 1*** & ***Figure 2***
Multi-Site Applications & FrontCounter BC Application Step 3 WSR 4 (c) WSR 3(1) (i) WSR 4 (d) WSR 3(1) (l) SCG 4.1 Step 3-4 f) SCG 5.2	Location/Site IDs and Site Map	***Appendix B*** - Application Sites: Individual maps/figures, location descriptions, information tables, General Location Map and Table A list of application sites
SCG 1.1 SCG 5.1.1.5	Consultations with First Nations	Part I.6 Consultation and Engagement
SCR 5.1.1.5	Archaeological Assessment Report	Attached to online application
WSR 3(1)(c) SCR 4.1 Step 3-4 a) & b) FrontCounter BC Application Step 3	Source Stream Names	***Appendix B*** - Individual site tables in Application Sites
SCR 5.1.1.4 e) FrontCounter BC Application Step 7	Roles and Responsibilities	Part I.4 Roles and Responsibilities Part VII Closure
SCR 4.0 SCR 5.1.2.6	QP Forms	Attached to online application
SCR 4.1 Step 3 4 c) SCR 5.1.1 WSR 3(1) (m) WSR 4 (g) FrontCounter BC Application Step 3	Detailed Description of Proposed Works	Part I.1 Introduction and Context, Part I.3 Background and Rationale Part II Description of Proposed Instream Works ***Appendix B*** - Individual "Proposed Site Works" sections
SCR 5.1.1.4 a) SCR 4.1 Step 3 4 d) FrontCounter BC Application Step 3	Project Footprint	Individual "Proposed Site works" tables in Application Sites ***Appendix B*** for each site
WSR 3(1) (f)	Use of Water	Not applicable to this project - works are related to relocating streams/ditches, upgrading culverts or adding offsets.

Regulation	Description	Application Information Location
WSR 3(1) (g)	Quantity of Water Use	Not applicable to this project - works are related to relocating streams/ditches, upgrading culverts or adding offsets.
SCG 5.2	Stream and Channel Relocations	***Appendix B*** - Application site figures/maps in Application Sites ***Appendices G, H, I, J & K -*** Design drawings
SCG 5.1.1.4 b) SCG 5.2	Equipment and Machinery	***Appendix B*** - Instream work identified within the Individual application site sections Part II.2 Construction Methods Part II.2.1 Methods for Fish Bearing Culvert Construction and Stream Realignments or Weirs Part VI.4.2 Methods for Offset Construction
WSR 3(1) (j) WSR 4 (i) SCG 4.1 Step 3-4 h FrontCounter BC Application Step 3	Crown Land Permission	***Table 5*** in Part I.6.5 Land Ownership ***Appendix C*** - Property Permissions
WSR 3(1) (n) FrontCounter BC Application Step 3	Land Description	***Appendix B*** - Proposed Sites Works individual subsections, property ID's shown on site maps/figures ***Table 5*** in Part I.6.5 Land Ownership ***Appendix C*** - Property Permissions
WSR 3(1) (o) WSR 4 (h) SCG 4.1 Step 3-4 h) FrontCounter BC Application Step 3	Land Ownership & Consent	***Table 5*** in Part I.6.5 Land Ownership ***Appendix C*** - Property Permissions
SCG 5.1.1.6	Impacts to other affected lands and people	Part I.6.5 Land Ownership ***Appendix D*** - Water Licenses
WSR 4 (f) SCG 4.1 Step 3-4 e) SCG 5.1.1.4 c) & d) FrontCounter BC Application Step 3	Construction Timeline	***Table 8*** Key timeline milestones for advanced works and construction of Highway 1 widening Part II.1 Phases and Schedule
SCG 4.1 Step 3-4 g) SCG 4.1 Step 5	Site Photographs	***Appendix B*** - Individual application sections in Application Sites ***Appendix E*** - Fish Habitat Descriptions
WSR 3(1) (p) WSR 4 (e) SCG 4.1 Step 4-1 SCG 4.1 Step 5 SCG 5.2 FrontCounter BC Application Step 5	Engineer Drawings	***Appendix B*** - Application site figures/maps ***Appendix G*** - Design Drawings ***Appendix H*** - Priority Culvert General Arrangement Drawings ***Appendix I*** - Offsite environmental Offset Designs ***Appendix J*** - Onsite Environmental Offset Designs ***Appendix K*** - Ancillary Culverts General Arrangement Design
SCG 5.1.2.3 1	Environmental Mitigation Hierarchy	Part VI.1 Environmental Mitigation Hierarchy ***Appendix L*** - Alternative design Memo
SCG 5.1.2.1 1	Stream Characteristics	Part IV.3 Aquatic Resources ***Appendix A*** - Environmental Strip Maps

Regulation	Description	Application Information Location
SCG 5.1.1.3	Environmental Context	*Part IV* Description of the Existing Environment ***Appendix A*** - Environmental Strip Maps ***Appendix B -*** Application Sites Technical Memo ***Appendix E*** - Fish Habitat Descriptions
SCG 5.1.2.1 2	Environmental Values	***Appendix A*** - Environmental Strip Maps ***Appendix E*** - Fish Habitat Descriptions ***Appendix F*** - MoTI Priority Species
SCG 5.1.2.2 1	Environmental Impacts including to Riparian Areas	Part III Environmental Impact Assessment Methodology Part IV Description of the Existing Environment Part V Assessment of Impacts on Ecological Values
WSR 2.6.3 SCG 5.1.1.3	Designated Sensitive Stream Info	Part IV.3.4.2 Designated Sensitive Stream (West Creek) Part IV.3.5.2 Designated sensitive Stream (Nathan Creek)
SCG 5.1.2.2 2	Hydrology	***Appendix B*** - Individual hydrology summary subsections for each site ***Appendix N*** Hydrotechnical Summary Memo - KWL report on the hydrology at Fish Trap Creek
SCG 5.1.2.1 3	Wildlife Conservation Areas	Not applicable to this project
SCG 5.1.2.1 4	Site Visits and Observations	***Appendix A*** - Environmental Strip Maps ***Appendix B -*** Annotated photographs of each site ***Appendix E-*** Fish Habitat Descriptions Part III.2.3.5 Raptor Nests
SCG 5.1.1.4 f)	Long Term Maintenance	Part V.1 Construction Impacts to Aquatic Resources – Table 35
SCG 5.1.2.3 2 SCG 5.1.2.5	Environmental Mitigation	Part VI.1 Environmental Mitigation Hierarchy Part VI Environmental Mitigations and Offsetting
SCG 5.3 SCG 4.1 Step 5	Archaeological assessments	Document upload to FrontCounterBC: Stantec Archaeological Overview Assessment: Highway 1 Improvement Program from the 264th Interchange to the Whatcom Road Interchange, and MoTI Archaeological Chance Find Protocol
SCG 5.3 & 5.1.1.7 SCG 4.1 Step 5 SCG 5.1.2.2 2	Hydraulic Analysis & Storm Water Management	Part II.3 Design of Key Instream Construction Elements ***Appendix B*** - Application Sites Technical Memo ***Appendix N*** - Hydrotechnical Summary Memo - KWL report on the hydrology at Fish Trap Creek
SCG 5.3 & 5.1.1.7 SCG 5.1.2.4	Off-Setting Plan	Part VI.4 Offsetting Plan ***Appendix B*** - Application Sites Technical

Regulation	Description	Application Information Location
		Memo Subsections 10, 11 & 19 of Application Sites ***Appendix I*** - Offsite Environmental Offset Designs ***Appendix J*** - Onsite Environmental Offset Designs
SCG 5.3 & 5.1.1.7 SCG 4.1 Step 5	Riparian Planting Plan	Detailed design of the riparian planting is a future activity. Reference and commitment to this part of the project is throughout the document. ***Appendix I*** - Offsite Environmental Offset Designs ***Appendix J*** - Onsite Environmental Offset Designs
SCG 5.4.2 & 5.1.1.7 SCG 5.1.2.5	Riparian Planting Monitoring	Part VI.4.7 Monitoring Measures Part VI.4.7.1 Post-Construction Environmental Monitoring
SCG 5.1.2.4 SCG 5.1.2.3 1&2	Habitat Balance	Part VI.6 Residual Impacts Part VI.7 Offsite Restoration and Offsetting ***Appendix M*** - Habitat Balance
SCG 5.3 & 5.1.1.7 SCG 4.1 Step 5	Species at Risk Management	Part IV.3.1 Species at Risk (aquatic) Species-at-Risk subsections within Part IV.3 Watersheds Part IV.4.6 Plant Species at Risk Part IV.5.2.4 Wildlife Species at Risk Part V.1.3.1 Fish Species at Risk Part V.3.4 Wildlife Species at Risk Part VI.3.8.2 Species at Risk Management Executive Summary Part I.5.1 Federal Legislation Part I.5.2 Provincial Legislation Part III.1.2 Assessment Boundaries Part III.2.1 Desktop Review Part III.2.3 Detailed Field Assessment
SCG 5.3 & 5.1.1.7 SCG 4.1 Step 5	Erosion and Sediment Control & CEMP	Part VI.3.4 Erosion and Sediment Control Part VI.3.1 Construction Environmental Management Plan (CEMP)
SCG 5.4.1 & 5.1.1.7 SCG 5.1.2.5	Post Construction Monitoring	Part VI.4.7.1 Post-Construction Environmental Monitoring

I.5.2.3 Wildlife and Wildlife Amendment Act

The provincial *Wildlife Act* (RSBC, 1996, c.488) (BC, 1996a) protects vertebrate animals from harm except as allowed by regulation (e.g., hunting). Permits under the Act are issued by the Minister of the Environment to authorize certain activities (e.g., beaver dam removal and wildlife salvage) if they will not jeopardize the survival or recovery of that species. In 2004, the *Wildlife Amendment Act* was introduced to protect and recover species at risk identified by the Lieutenant Governor in Council, making it an offense to kill, harm, harass or capture an animal identified as at risk (Bill 51-2004).

This Act largely pertains to the site preparation and construction phases of the project. The Act protects wildlife and their habitats from destruction or disruption. Appropriate mitigation measures, such as captures, salvages and relocations, may be required to avoid contravention of this Act. Should it be deemed necessary, a General Permit under the *Wildlife Act* will be required to trap and relocate wildlife prior to construction.

I.5.2.4 Weed Control Act

The provincial *Weed Control Act* (RSBC, 1996, c.487) (BC, 1996b) designates provincially and regionally noxious weeds (listed on Schedule A of the Act) and the associated regulations governing those plants (BC, 1996b). The Act provides guidelines for noxious weed prevention and management, stating that it is the responsibility of the landowner to manage and prevent spread of noxious weeds. Noxious weeds are typically non-native plants that have been introduced to BC without the insect predators and plant pathogens that help keep them in check in their native habitats. For this reason and because of their aggressive growth, these alien plants can be highly destructive, competitive, and difficult to control (RSBC, 1996, c. 487). Any noxious weeds identified in the project area may require management throughout project works.

A summary of the potentially applicable permits for this project are listed in ***Table 4*** with their relevance outlined.

Table 4. Potential project permits.

Legislation	Agency	Area of Regulation	Possible Permits / Authorizations / Actions
Federal			
Fisheries Act (RSBC, 1985, c.F-14)	DFO	Protects fish and fish habitat, working in and around a waterbody.	Works below the high-water mark fish bearing water courses. Project Review or Authorization may be required. Additionally, a fish collection permit will be obtained prior to the start of instream works.
Species at Risk Act (SC, 2002, c.29)	Environment Canada	Protects wildlife and wildlife habitat listed as threatened or endangered.	Permit may be required if destruction of critical habitat is to occur.
Migratory Birds Convention Act (SC, 1994, c.22)	Environment Canada	Prohibits injury, molestation and destruction of migratory birds and their nests.	If any vegetation (includes grasses and shrubs) is to be removed during the bird nesting season, then Bird Nest Surveys required.
Provincial			
Water Sustainability Act (SBC, 2014, c.15)	Ministry of Forests (MOF)	Regulated activities in and around water and water use.	Notifications required for project works that meet the approved work criteria. Based on final drainages design, an Approval for instream works may be required and would be subject to a minimum 140-day review period (likely more than 140 days).
Wildlife Act (RSBC, 1996a, c.488)	Ministry of Land, Water and Resource Stewardship (MLWRS)	Regulates works around the protected nests of Bald Eagle, Great Blue Heron, Golden Eagle, Peregrine Falcon, Gyrfalcon, Osprey and Burrowing Owl.	A sweep for raptor nests must occur prior to construction activities. Under Section 34, Provincial Wildlife Act, bald eagle nests are protected year-round regardless of occupancy. Bald eagle breeding window generally occurs in April to August of a given year; construction should be carefully planned to avoid significant disturbance. A General Wildlife Permit will be obtained prior to initiation of construction works, to allow salvage of wildlife as needed.
		Regulates works that impact breeding birds.	Protects birds and their nests during the bird breeding season as well as the nests, nest trees and eggs of certain species of birds all year.

Legislation	Agency	Area of Regulation	Possible Permits / Authorizations / Actions
Wildlife Act Designation & Exemption Regulation (RSBC, 2014, Reg. 168/90)	MOF	Exempts from permitting required under the Wildlife Act for nuisance wildlife.	Certain nuisance birds such as house sparrows, starlings, cowbirds and crows are not protected under the Wildlife Act.
Weed Control Act (RSBC, 1996, c.487)	Ministry of Environment (MOE)	Regulates control of designated noxious plants.	Act imposes a duty on all landowners to control designated noxious plants. Noxious plants have been identified in and around the Site.
Environmental Management Act (SBC, 2003, c.53)	MOE	Regulates the disposal and storage of hazardous materials and hazardous materials spill reporting.	Permit may be required for the transportation, storage or disposal of listed waste materials.
Heritage Conservation Act (RSBC, 1996, c.187)	MOF	Protection of archaeological and heritage sites.	Permits and assessments required related to archaeological and heritage impact management.

I.6 CONSULTATION AND ENGAGEMENT

I.6.1 First Nations

MoTI initiated consultation and engagement for the Project with the following First Nations, beginning in January 2021:

1. Kwantlen First Nation
2. Leq'á:mel First Nation
3. Matsqui First Nation
4. Musqueam Nation
5. People of the River Referrals Office (PRRO)
6. Peters First Nation
7. Seabird Island Band*
8. Semá:th First Nation**
9. Semiahmoo First Nation
10. Shxw'ōwhámél First Nation*
11. Skawahlook First Nation*
12. Soowahlie First Nation*

* Member of the S'ólh Téméxw Stewardship Alliance (STSA) who have requested consultation through the PRRO
** Member of the STSA who has been consulting directly with MoTI and through PRRO

This work is ongoing at varying levels of engagement on topics such as environmental investigations, habitat offsetting, archaeological investigations, geotechnical investigations, public engagement, utilities, and advanced works including upgrades to the Bradner Rest Area, tree clearing, utility locates, soil removal, and pre-loading. MoTI will continue consultation on the components of the Project that have the potential to impact First Nations' Aboriginal Interests.

Due to potential Project impacts and the Project location, MoTI has been consulting with Kwantlen, Matsqui, Semá:th and Leq'á:mel First Nations through regular in-person and virtual meetings, information sharing, and joint review of the Project's detailed design. MoTI has responded to the interests identified by these First Nations by facilitating attendance of cultural monitors during archaeological and geotechnical investigations, providing capacity funding for participation in Project consultation and field investigations, incorporating feedback into habitat offsetting planning, and identifying interests for potential mitigation or accommodation as well as opportunities for collaboration. MoTI's thorough consultation with Kwantlen, Matsqui, Semá:th, and Leq'á:mel First Nations will continue throughout the Project's life cycle.

I.6.2 Other Stakeholders

There will be a total of 47 properties impacted by the Project; 29 are at the 264 Street Interchange and the remainder are along the highway alignment (***Appendix C***). Seven of the properties are zoned commercial / industrial, 39 are in the Agricultural Land Reserve (ALR), one is zoned residential, and one is provincial. The potential property impacts relating to trenchless installation of the two deep culverts west of Mt Lehman Road have been considered. MoTI will work with these property owners to negotiate property takes at an appropriate stage in the Project. See Section 1.6.3 for a general list of property ownership. See site figures in ***Appendix B*** for property mapping.

A separate impact assessment is being prepared by the project team for the Project, considering agricultural effects. Further, an application will be filed with the Agricultural Land Commission for the use of ALR lands. These ALR sites are minor widenings of approach roads, plus the offsite offsets for environmental enhancement.

MoTI has been working closely with both the Township of Langley and the City of Abbotsford to review design. ***Appendix C*** does not include property with temporary Licenses to Construct (LTCs). However, MoTI land agents will negotiate LTCs before active construction commences.

I.6.3 Land Use

The 13 km length of highway planned for widening is adjacent to many land uses. By area, most lands are agricultural, commercial, and residential; however, recreational lands, school and municipal lands, a hospital, and an international airport are all located nearby to the Project footprint.

I.6.4 Water Licenses

A search of iMapBC (OCIO, 2021c) provincial database identifies 11 aquifers along the widening alignment (***Table 5***). Within 200 m of the alignment footprint (LAA) there are 234 groundwater wells documented (licensed and unlicensed). Their depth, licence status and associated aquifer are provided in ***Appendix D, Table 1***. Furthermore, there are six water licenses registered with the province; license number, purpose, water source and volume of extraction are provided in ***Table 6***. Water license status and well tag number (if applicable) around the project footprint are depicted in ***Appendix D, Figure 1***. The drainage designs are intended to not divert water or require water licenses. Drainage design has replicated existing drainage paths in terms of sources and outlets to downstream drainage.

Table 5. Aquifers within the alignment footprint.

Aquifer No.	Aquifer Name	Segment	Descriptive Location	Material Type	Subtype	Lithostratigraphic Unit	Vulnerability	Productivity	Demand	Area (m^2)
1193	Aldergrove Quadra	1	Township of Langley and Washington State	Sand and Gravel	Confined sand and gravel - glacial	Quadra Sands	Low	Moderate	Low	21536092.69
51	South of Murrayville AC	1	South of Murrayville	Sand and Gravel	Confined sand and gravel - glacial	Vashon Drift	Low	Moderate	Low	94868196.08
35	Hopington AB	1	Hopington - Township of Langley	Sand and Gravel	Unconfined sand and gravel - late glacial outwash	Sumas glaciofluvial deltaic	High	High	High	23872303.88
33	West of Aldergrove	1	West of Aldergrove	Sand and Gravel	Confined sand and gravel - glacial	Early Fort Langley or Vashon intertill glaciofluvial/ glaciomarine outwash	Low	Moderate	Moderat e	47188197.13
1195	South of Murrayville B	1	Township of Langley	Sand and Gravel	Confined sand and gravel - glacial	Vashon Drift	Low	Moderate	Low	73531366.14
32	Beaver River	1	Beaver River	Sand and Gravel	Confined sand and gravel - glacio-marine	Early Fort Langley or late Vashon glaciofluvial/ glaciomarine outwash	Low	High	Moderat e	68671659.89
1234	Sperling	1	Township of Langley	Sand and Gravel	Confined sand and gravel - glacial	Fort Langley Formation	Low			73047929.92
1192	Aldergrove CD	1	Township of Langley	Sand and Gravel	Confined sand and gravel - glacio-marine	Fort Langley Formation	Moderate	Moderate	Moderat e	22902976.3
27	Aldergrove AB	1, 2	Aldergrove AB	Sand and Gravel	Confined sand and gravel - glacio-marine	Fort Langley Formation	Moderate	High	High	97829485.72
969	969	2	Sumas mountain	Bedrock	Fractured sedimentary rock	Sedimentary rk; Kitsilano Formation; Cenozoic Era	Moderate	Moderate	Low	22902976.3
15	Abbotsford-Sumas	2	Abbotsford - Sumas	Sand and Gravel	Unconfined sand and gravel - late glacial outwash	Sumas Drift; glacial outwash	High	High	High	49996592.51
28	28	1, 2	Northwest of Clearbrook	Sand and Gravel	Confined sand and gravel - glacial	Fort Langley Formation	Low	Moderate	High	41294454.96

Table 6. Water licenses within the alignment footprint.

License No.	License Status	Segment	Purpose	Source	Quantity	Quantity Units
C104206	Current	1	03B - Irrigation: Private	Moorhen Creek	9497.796	m^3/year
C104206	Current	1	08A - Stream Storage: Non-Power	Moorhen Creek	9497.796	m^3/year
504227	Current	1	WSA08 – Livestock & Animal	Aquifer 27	58.400	m^3/year
500575	Current	1	WSA08 – Livestock & Animal	Aquifer 27	13400.000	m^3/year
500615	Current	2	11B - Conservation: Use of Water	Aquifer 28	0.0025	m^3/sec

I.6.5 Land Ownership

In accordance with the multi-site FrontCounter BC application, existing land ownership information for each site is summarized in ***Table 7***. At major culverts there will be either property acquisitions by MoTI or Licences to Construct on private lands. At side road widenings there will be a similar need for acquisitions and/or Licences to Construct. These are not listed in the table and will be part of a land agent program that is common to most BC MoTI projects.

Table 7. Summary of land ownership.

Site ID	Site Name	Land Description, Crown Land Permission, Land Ownership, Consent, Other Affected Lands
1	Coghlan 1	Statutory Highway Right-of-Way, Provincial Crown Land
2	Coghlan 2	Statutory Highway Right-of-Way, Provincial Crown Land
3	Coghlan 3	Statutory Highway Right-of-Way & PID 013-769-651 Rem Lot 7 Plan NWP2553: Provincial Crown Land
4	West Creek 1	Statutory Highway Right-of-Way, Provincial Crown Land
5	West Creek 2	Statutory Highway Right-of-Way, Provincial Crown Land
6	West Creek 3	Statutory Highway Right-of-Way, Provincial Crown Land
7	Nathan Creek 1	Statutory Highway Right-of-Way, Provincial Crown Land
8	Nathan Creek 2	Statutory Highway Right-of-Way, Provincial Crown Land
9	Nathan Creek 3	Statutory Highway Right-of-Way, Provincial Crown Land
10	Bradner North	PID 024-047-945 Part SE 1/4 Section 33, Provincial Crown Land
11	Nathan Creek East	PID 004-279-328 Rem Lot 2 Plan NWP20871, Provincial Crown Land
12	Salmon River Tributary	Statutory Highway Right-of-Way, Provincial Crown Land
13	Fishtrap 1	Statutory Highway Right-of-Way, Provincial Crown Land
14	Fishtrap 2	Statutory Highway Right-of-Way, Provincial Crown Land
15	Fishtrap 3	Statutory Highway Right-of-Way, Provincial Crown Land
16	Enns Brook 1	Statutory Highway Right-of-Way, Provincial Crown Land
17	East Fishtrap Creek	Statutory Highway Right-of-Way, Provincial Crown Land
18	Enns Brook 2	Statutory Highway Right-of-Way, Provincial Crown Land
19	Salmon River	North of the highway: east ponds PID 013-872-311 NWP 853 REM Parcel D REM Lot 7, west pond PID 017-174-805 Part A 317. Both parcels are Provincial Crown Land South of the highway: PID 043-011-418 Parcel B REF Plan 3342, Trinity Western University property (permission letter from property owner in progress).

PART II DESCRIPTION OF PROPOSED INSTREAM WORKS

The proposed construction activities are summarized along with equipment, materials and timing of works. Design drawings are provided for the overall highway reconstruction (***Appendix G***). Large scale drawings, impact assessments and design rational are provided for key fish bearing culverts, bridges, fish bearing stream or ditch relocations, onsite and offsite offsets.

Environmental strip maps, provided in ***Appendix A: Figures 1*** and ***2***, provide a landscape context for these works, to complement and contextualize the corresponding engineering drawings. We recommend reviewing the strip maps concurrently with the engineering drawings to gain a sense of location and totality. ArcGIS software was used to create these maps, with a focus on stream class for both aquatic and riparian areas.

II.1 PHASES AND SCHEDULE

At a high level, key timeline milestones for advanced works and construction of Highway 1 widening are identified below (***Table*** 8***8***). These times are subject to Treasury Board endorsement of the procurement budgets. Early stage clearing and site preparation works are expected to commence in Q3 2023, and the bulk of the Project is expected to be completed in Q2 2024 through Q4 2028.

Table 8. Key timeline milestones for advanced works and construction of Highway 1 widening.

Activity	Anticipated Timing of Works
Environmental Offsite Offsets	August 2023 – December 2028
Tree Clearing	September 2023 – March 2024
Grubbing and Pre-load	August 2023 - March 2024
Bradner Rest Area	August 2023 - August 2024
Construction	Q2 2024 – Q4 2028

The Project will be staged to correspond with environmental reduced risk timing windows where possible and to minimize impacts on traffic. Environmentally sensitive construction will be targeted to specific times of year. These timing windows are discussed in ***Part VI.3.8.1***.

II.1.1 Design Phase

The Project is currently at the design phase. General arrangement drawings for the priority culverts at high value instream habitats have been provided in ***Appendix H***, and offsetting habitats are illustrated in ***Appendices I and J***. Further design stages are anticipated for the Project.

The impacts and enhancements are illustrated in a series of three environmental strip maps, provided in ***Appendix A***. The strip maps have been developed through ArcGIS and capture the environmental mapping, including stream classifications. The power of GIS has been utilized to determine the interaction of the design with the environment and generate the areas of various classes of disturbance and enhancements. These three environmental strip maps are intended to complement and contextualize their corresponding engineering drawings. It is recommended that the strip maps be reviewed concurrently with engineering drawings to gain a sense of location and totality.

II.1.2 Pre-Construction Phase

Early and advance works include:

- Habitat compensation at offsite offset locations
- Advance tree clearing outside the nesting bird window in the Winter, 2023
- Preload / surcharge in the highway median and several infrastructure locations
- Bradner Rest Area improvements adjacent to Nathan Creek
- Advance third-party and municipal utilities relocations
- Invasive species treatment

II.1.3 Construction Phase

The broad scope of the project construction includes:

- Early works that includes tree clearing and grubbing, preload, and retaining walls and temporary access and staging areas.
- Widening of Highway 1 to 6 lanes including HOV, plus bus-on-shoulder and truck climbing lanes.
- Multi-use path (MUP).
- Replacement of the 264 Street Interchange, traffic movement and approaches.
- Bradner Rest Area expansion and upgrade.
- Replacement of the Bradner Road Overpass.
- Replacement of the culverts with a new bridge across Fishtrap Creek.
- Realignments of ramps and roads around full movement interchanges and at existing bridge crossings located at:
    - Mt Lehman Road Interchange
    - Fraser Highway East and West Underpass

II.1.3.1 Construction Staging

Main construction contract staging includes widening and culvert installation works. The median HOV lanes and the climbing lanes can generally be constructed off-line, during night work. Temporary shoulder / lane closures will be required where the new lanes tie to the existing highway as well as for the mill and overlay operations of existing pavement.

Major culvert crossings are expected to be replaced by open cut with staged construction and highway detours. The two deeper culverts CUL-3 and CUL-7 are located west of Mt Lehman Road and require trenchless installation to minimize disruption to the highway traffic. The approach for culvert construction is to leave the existing culverts in place while new culverts are being constructed, then to switch flow to the new culvert and decommission in place the old culverts, which will require minor channel work upstream and downstream of new culvert locations to tie into existing watercourses.

Subject to further investigation and construction logistics, other culverts might also be built with trenchless installation (pipe jacking) to reduce impacts on traffic.

Bradner Overpass Structure will need to be built in stages to accommodate traffic on Highway 1, traffic on Bradner Road, complexities related to bridge construction sequencing including stone columns, and a compact working area.

Fishtrap Creek Bridges can be built in stages with traffic detouring around construction zones, and the shallow bridges can be built close to operating traffic. Essentially, two lanes in each direction are detoured into the current median, while the outer portions of the new bridges are built. Traffic is then diverted onto the newly constructed decks and the remaining portion built. Most of the detouring length can use permanent highway widening pavement; however, temporary culverts will likely be required for the detour lanes until the final bridge construction is complete and the temporary culverts can be decommissioned.

Other work is expected to be a combination of off-line, overnight, and temporary lane closures.

II.1.4 Construction Closure

Although the highway will continue in operation, the construction contracts will end with closure phases. Each construction contract will be closed out by Ministry construction supervision personnel. This involves a road safety audit and deficiency compilation (punch list) and rectification. Any cost claims will also be resolved.

After construction of environmental components, environmental monitoring will commence – as described in ***Part VI.3.2***. Environmental repairs and adjustments that are identified will be made as required to assure performance.

II.2 CONSTRUCTION METHODS

Early works are meant to de-risk the construction schedule and meet environmental obligations.

The primary construction contract follows and will be based upon MoTI's well established procurement process, contract forms, special provisions, standard specifications and construction supervision processes.

Heavy civil construction is the primary activity involving excavation and placement of earthworks. Cuts and fills will be from onsite materials augmented by imported earth, where needed for quantity balance or to replace unsuitable (wet) excavations. Unsuitable materials will be disposed at selective (non-riparian) on site locations or exported offsite to approved locations (typically pits or non-ALR sites that require flood proofing).

Utility relocations are a complex part of the process. They involve extensive consultation with the utility jurisdictions and integration with the construction staging plan. Utilities are reinstated to pre-project conditions.

Structural construction will proceed independently and is less weather sensitive. Starting with foundations (typically piles or spread footings), then columns or walls, followed by superstructure and deck/parapets. Overpass/underpasses and major open cut (non-jacked) culverts will require detours of the mainline to sequentially create the construction zones for eastbound and westbound. More complex staging is required at interchanges.

The proposed new drainage culverts, storm sewers, ditches and ponds will be introduced on an opportunity basis, as controlled by the staging sequence and detours. With the drainage network progressively completed, an area of focus will be temporary drainage, to work with the various construction stages, for the safety of vehicles and the protection of the environment. Contractors are required to provide erosion and sediment control plans for this purpose.

The pavement structure is typically a metre thick and laid down sequentially in layers. The construction staging will be designed to integrate with the structural detours and progressively complete the overall driving surface. There will be some temporary paved areas, typically for detours to cross the median, which will be later removed.

Finishing involves the top lift of asphalt, shouldering, top soiling, planting, marking, signage and lighting.

II.2.1 Methods for Fish Bearing Culvert Construction and Stream Realignments or Weirs

Our approach for fish bearing culverts is to build during reduced risk windows. In many cases the existing culvert will temporarily remain in place, while the new culvert is installed adjacent to it. It is also possible to dam off the culvert construction zone and detour water across the site with screened pumps and a temporary pipe. Environmental mitigations during construction are described in ***Part VI.3***.

As shown on the culvert GAs drawings (***Appendix H***), culvert construction may include embedment with boulders and aggregates, backwatering weirs or riffles, maintenance access road, scour protection at inlets and outlets, headwalls, embankment slope protection from erosion, reinstating the stream approaches, riparian planting, and stream complexing. The design is subject to evaluating a number of options to achieve fish passage flow velocities, which will be refined further during later design phases.

Most earthwork will be conducted with backhoes/excavators, with dump trucks used to move materials around. This heavy equipment will generally be confined to the riparian zone for placement and access/egress. Temporary roads will be built where needed and generally removed later during site reinstatement. For instream work hoes would reach out into the stream from their placement in the riparian zone. In effect this is working from the top of bank, outside of the stream channel.

Where concrete headwalls or concrete weirs are required, the preference will be for pre-cast components. If poured-in-place concrete is necessary, then a dry work zone to be created, that is isolated from the stream for the fabrication period.

II.2.1.1 Trenchless Culvert Installation

At very deep highway embankments, trenching for culvert construction is not practical. As mentioned, pipe jacking technology will be considered in these cases. Typically, a jacking pad or pit is established as a working platform. New pipes are then pushed through the highway embankment. This method is only to be used following geotechnical review, and should trenchless installation be used, best practices would be followed including monitoring of annular pressure to limit risk.

Currently it is assumed trenchless installation for culverts CUL-3 and CUL-7. Those culverts are to be welded round steel pipes, to have the strength and integrity to be jacked (pushed) through the embankments. Both will have jacking and receiving areas. The work also requires access roads to move the heavy equipment in and out. The working footprints of the construction disturbance areas are shown on the drawings have been considered in the habitat impacts and will be reinstated afterwards. Should trenchless culvert installation be used, environmental mitigations will be applied, as outlined in ***Part VI.3.4.***

II.2.1.2 Open Cut Culvert Installation

The method of open trench excavation will be up to the contractor. Typically, this involves the use of excavators to dig down to the underside of proposed pipes, place the pipes and backfill. The challenge will be the safe execution of these generally deep open cuts in the order of 6 m deep. Due to the depths, geotechnical design will be required for worker safety. Combinations of back slopes, trench cages and benching are likely required.

Regardless of the construction method, the impacts upon the streams should be limited to the end treatments of the culverts: headwalls, armoring and boulder riffles or weirs. To minimize impacts, isolation of the culvert work zone should be undertaken to allow earthworks for the pipe installation to be conducted in the dry. This isolation process typically involves installing temporary dams at each end, conducting a fish salvage and detouring creek flows through a separate conveyance using pumps, maintenance pipes and/or existing pipe (to be removed upon completion of construction).

II.3 DESIGN OF KEY INSTREAM CONSTRUCTION ELEMENTS

II.3.1 Roads

This Project includes reconfiguration of several road crossings:

- 264 Street Interchange: addition of new bridge structure, incorporation of the MUP, new on and off ramps, mobility hub (Transit Loop and 322 Park and Ride lot) and a 29-stall truck parking lot with pedestrian access to the north side of the highway.
- Replacement of the Bradner Road Overpasses and Widening of Highway 1 to accommodate an eastbound climbing lane from Bradner Road Overpass to Mt. Lehman Road
- Widening of the existing Mt Lehman Road Underpass to accommodate an additional southbound lane and a MUP on the east side of the bridge.

Furthermore, signal and lane upgrades to 56 Avenue, 57 Avenue, 52 Avenue and Gloucester Way will occur. The following pull-outs will also be upgraded:

- Existing Bradner Rest Area to be expanded to accommodate more vehicles, EV charging and improved lighting and relocated sani-dump.
- Four Commercial Vehicle Safety and Enforcement inspection pullouts. Two are located within the 264 Street interchange footprint and one on either side of Highway 1 west of the Bradner Rest Area.

Primarily watercourse impacts through road construction involves the infill of the previously constructed habitats within the median.

II.3.2 Fishtrap Creek Bridge

The sole pair of water crossing bridges are at Fishtrap Creek. Currently, East Fishtrap Creek and Enns Brook cross Highway 1 through four culverts, converging at a city owned and operated weir on the north side of South Fraser Way east of Deacon Street. Two new clear-span, pile-supported bridges with an open channel median are proposed at the East Fishtrap Creek to replace the four existing culverts. This will require a new creek alignment crossing the highway (***Figure 4***). This new channel will be constructed with an opening size of 4 m bottom width and 2:1 side slopes. The new channel will provide 700 mm depth of water under low flow conditions.

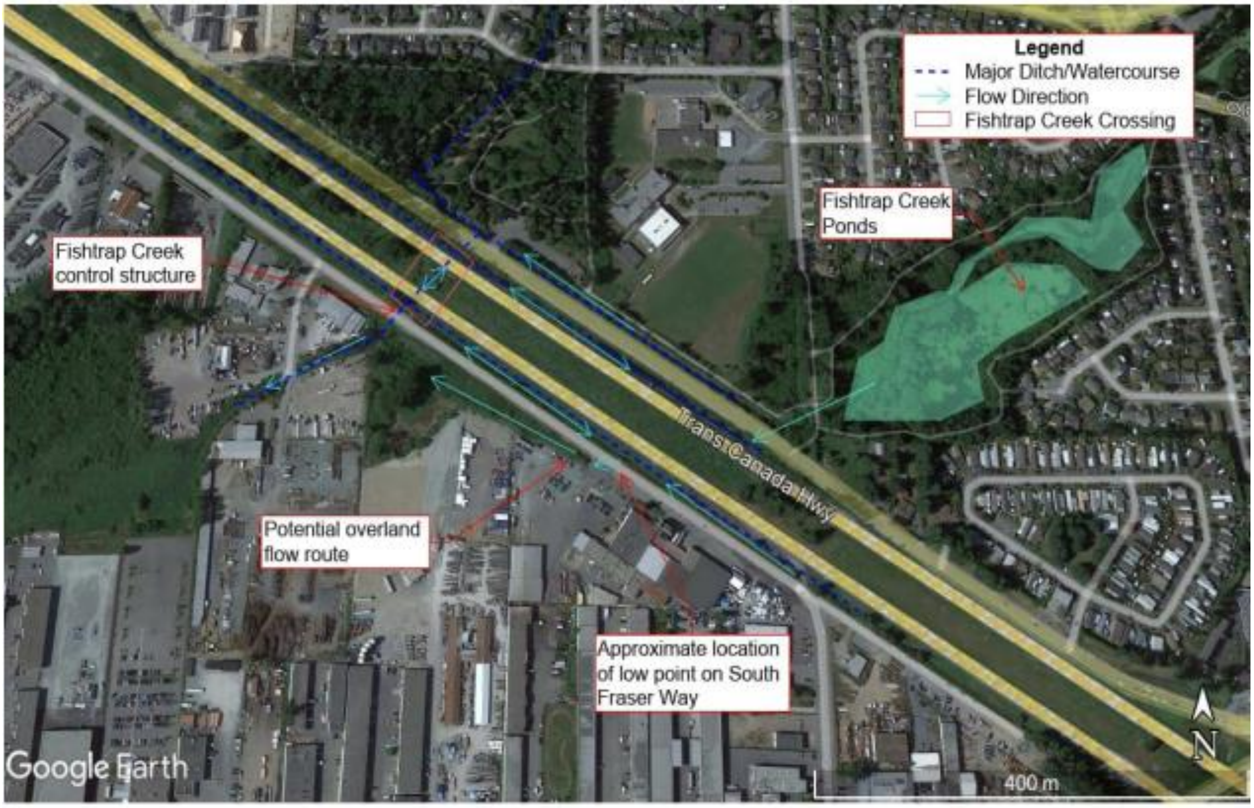

Figure 4. Fishtrap Creek crossing and potential overland flow location.

The current design has spans that are 17 m eastbound and 19 m westbound. This can be achieved using precast box girders. Each set of box girders will act together with the composite concrete deck. Based on the geotechnical investigation, liquefaction is a possibility near the proposed Fishtrap Creek Bridges but requires further analysis. The soft soils will require ground improvement before permanent fill construction. A temporary surcharge is proposed over about a distance of about 1,000 m within the median near the Fishtrap Creek crossing to address compressible subgrade conditions.

The city owned and operated weir is located downstream of the proposed bridge crossing (between Highway 1 and South Fraser Way). During a storm event, water flows through the watershed to the city weir, which backwaters the channel to fill the Fishtrap Creek detention ponds on the north side of the highway. During a significant storm event, beyond the design capacity of the ponds, water will overtop the weir. Further design of this structure is needed to consider the key elevations around the city weir, the changing flow directions of Fishtrap Creek, the capacity of the ponds, probable overland flow paths, and climate change adjustment factors.

II.3.3 Culverts

Culverts have a well-defined design process as set out in the BC Highway Design Manual. Hydrologic modelling generates water flows at different return period storms. These flows account for historical records, times of concentration, watershed infiltration, climate change, and other factors. Hydraulic modelling allows the calculation of flow velocities and flow depths which are key parameters for fish passage design.

For the Highway 1 Project, most of the new culverts cross both eastbound and westbound lanes and replace two older culverts with a single larger culvert. The largest culverts are also paired with a bypass or diversion culvert used for maintenance purposes. The culverts are sized based on the following criteria, as outlined by the MoTI Supplement to TAC Geometric Design Guide (MoTI, 2019b).

II.3.3.1 Design Flow Criteria

The MoTI drainage design process generally uses peak instantaneous flow rates for various return period flow projections. These are significantly larger flow rates than maximum daily flow rates.

There is a difference in the return period guidelines to use between MoTI and WSA. MoTI provides for 200 year with >3 m widths and 100 year with <3m widths, at the discretion of the engineer. WSA guidelines instead refer to channel capacity and 200-year return period. However, the streams culvert design has generally used the 200-year return period to satisfy both guidelines.

Table 9 provides various design case flow rates for example culverts (i.e., different return periods and peak instantaneous versus maximum daily). In bold is the flow used for design, which are significantly higher than the daily maximum flow rates to demonstrate that both MoTI and WSA/MoF criteria are accounted for.

Table 9. Comparison of design criteria flow rates.

Culvert	Q200 Peak Instantaneous (95^{th} percentile CC) m3/s	Q200 Peak Instantaneous CC m3/s	Q200 Maximum Daily (95^{th} percentile CC) m3/s	Q200 Maximum Daily CC m3/s	Q100 Peak Instantaneous CC m3/s
C-2/3	**16.07**	14.00	4.11	3.58	12.08
C-4/5	5.30	**4.62**	1.38	1.20	3.99
C-7/8	2.87	**2.50**	0.81	0.71	2.17
C-38/39	3.51	**3.06**	0.60	0.52	2.62
C-9/10	1.61	**1.40**	0.31	0.27	1.20
C-11/12	**6.12**	5.33	1.09	0.95	4.56
C-14/15	1.30	**1.13**	0.23	0.20	0.97
C-16/17	**5.71**	4.98	1.31	1.14	4.27
C-18/19	1.83	**1.60**	0.22	0.19	1.35
C-6	3.30	**2.88**	0.58	0.45	2.46

II.3.3.2 Culvert Information

The culvert information required in support of the WSA application is included below:

- Replacement culverts in fish-bearing watercourses have been designed and/or upgraded to be passable for various life stages of fish using the associated reaches.
- Fish passage is calculated based on the flow velocity at Q_H (the design flow stage – 25% volume of 2-year return period).
- Fish swimming speeds were compared to a fish swimming speeds table (USDOT, 2010). Due to the variety of species, 0.6 m/s was selected as the maximum speed, which is representative of trout. However, lower flow speeds (i.e., less than 0.6 m/s) are desired for small and juvenile fish species. As such, baffles may be considered in fish-bearing culverts. Various tools for achieving fish passage will be considered as design progresses. Except for one fish-bearing culvert, proposed design velocities are low (***Table 14***). Existing fish-bearing culvert conditions (which are being replaced) are provided (***Table 12***).
- Velocity assessments for potentially fish-bearing culverts were made where Class A or A(O) watercourses are present upstream and downstream.
- Where one end of a non-fish-bearing culvert connects with a Class A or A(O) stream, designs provide for non-fish-bearing culvert replacements in ***Appendix K***.

II.3.3.3 Project Culvert Assessment

To ensure sufficient design at this stage of the Project, a key process was to identify:

- Fish-bearing culverts,
- Culverts interfacing at one end only with a fish-bearing stream and
- Culverts with no interaction with fish-bearing streams.

As such, the level of environmental performance required for a culvert is determined by the class of the interfacing streams, as summarized in ***Table 10***.

- Culverts with Class A streams at both ends are to provide for fish passage with pools and riffles as appropriate.
- Culverts with Class A(O) streams on both ends are to have measures to prevent fish stranding when those Class A(O) streams dry out. For the remainder of the year, when flows are present, provisions are made for fish passage in the design.
- Culverts with Class A or A(O) at only the downstream end are to be designed to interface with the Class A / A(O) habitat, minimizing aquatic interference, minimizing riparian impact, and with erosion protection. These culverts are considered non-fish bearing.
- Culverts with Class B or C interfaces are also considered non-fish bearing. These can generally be designed to civil engineering design guidelines with minimal biological design parameters, other than avoiding erosion and interfacing with landscaping vegetation treatments. Culvert construction along streams will require rehabilitation of any disturbance of the riparian habitat.

Table 10. Stream class interfaces and required environmental performance.

Stream Interface Classes		Environmental Treatment
Outlet	Inlet	
A	A	Fish passable
A(O)	A(O)	Fish passable with stranding avoidance
A/A(O)	B or C or none	Footprint minimization & definition at A/A(O) end
B or C or none	B or C or none	Civil design requirements only

Drawings of other culverts with their treatments are provided in ***Appendix K***. Fish bearing culverts are further detailed in ***Part II.3.3.4*** below.

II.3.3.4 Fish-Bearing Culverts

Eight priority culverts planned for construction are designated to be fish-bearing: C2/3, C4/5, C7/8, C11/12, C16/17, C18/19**,** CUL-3 and CUL-7. General arrangement drawings are provided in ***Appendix H***. There are also several minor culverts on local side roads that are fish bearing. These have flat grades with low flow velocities and are therefore fish passable.

The existing culverts at the fish-bearing locations are being replaced. Due to widening toward the median, the north (westbound) and south (eastbound) culverts will become one new culvert. For reference, the existing culvert conditions are set out in ***Table 11***.

Table 11. Existing fish-bearing culverts.

Culvert	Length	Gradient	Material	Conditions	Fish Passable?
C-2/3 South	40.1m	0%	Concrete	Class A	Y
C-2/3 North	38.7m	0%	Concrete	Class A	Y
C-4/5 South	32.2m	0%	Concrete	Class A(O)	Y
C-4/5 North	43.9m	0.1%	Concrete	Class A(O)	Y
C-7/8 South	31.2m	0.16%	Concrete	Class A(O)	Y
C-7/8 North	27.8m	0.5%	Concrete	Class A(O)	Y
C-11/12 South	24.6m	2.84%	Concrete	Class A(O)	N
C-11/12 North	22.7m	0.2%	Concrete	Class A(O)	Y
C-16/17 South	39.1m	0.5%	Concrete	Class A(O)	Uncertain
C-16/17 North	27.1m	1.0%	CSP	Class A(O)	Y
C-18/19 South	35.9m	4.57%	Concrete	Class A(O)	N*
C-18/19 North	36.1m	4.1%	Concrete	Class A(O)	N*
CUL-3	140.7m	1.55%	Concrete	Class A(O)	Y
CUL-7	126.0m	1.4%	Concrete/CSP	Class A	Y
Fishtrap WB East	25.1m	-0.01%	Concrete	Class A	Y
Fishtrap WB West	30.9m	0.01%	CSP	Class A	Y
Fishtrap EB East	26.2m	-0.01%	CSP	Class A	Y
Fishtrap EB West	33.4m	0.01%	Concrete	Class A	Y

**Stream considered to be fish-bearing if culvert barrier removed.*

The fish bearing shortlist of the Project's priority culverts required more extensive design for biological performance. By following the design process, to ensure adequate habitat elements within fish-bearing culverts, an updated and detailed culvert design was achieved for each of these eight priority culvert replacement locations (where they are not being replaced with bridges). Subject to further refinement, design elements and corresponding velocities are provided in ***Table 12***. Plan / profile and cross sections drawings are provided (***Appendices H & K***), with upstream and downstream interfaces defined. Detailed elements of culvert design for fish passage are described below in ***Parts II.3.3.5*** to ***II.3.3.10***. These design approaches illustrate the various measures to achieve the fish passage objectives. Further refinements may be applied during the detailed design phase; but adjustments will respect the fish passage design objectives, set out below.

Table 12. Proposed fish-bearing culvert dimensions.

Culvert Name	Design				Inlet			Outlet			Velocity			Minimum Gravel Size for Embed-ment	Inlet Stream Class	Outlet Stream Class	Fish Passable (Y/N)
	Size (mm)	Material	Length (m)	Grade	Q100/200 Depth (m)	Q2 Depth (m)	Q_H Depth (m)	Q100/200 Depth (m)	Q2 Depth (m)	Q_H Depth (m)	V100/200 (m/s)	V2 (m/s)	Vh (m/s)				
C2/3	4250 x 3950	Concrete Box	77.5	0.50%	2.12	1.22	0.95	1.89	1.51	1.33	2.12	0.7	0.2	25mm	A	A	Y
C4/5	2700 x 2400	Concrete Box	110	0.35%	1.52	0.87	0.61	1.32	1.09	0.97	1.45	0.53	0.15	20mm	A	A	Y
C7/8	2400	CSP	72.5	0.50%	1.05	0.52	0.3	0.75	0.58	0.48	1.42	0.55	0.16	30mm	A(O)	A(O)	Y
C11/12	3650 x 2100	Concrete Box	67.5	0.35%	1.43	0.86	0.61	1.17	0.96	0.83	1.57	0.64	0.19	75mm	B	A(O)	Y
C16/17	3650 x 2100	Concrete Box	87.5	0.76%	1.27	0.67	0.34	1.28	1.08	0.96	1.31	0.53	0.15	20mm	A(O)	A(O)	Y
C18/19	1600	SWSP	87.5	5.53%	0.87	0.43	0.15	0.38	0.19	0.08	2.75	1.94	1.18	50mm	A(O)	A(O)	Y
CUL3	2100	SWSP	145.4	0.80%	1	0.46	0.2	1.38	1.21	1.12	0.83	0.26	0.07	30mm	A(O)	A(O)	Y
CUL7	1980	SWSP	128.5	0.40%	0.77	0.64	0.33	0.95	0.91	0.81	0.76	0.57	0.16	30mm	A	A	Y

SWSP = Smooth Wall Steel Pipe, necessary for trenchless installation
CSP = Corrugated Steel pipe
Q 100/200 = Water flow for the 100 or 200 year return period storm – the design case for peak flow or major event
Q 2 = Water flow for the 2 year return period storm – the design case for high water or bank full
Q H = High passage flow – the design case for fish passage
V 100/200 = Flow velocity at Q 100/200
V 2 = Flow velocity at Q 2
V H = Flow velocity at Q H

II.3.3.5 Culvert Embedment

Embedding the fish-passable culverts is preferred because it extends a more natural substrate through the culvert and promotes sufficient water depths to allow fish passage (***Figure 5***). Embedment may also result in a wider culvert with more light penetration, in the case of small culverts. Embedment provides some roughness that can slow velocities, but only to a certain extent.

However, there are fish-passable culverts where embedment is not warranted. These are the steeper or higher flow velocity culverts where substrate is unlikely to remain in the culvert. Also, where offset bottom baffles are used, embedment is not compatible with that design.

The design of the embedment will occur during detailed design. It involves selecting aggregate sizes that will stay in the pipe during major flows. There is also a need to ensure water flow remains surficial. Where there is an established migration of stream bed materials, this will continue through the culvert. There could be the potential for embedment baffles to give more stability to retain substrate. Embedment is specified for some of the fish-bearing culverts.

Figure 5. Example of embedded culvert.

II.3.3.6 Culvert Backwatering

Where practical backwatering provides for passage of all sizes and species of fish at lower water levels. Backwatering reduces flow velocities within the culvert.*Error! Reference source not found.* Detailed design w ill consider the ground water effects due to backwatering and may require adaptions to the stable design of the highway embankment.

II.3.3.7 Minimum Water Depth

FHWA Hydraulic Circular No. 26 (USDOT, 2010) provides guidance on minimum depths for fish passage. See table 4.2 from that document in (***Figure 6***).

Fish Species	Minimum Depth (ft)	Minimum Depth (m)
Pink Salmon	0.59	0.18
Chum Salmon	0.59	0.18
Coho Salmon	0.59	0.18
Sockeye Salmon	0.59	0.18
Spring Chinook	0.79	0.24
Summer Chinook	0.79	0.24
Fall Chinook	0.79	0.24
Steelhead Trout	0.79	0.24

Figure 6. Minimum depth criteria for fish passage (USDOT, 2010).

Subject to further refinement, the depths in ***Table 13*** are copied from ***Table 12*** for easier reference in the water depths assessment:

Table 13. Water depths at Q_H flow.

Fish-bearing Culvert	Inlet Depth at Q_H Flow	Outlet Depth at Q_H Flow	Embedded
C-2/3	0.95 m	1.33 m	Yes
C-4/5	0.61 m	0.97 m	Yes
C-7/8	0.30 m	0.48 m	Yes
C-11/12	0.61 m	0.83 m	Yes
C-16/17	0.34 m	0.96 m	Yes
C-18/19	0.20 m	0.10 m	No
CUL-3	0.20 m	1.12 m	Yes
CUL-7	0.33 m	0.81 m	Yes

II.3.3.8 Downstream Riffles

Where culverts and their interfacing streams are relatively flat and deep, the velocities will be low and no further treatment is necessary. A wide range of fish species and sizes should be able to traverse the culvert at most migrating water levels and flows.

Where there is more grade and where slow, deep flows are not the natural character of the stream, the next step in achieving fish passability involves modifications to the stream. Where culvert grades are not flat but are modest, and where the drop in the run of the culvert is in the order of 1 m or less, then culvert backwatering and pool creation can be constructed by one or two boulder riffles downstream of the culvert. For this Project, a Newbury style of boulder riffle has been adopted (***Figure 7***). These were originally documented in "Newbury, R.W. & Gaboury, M.N. (1994). Stream Analysis and Fish Habitat Design – A Field Manual – Second Printing". Many other papers have been presented on the application of these riffles.

Figure 7. Newbury boulder riffle.

Boulder riffles are shown on the culvert general arrangement drawings. They are a key component in achieving the flatter grades with lower fish passable flow velocities.

Our selected riffles are typically up to 0.5 m high and have a 5% downstream slope to facilitate fish passage (***Figure 8***). The typical 0.5 m height limits the downstream length of the riffle to about 10 m (based on the 5% criteria). Two Newbury boulder riffles, with a pond between them, create additional water depths in the order of 1.0 m (above the original thalweg).

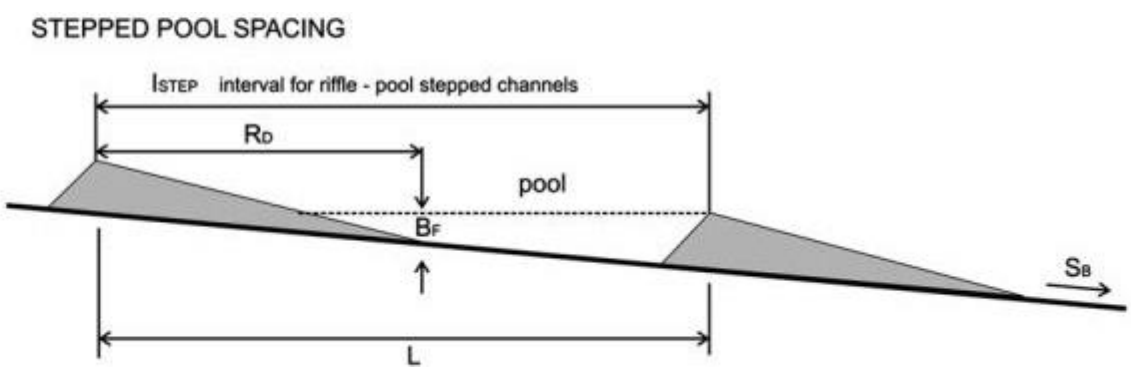

Figure 8. Sequential boulder riffles.

II.3.3.9 Self-Draining Riffles

Class A(O) or ephemeral streams present an additional challenge. Since the streams dry out in the summer, there is a risk of fish stranding. To minimize this, pools or boulder riffles need to be self-draining at low flows (***Figure 9***).

To this end, a hybrid riffle was developed, which involves a concrete weir surrounded by boulders. The concrete weir provides a stable slot within the backwatering rock riffle such that the riffle provides the desired backwatering and fish passage while draining out at very low waters. The configuration of these self-draining riffles is shown in the culvert drawings as a typical detail.

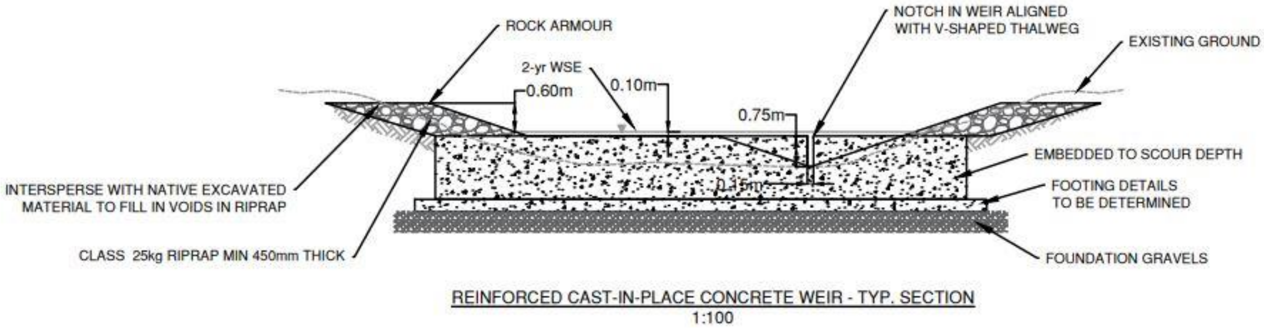

Figure 9. Design of a self-draining riffle / weir to create backwatering.

The design of the slot is wide enough for fish to be flushed out or swim through when the upstream ponds no longer have enough supply flow and are draining out. During other stages of flow, when the pond is upstream of the weir, water will flow through the slot and also over the weir. The downstream side of the weir has a 5% nominal grade boulder riffle. As such, fish could swim over the weir via the boulder riffle.

II.3.3.10 Determining the Need for Baffles

Flow volumes have been calculated with resultant flow velocity within the culverts at three situations:

- Q_P Peak design flow. These flows are extreme events, and the design intent is the survival of the culvert and road structure. Fish are not migrating in these conditions.
- Q_2 Two-year return storm. This represents the maximum flow that typically occurs. It is also the water level used to define the limit of aquatic habitat for area calculation and drawing definition purposes. This event is also somewhat extreme, not occurring often, and fish are not expected to be migrating during these storms.
- Q_H High passage design flow. There is no detailed stream gauging information to determine these and have therefore applied 25% of Q_2, as recommended by FHWA Hydraulic Circular No. 26, October 2010, page 7-3. Fish are expected to be migrating at these flows. Q_H is used as an indicator of culvert velocities for fish passage evaluation.

The need for baffles may be indicated by comparing the high passage flow velocity Q_{HV} and the swimming speed of the fish. For longer culverts, for which there are several, the sustainable swim speed is less. The following table from FHWA Hydraulic Circular No. 26 (UWDOT, 2010) shows a range of swim speeds (***Figure 10***).

Table 4.3. Fish Passage Design Criteria for Culvert Installations.

		Adult Trout > 6 in (150 mm)	Adult Pink or Chum Salmon	Adult Chinook, Coho, Sockeye or Steelhead
Culvert Length (ft)	Culvert Length (m)	Maximum velocity, ft/s (m/s)		
10 – 60	3-18	4.0 (1.2)	5.0 (1.5)	6.0 (1.8)
60 – 100	18-30	4.0 (1.2)	4.0 (1.2)	5.0 (1.5)
100 – 200	30-61	3.0 (0.9)	3.0 (0.9)	4.0 (1.2)
> 200	> 61	2.0 (0.6)	2.0 (0.6)	3.0 (0.9)
		Minimum water depth, ft (m)		
		0.8 (0.24)	0.8 (0.24)	1.0 (0.30)
		Maximum hydraulic drop in fishway, ft (m)		
		0.8 (0.24)	0.8 (0.24)	1.0 (0.30)

Figure 10. Fish swim speeds.

The species of fish shown in the table are representative of the stronger fish. Coho, in particular, are a primary species of concern to be designed for. Recognizing the longer culverts, then 0.9 m/s is a threshold where baffles are warranted for coho. However, there are also smaller fish in the system. For example, adult trout require 0.6 m/s or less velocity. Younger or smaller fish need lower velocities.

Referring to the swim speeds for longer culverts and different species and then comparing with the Q_H velocities (***Table 14***) indicates that baffles are required in culvert C-18/19 due to higher velocities. As described in ***Part II.3.3.7***, water depth requirements also triggered the need for baffles in this same culvert. Other general arrangement drawings also show baffles; however, these may not be needed, subject to further detailed design.

Table 14. Fish-bearing culvert flow velocities.

Culvert	Q_H Flow Velocity
C2/3	0.2 m/s
C4/5	0.15 m/s
C7/8	0.16 m/s
C11/12	0.19 m/s
C16/17	0.15 m/s
C18/19	1.3 m/s
CUL-3	0.07 m/s
CUL-7	0.16m/s

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II.3.3.11 Non-fish Bearing Culverts

Culverts designed on streams which were not fish -bearing were designed to MoTI civil drainage guidelines. These design drawings may be found in ***Appendix K***.

II.3.4 Storm Sewers, Catch Basins, and Spillways

Storm sewers are generally biologically barren, with limited environmental objectives to achieve. These collect runoff at catch basins and discharge this water via an outfall directly to ditches or other open watercourses. Within the Project, catch basins and spillways were spaced to drain a maximum paved area of 500 m^2 (20 m apart) or based on lane geometrics and calculated ponding widths (0.9 m for BOS). Spillways are incorporated along the design where flow could be directed to a ditch without the obstruction of a sound wall. Where a sound wall impeded spillway use, catch basins are proposed to convey flow under the sound wall with the lead discharging to the ditch. Catch basins have also been proposed to drain the road surface into the storm sewer in locations where a sewer is present.

Stormwater outfalls often connect to Class A or A(O) fish-bearing streams. In these situations, outlet objectives are to:

- Control discharge velocities to avoid erosion.
- Be stable within the earthworks construction.
- Have a minimum footprint within the riparian zone.
- Minimize or avoid intrusion into the aquatic zone.

In these instances, a design plan view drawing is provided, illustrating the interface of the storm sewer outlet with the Class A / A(O) stream. For these ancillary culvert General Arrangement designs see ***Appendix K***. The drawings show area of disturbance, appropriate erosion measures, and general construction configuration. Rip rap, headwalls, pipe sizes, material types are indicated, and profiles included.

II.3.5 Ditches

Ditches are the primary treatment for conveying stormwater in the Project. In most cases these are at the edge of the grade. These locations remove water from the gravel structure, which maintains the road strength and captures pavement runoff.

The typical highway ditch has a 1 m-wide bottom and 2:1 side slopes. Where capacity warrants, ditches are wider. Side slopes are also adjusted based on soil conditions, clear zone, landscaping, or other factors. Grade is the key design parameter for ditches as this affects flow velocity, capacity, and erosion potential. Velocity control measures are often introduced, in the form of check dams or rip rap.

Where ditches are known to have potential fishery values, they have been classified as A, A(O), or B for environmental design purposes, based on their location within the watershed relative to existing watercourses. These classifications require riparian habitat rehabilitation with natural vegetation, adjacent to the channel to achieve those biological functions (***Figure 11*** and ***Figure 12***).

In the case of A/ A(O) ditches velocity control to below fish passage speeds is also required. The ditch flow velocity checks and any control measures are deferred to detailed design. Checks on minimum flow depth and fish passable velocities will need to be made and modified if necessary.

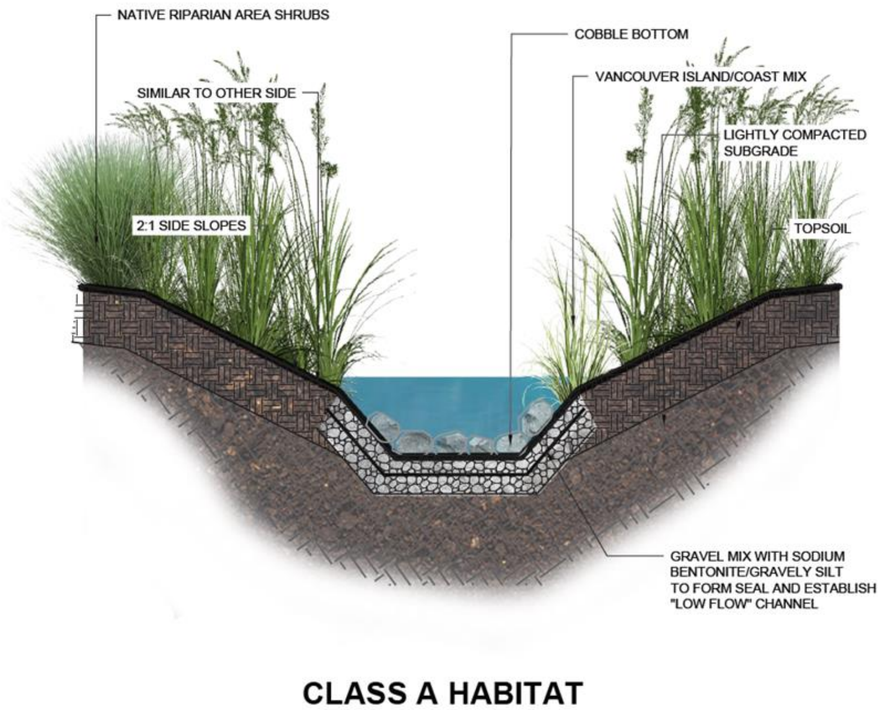


Figure 11. Example Landscaping Treatment of Class A/A(O) Ditch

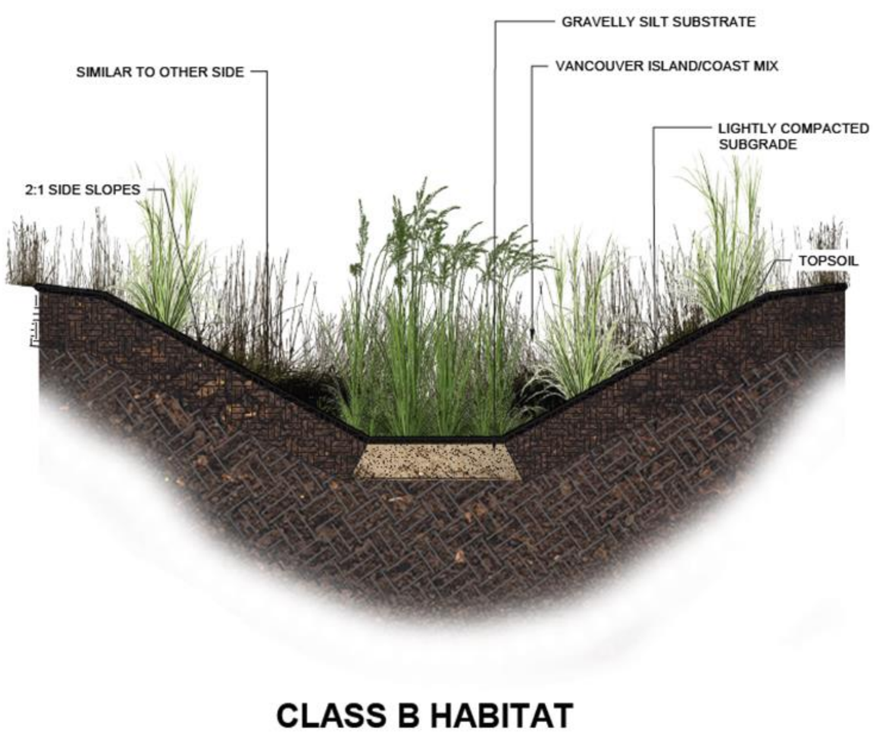


Figure 12. Example Landscaping Treatment of Class B Ditch

II.3.6 Ponds

Ponds are an effective drainage and environmental component and are used for stormwater retention, stormwater treatment (settling of sediments), water quality improvement (biofilter), and as natural habitat feature as wetland.

Where designed ponds are known to have potential fishery values, they have been classified as A, A(O), or B for environmental design purposes based on their location within the watershed relative to existing watercourses. Isolated ponds were classified as Class C designation, as they do not connect to fish habitat. These ponds have been applied as a key feature in the design of the onsite and offsite offsets.

PART III ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

III.1 OVERVIEW

Triton completed the initial assessment of the Project in the Spring and Summer of 2021, during the preliminary design phase. This included an environmental review of existing conditions within the Project footprint, constraint mapping, and initial investigation of potential restoration areas that were refined to approximately 10 sites. From Fall 2021 through Summer 2022, Triton (holder of the valid fish collection permits), McElhanney, and AE completed a more detailed environmental assessment in support of the design drawing elements. This included a detailed environmental review of Project wildlife and vegetation resources (AE), an environmental review of aquatic resources (McElhanney and AE), and a habitat impacts and gains analysis (McElhanney).

III.1.1 Assessment Objectives

The primary objective of this application was to meet the requirements outlined in the "Guidance for Applications or Notifications for Changes in and about a Stream under the *Water Sustainability Act* in the South Coast Region" (GoBC, 2019) and follow requirements listed in the Users' Guide for Changes In and About A Stream in British Columbia (GoBC, 2022b) to meet the following key objectives:

- Establish the existing environmental baseline conditions, within the temporal and spatial scope boundaries of the Project.
- Evaluate the potential for effects / impacts to baseline conditions, both qualitatively and quantitatively, based on field observations, available detailed engineering design, and most probable methods of construction.
- Avoid impacts through mindful design considerations.
- Identify or describe proposed environmental enhancements to mitigate unavoidable effects.
- Evaluate residual effects.

The guidance and activity guide documents were used to develop the methods described in the remainder of this document for evaluating overall impacts to fish and wildlife and their habitats, and ultimately how to avoid, mitigate or offset those impacts.

III.1.2 Assessment Boundaries

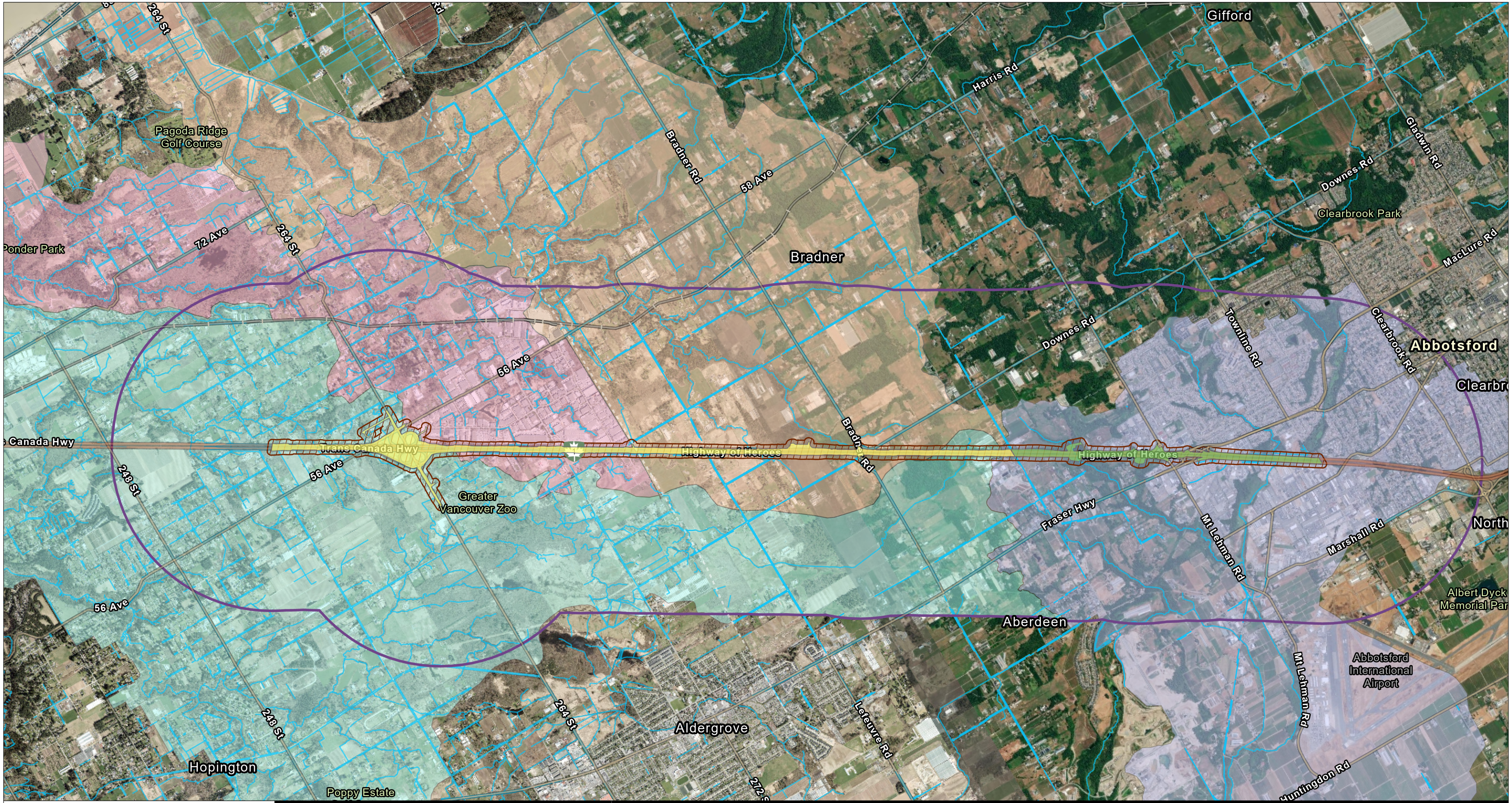
Spatial assessment areas for this Project were characterized as:

- *Local Assessment Area*: *(LAA)* defined as areas within the engineering and construction footprint; up to the clearing and grubbing line.
- *Extended Assessment Area (EAA)*: includes areas within 50 m of the engineering and construction footprint for fish, and up to 100 m of the footprint for wildlife.
- *Regional Assessment Area (RAA)*: includes areas within 2 km of the engineering and construction footprint. This was primarily considered to identify potential species and habitats at-risk in the surrounding area.

The Project team conducted the assessment of fish and fish habitat within the EAA, on either side of Highway 1 from 1.65 km west of 264 Street to Townline Road. Biologists from McElhanney and AE conducted an aquatic habitat assessment that complemented the works to date by Triton and included watercourses within the EAA. The team surveyed drainage features within the EAA unless access was not possible, or they were on the outer side of a municipal road (opposite side to the highway) and not within the clearing / grubbing area.

AE also conducted terrestrial habitat assessments within the LAA, to characterize vegetated ecosystems and wildlife habitat. They carried out species-specific surveys targeting species at risk identified as likely to occur within the Highway 1 corridor based on Triton's preliminary assessment. Areas of suitable habitat and / or where species at risk had been previously documented were surveyed to confirm presence or habitat characterization.

Figure 13 illustrates Project assessment boundaries showing the LAA, EAA and RAA.



McElhanney

Scale 1:45,000

0 2,500 Meters

TITLE

Figure 3. Project Assessment Areas.

INSET

LEGEND

Local Assessment Area (LAA):
- Segment 1 (ISL Engineering)
- Segment 2 (Associated Engineering)

- Streams
- Regional assessment area (RAA)
- Extended assessment area (EAA)

Watershed
- Fishtrap Creek
- Marshall Creek
- Nathan Creek
- Salmon River
- West Creek

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III.2 METHODOLOGY

The project team characterised existing instream and riparian habitats through base data compilation, field assessment, and post-field data processing in the Project GIS. The data collection for this Project was completed in two main phases to date:

- *Preliminary Assessment* – Spring, Summer and Fall 2021. The initial 2021 field program, from March to August 2021, was Triton's responsibility. Additional eDNA fish sampling was also completed in December 2021. This work supported the preliminary design stage.
- *Detailed Assessment* – Fall 2021 to Summer 2022. McElhanney and AE completed a more detailed review of Project elements from October 2021 through Summer 2022, including field work in November 2021, and April, August, and October 2022. This included inventory of stream habitat, wildlife and vegetation, and an impacts assessment.

III.2.1 Desktop Review

III.2.1.1 Preliminary Assessment

Prior to field work, an information review was completed by the environmental team to identify existing environmental sensitivities and to help target the field assessments. The review identified known watercourses and wetlands, historically known fish species within the Project Area, as well as previously occurring or likely-to-occur aquatic, terrestrial, and vegetative species under the federal Species at Risk Act (SARA).

The preliminary Project team completed an information review using the following sources:

- BC Species & Ecosystem Explorer website (CDC, 2022a)
- Province of British Columbia (BC) iMapBC mapping program (CDC, 2022b, OCIO, 2021c)
- Province of BC Habitat Wizard program (MOECCS, 2022a)
- Province of BC Invasive Alien Plant Program (IAPP; MOECCS, 2022e)
- E-Fauna BC: Electronic Atlas of the Fauna of British Columbia (UBC, 2021b)
- E-Flora BC: Electronic Atlas of the Flora of British Columbia (UBC, 2021c)
- BC's Data warehouse (for mapping layers)
- Multiple previous reports for the Project, provided by MoTI

The project team identified additional reports and assessments during the review, which were provided by the City of Abbotsford. This ultimately resulted in a list of identified watercourses, wet ditches, and culverts of interest to be confirmed by Appropriately Qualified Professionals (AQPs) during the preliminary site surveys.

III.2.1.2 Detailed Assessment

The detailed assessment Project team reviewed the following database records for potential flora, fauna, and species and communities at risk to occur within the EAA. These lists were then narrowed based on species habitat preference and observations of suitable habitat at the site level. Fisheries data were compiled at a watershed level. The following sources of information were compiled and reviewed to characterize existing environmental conditions and identify potential fish and fish habitat values and concerns:

- Aerial imagery and orthophotographs of the Study Area
- LiDAR data for the Study Area
- Preliminary Environmental Assessment Report and Constraint Mapping - Fraser Valley Highway 1 Corridor Improvement Program 264th Street-Whatcom Road (Triton, 2021)
- Fraser Valley Invasive Species Society (FVISS, MoTI 2022)
- Online government agency databases and associated reports including:
    - DFO Aquatic Species at Risk Online Mapping System (DFO, 2022)
    - Township of Langley Online Mapping System (Township of Langley, 2021)
    - City of Abbotsford Online Mapping System (City of Abbotsford, 2021)
    - Fraser Valley Watershed Atlas (Community Mapping Network, 2021)
    - EcoCat Ecological Reports Catalogue (MOECCS, 2022c)
    - Fisheries Inventory Data Queries (MOECCS, 2022d)
    - Habitat Wizard (MOECCS, 2022a)
    - Invasive Alien Plant Program (MOECCS 2022e)
    - Metro Vancouver's Sensitive Ecosystem Inventory (SEI; Meidinger et al., 2014)
    - BC Species and Ecosystem Explorer (CDC, 2022a)
    - BC Government Data Catalogue (OCIO, 2021a)
    - Province of British Columbia (BC) iMapBC mapping program (OCIO, 2021c),
    - Species at Risk Act (SARA) Public Registry (ECCC, 2022)
    - eBird (Cornell, 2022)
    - Wildlife Accident Reporting System (WARS; MoTI, 2021) Field Collection

McElhanney and AE characterized existing instream and riparian habitats through base data compilation, field assessment, and post-field data processing in the Project Geographic Information System (GIS).

III.2.1.3 Project Database

McElhanney developed a GIS to collect and warehouse field data related to corridor-wide stream, wetland, and wildlife observations. Initial set-up of this system involved combining readily available data sets from open data sources and included the creation of a comprehensive stream-line network as well as previously mapped features collected by Triton during summer field work in 2021.

Field work during 2021 was initiated to confirm the location of previously mapped features and to identify unmapped features to include in the corridor-wide database. A team of AQPs was equipped with field tablets loaded with ArcGIS Collector, which provided for real-time data collection and upload to McElhanney's local server (***Figure 14***). Representatives of local First Nations accompanied the Project team and provided valuable support during this stage of environmental assessment.

Detailed stream attribute information was also collected at each watercourse segment, including but not limited to average bankfull width, dominant substrate, fisheries potential, and riparian area composition.

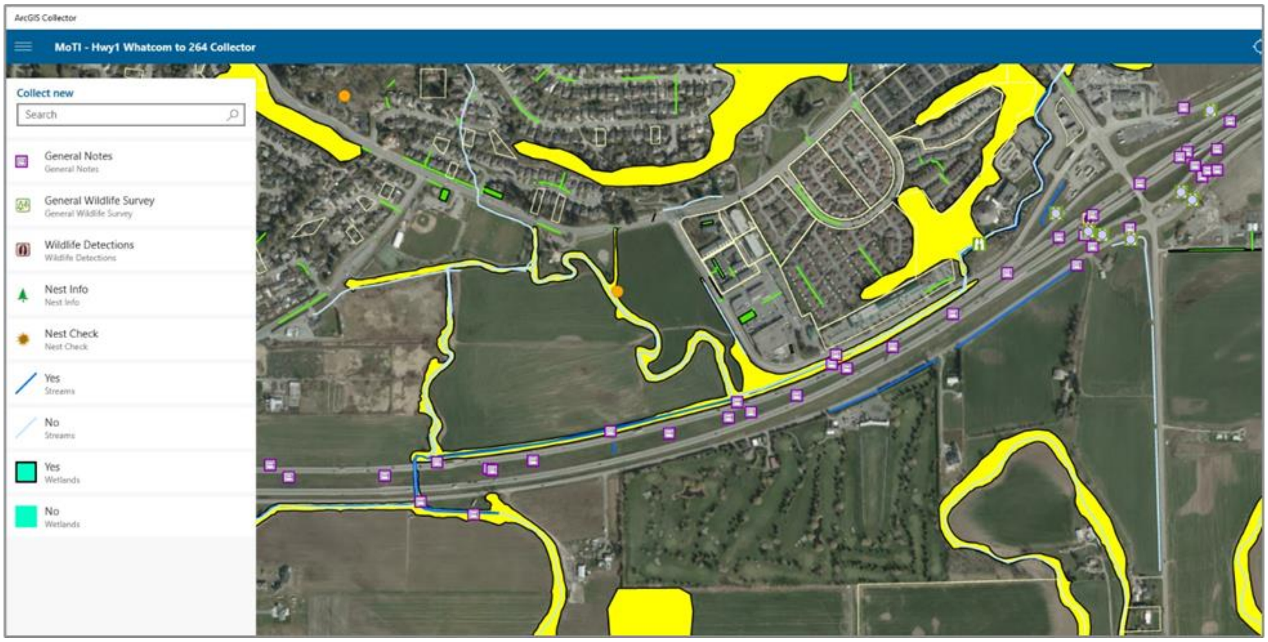


Figure 14. Screen grab from the ArcGIS Collector provides an insight into the field mapping interface implemented in the field.

III.2.2 Preliminary Field Assessment

The preliminary field assessment conducted by Triton included a traverse of the median, as well as margins, interchanges, and adjacent areas of interest, to document existing environmental features. AQPs and First Nations representatives from Matsqui and Kwantlen First Nations conducted the assessment.

III.2.2.1 Fish Sampling

Fish sampling used electrofishing (efishing) where possible, and minnow trapping where efishing was not possible. Where efishing returned zero results, minnow trapping was performed. When either or both (depending on if both were used) returned zero, eDNA was taken to confirm.

III.2.2.2 Minnow Trapping

Minnow trapping consisted of setting two minnow traps at each sample site, baited using cat food in a bait bucket. Traps were set for approximately 24 hours and various physical characteristics of the fish were recorded after capturing. A maximum total of 30 fish of each species were measured at each site and the remainder were counted.

III.2.2.3 eDNA

Watercourses of interest were selected for eDNA sampling throughout the LAA in August and December 2021. For each watercourse, sampling sites targeted best-available fish habitat (e.g., flowing water, cover, suitable depths, etc.). At each site, three replicate 1 L water samples were collected. Field samplers followed best practices for QA/QC, including the collection of field blanks and disinfection protocols to avoid contamination. Samples were filtered and stored in silica for preservation after field collection. Bureau Veritas Laboratories processed samples for comparison against site-specific target assays (i.e., Salish sucker (*Catostomus* sp. 4), Coho salmon (*Oncorhynchus kisutch*), eFish for all fish, and pacific water shrew

(*Sorex bendirii*)). The laboratory assessed sample results assessed and produced reports to determine if species are present or not as detected by eDNA sampling.

III.2.2.4 Features of Interest

While surveying the LAA, Triton crews identified wildlife and vegetation features of interest including indicators of bird nesting (e.g., stick nests, cavities, bird behaviour), potential mammal dens, bedding areas and burrows, hibernacula sites (e.g., for snakes), and other wildlife signs (e.g., scrapes, tracks, scat, and browsed vegetation). The crews evaluated terrestrial habitat for its potential to support rare plants and noted rare plant species and non-native species where encountered.

III.2.3 Detailed Field Assessment

III.2.3.1 Streams Inventory

Following compilation of base data for streams and wetlands, AE completed the aquatic field assessments to visually assess watercourses, and ditches within the EAA, documenting biophysical attributes, including detailed stream attribute data. The aquatics assessment report builds upon the previously completed Overview Aquatic Effects Assessments for high-value and low-value habitats. This overview identified watercourses within and adjacent to the Project alignment, down to a numerical identifier for each inventoried segment. These inventories were presented in an appended table, with habitat data itemized per segment (***Appendix E***).

The team conducted these high-flow aquatic field assessments within the EAA between November 8 and 26, 2021. Weather conditions during the November assessments were cool with a mean temperature of 7˚C, moderate winds, clouds, and rain. Total estimated precipitation in Abbotsford during November of 2021 was 540.7 mm compared to the typical November average of 245 mm (Abbotsford Weather Stats, 2021).

The high-flow aquatic field assessments documented existing habitat conditions and identified potential sensitive habitats and / or areas of concern within or adjacent to the EAA. Methods were adapted from Resource Information Standards (RISC) Fish and Fish Habitat Inventory Standards and Procedures (RISC 2001) and Fish Habitat Assessment Procedures (MoF, 1996). At each watercourse segment, observations included channel depth (wetted and bankfull), channel width (wetted and bankfull), gradient, habitat type (primary and secondary), substrate (major, minor, some), LWD, undercut banks, deep pools, instream vegetation). Additionally, the project team assessed riparian habitat quality through a review of the right and left banks, and included documentation of dominant and secondary vegetation type, a description of slope, and a list of invasive species. The project team assessed cover from within the channel. The team took representative photographs of habitat and anthropogenic features (e.g., culverts) in the Project area. Once the team had characterized existing instream and riparian habitats an assessment of impacts was possible.

McElhanney and AE conducted additional sampling in the low-flow period, to further document the habitat conditions within the known habitats used by fish, per the results of the preliminary assessment. These assessments focused on culvert inlets and outlets, and documented flow, as well as visually assessed habitat conditions within and adjacent to the culverts, within the LAA. Field work was conducted from August 16 to 23, 2022, during hot, sunny conditions in which no precipitation had occurred within the previous week. Observers from the Sumas First Nation and Matsqui First Nation were present for all detailed assessment activities.

The project team assessed the suitability of watercourses within the Project area for species at risk, primarily pacific water shrew and northern red-legged frog, during the aquatic field assessments. The project team inventoried watercourses and assigned a rating of none, low, moderate, or high for both pacific water shrew and amphibians in general.

Watercourse naming within the RAA is inconsistent among various available online databases (i.e., Habitat Wizard, iMap, Abbotsford's Map Viewer). For the purpose of this report, watercourse naming is consistent with Fish Inventories Data Queries (MOECCS, 2022d). Watercourses were mapped, including confirmation of stream centrelines and wetland perimeters in the field using GIS, and this data was supplemented with data collected during the field assessment.

III.2.3.2 Wildlife and Vegetation

AE conducted terrestrial field assessments between November 12 and December 9, 2021. These assessments sought to characterize existing wildlife habitat and terrestrial ecosystems and identify suitable habitat and species potential for targeted surveys the following spring. Significant wildlife features, which are often more visible during the late fall / winter, were also noted for follow up inspections (e.g., stick nests, mammal dens and burrows).

The Project involves the upgrade of an existing highway within a highly developed corridor. Given the size of the Project area, the fragmented and disturbed nature of vegetated ecosystems along the highway corridor, and that anticipated effects are localized (i.e., constrained to the existing corridor), a high-level approach was used to characterize terrestrial ecosystems in the LAA. Broad ecosystem mapping was developed for the LAA based on the Metro Vancouver Sensitive Ecosystem Inventory (MVSEI), which was developed in 2012 to document ecologically significant and relatively unmodified sensitive ecosystems and human modified ecosystems that retain ecological value across the lower mainland and encompassed the City of Abbotsford at that time (Meidinger et al., 2014). These MVSEI polygons were reviewed during fieldwork and adjusted as required to consolidate broad ecosystems and ensure habitat classifications were still accurate (e.g., where previously forested areas had been cleared or developed) and subsequently re-labeled to represent broad ecosystem classifications. The MVSEI focuses on natural areas and therefore agricultural land along with parks and urban landscapes (e.g., golf course) are not mapped in the polygons.

Based on the results of Triton's preliminary EA and the terrestrial field assessments conducted in late fall 2021, a field program was designed for the spring of 2022 to confirm the presence of species at risk or of regional concern with the potential to occur in the LAA and likely to be impacted by the Project.

III.2.3.3 Targeted Species-at-Risk Surveys

Targeted surveys were conducted for Oregon forestsnail (*Allogona townsendiana*), Townsend's mole *(Scapanus townsendii),* northern red-legged frog (*Rana aurora)* and nesting raptors between March 15 and April 26, 2022.

III.2.3.3.1 Oregon Forestsnail

Intact forest ecosystems in the LAA were traversed in late March through April to locate pockets of suitable habitat for the Oregon forestsnail. Suitable habitat includes bigleaf maple (*Acer macrophyllum*) canopy with stinging nettle (*Urtica dioica*) in the understorey. Observers opportunistically walked through an area of interest, targeting suitable microhabitat features (e.g., nettle patches), and searched the forest floor for snails (SCCP, 2018). Where live specimens were encountered, the entire contiguous forest polygon was identified as having the potential to support Oregon forestsnail. However, if only empty shells were found, consideration was given to habitat condition and the age of the shell (SCCP, 2018).

III.2.3.3.2 Townsend's Mole

Molehill sites were documented during both the preliminary EA (Triton, 2021) and terrestrial field assessments in November / December 2021. These sites were revisited in Spring 2022 to assess whether there was evidence to support the likely presence of Townsend's mole in the Study Area. Mound and tunnel measurements were collected to assess the likelihood of Townsend's mole occurring in the LAA (RIC, 2001). Sheehan and Galindo-Leal (Sheehan & Galindo-Leal, 1997) determined that encampments in southwestern BC containing mounds which exceed 15 cm in height and 40 cm in width with shallow tunnel diameters greater than 4.5 cm strongly indicate the presence of Townsend's mole (RIC, 2001).

Townsend's mole known range in BC is restricted to approximately 20 m^2 in the vicinity of Abbotsford and Huntingdon (COSEWIC, 2003); however, its presence in the Project area cannot be precluded. The coast mole is extremely abundant and extensively distributed in the Lower Mainland (RIC, 2001), and therefore is considered the species most likely to be encountered in the LAA.

III.2.3.4 Amphibians and Reptiles

Suitable habitat in the Study Area, including vegetated watercourses and wetlands with upland forest habitat, were surveyed during the amphibian breeding season for the presence of northern red-legged frog and western toad. A visual encounter survey approach for presence / not detected (RIC, 1998) was employed in which the crew searched appropriate microhabitats for individuals and / or egg masses. Further, large wetlands were thoroughly searched with binoculars for the presence of basking turtles.

III.2.3.5 Raptor Nests

Stick nests were documented along the Project area during both the preliminary EA (Triton, 2021) and the terrestrial habitat assessments in late Fall 2021, when these nests are most visible. These sites were revisited in Spring 2022 to confirm the nesting species. The City of Abbotsford has an inventory of raptor nests, available through their online mapping system (CoA, 2022); these sites were also visited where possible.

III.2.3.6 Invasive Species Surveys

Invasive species surveys within the Project area are completed annually by the Fraser Valley Invasive Species Society, Each spring following plant emergence, areas along the Highway, within the EAA, are walked and visually assessed (from the shoulder and from the median). Inventory is focused on *MoTI Priority Species (**Appendix F)***. Wild chervil *(*An*thriscus sylvestris*) plants are spot treated, and incidental observations of Japanese knotweed *(*Reynoutria japonica*),* giant hogweed (*Heracleum mantegazzianum*), and shiny geranium (*Geranium lucidum*) are flagged, with patch size and density noted. GPS coordinates are collected at each observation. Invasive species were noted where encountered during consultant field surveys in both Winter 2021 and Spring 2022; however, no targeted surveys for invasive plant species, nor rare plants, were carried out during the detailed assessment.

III.2.4 Data Processing

III.2.4.1 Existing Fish Habitat

III.2.4.1.1 Stream Classifications

Following the initial 2021 field assessment, the teams assigned a stream classification to each stream segment. Watercourse 'classifications' were based on 'coding' that has been adopted by various municipalities in the Lower Mainland. Watercourses were classified based on fish presence and fish habitat components such as permanence of water flow, existing or potential riparian vegetation, and overall habitat value, borrowing from an approach used by adjacent municipalities. These valuable definitions incorporate a given system's nutrient and food contribution to downstream fish populations into its classifications. Classifications are as follows.

- ***Class A*** – Watercourses inhabited year-round or with potential for year-round fish presence given reasonable access enhancements (***Figure 15)***.

Figure 15. Example photo of a Class A stream.

- ***Class A(O)*** – Typically ephemeral watercourses that are inhabited by (or potentially inhabited by) fish during over-wintering period. These are often dry in summer, which limits utility (***Figure 16***).

Figure 16. Example photo of a Class A(O) stream.

- ***Class B*** – Watercourses that are significant or potentially significant sources of food and nutrients to downstream fish populations. These watercourses are characterized by no fish presence and no reasonable potential for fish presence through flow or access enhancement (***Figure 17***).

Figure 17. Example photo of a Class B stream [subject to field verification of no fish but connecting to A/A(O)].

- ***Class C*** – Watercourses that provide an insignificant contribution of food or nutrients to downstream areas that support or potentially support fish populations (***Figure 18***).

Figure 18. *Example photo of Class* C stream (isolated from Class A/A(O)/B).

- ***Wetland*** – Refers to a swamp, marsh, fen, or prescribed feature under the provincial *Water Sustainability Act* (BC, 2022; ***Figure 19***).

Figure 19. *A typical wetland area in the project area.*

- ***Unclassified*** – Watercourses for which there is a lack of adequate fisheries or flow information to permit classification.

Following the Summer 2022 field work focused on Class A / A(O) watercourse identified in 2021, the project team re-assessed classifications based on summer flow conditions. McElhanney completed a review of both Summer 2021 and Summer 2022 data for Class A streams to determine whether any of these streams were dry for both summers. Dry stream segments were reclassified to be Class A(O) habitat, given that fish presence was previously confirmed.

III.2.4.1.2 Existing Riparian Area Widths

Following stream classification, a habitat characteristic-based rubric (***Table*** 15***15***) was used to assign riparian widths to each assessed stream segment. Riparian area widths were selected to be consistent with the Riparian Areas Protection Regulation Detailed Assessment Methods (RAPR). While MoTI works are not subject to RAPR, this methodology provides an accepted standard for riparian impact calculation.

Table 15. Riparian setbacks for each stream segment type, based on RAPR.

Classification	Stream Segment Habitat Characteristics	Riparian Setback Applied
Class A	Fish, permanent water, large woody debris (LWD), heavy vegetation (Channelized or Natural Stream)	10 m
Class A	Fish, permanent water	5 m
Class A(O)	Overwintering fish, but not permanent water, LWD, heavy vegetation (Channelized or Natural Stream)	10 m
Class A(O)	Overwintering fish, but not permanent water	5 m
Class B	No fish, but permanent water, LWD, heavy vegetation (Channelized of Natural Stream)	10 m
Class B	No fish, but permanent water	2 m
Class C	Ditch, no fish, no permanent water	none

III.2.5 Impact Assessment

III.2.5.1 Vegetation Impacts Assessment Approach

Vegetation on the property will be directly affected by construction of the highway expansion. Anticipated effects on vegetation and ecosystems include:

- Loss of vegetation – both temporary and permanent removal of vegetation due to clearing activities and the requirement for maintenance access
- Introduction or spread of invasive plant species – ground disturbance has the potential to introduce and encourage the spread of invasive species, further degrading vegetated ecosystems in the LAA

To complete the vegetation impact assessment, the design drawings were overlaid on the MVSEI polygons field confirmed within the LAA (***Part III.2.3.2***). Area-based calculations were derived to summarize temporary and permanent effects on these terrestrial ecosystems anticipated by Project works. The loss of broad ecosystem types is quantified based on the permanent project footprint overlap with mapped ecosystems. The loss of rare plants and the potential spread of invasive species is qualitatively reviewed based on the anticipated footprint, the suitability of the habitat, and the construction methods proposed.

III.2.5.2 Wildlife and Wildlife Habitat Impact Assessment Approach

Data collected during the field surveys were used to identify where the LAA and associated activities are anticipated to exert a change over the existing baseline condition and change how wildlife are currently using this habitat. Environmental effects on wildlife typically associated with road upgrades and highway expansion include habitat loss, change in habitat, sensory disturbance, and mortality.

The effects associated with site preparation, construction and operation change as the Project moves through the phases. This review of effects is primarily qualitative as the predicted effects are based on habitat potential and vary based on how wildlife use the habitat, which can be influenced by non-Project-related factors. Wildlife use of habitat along the highway corridor is assessed based on the broad ecosystem types mapped along the corridor and the wildlife species typically associated with those ecosystem types. Use is further evaluated based on the level of disturbance in those vegetated ecosystems, and the wildlife species level of tolerance to disturbance. Other factors associated with development, for example changes in hydrology or fragmentation, can affect wildlife use of an area. A qualitative assessment considers the habitat condition and size, the diversity of wildlife likely using the area, and the presence of alternate suitable habitat in the vicinity, in addition to the size of the footprint and the construction methods, to determine the anticipated overall effect on that species or species group.

III.2.5.3 Fish and Fish Habitat Impacts Assessment Approach

Impacts to fish and fish habitat through Project works will be based on loss or alteration. A potential to cause fish mortality exists, and fish may be directly affected by loss or alteration of instream habitats or by changes to water quality. Indirectly, the loss or alteration of nutrient sources and the loss or change in riparian habitat may impact fish.

III.2.5.3.1 GIS Data Processing

Following the confirmation of stream classification and assignment of associated riparian setback widths, the instream and riparian areas were calculated and mapped using GIS coding scripts. These area calculations are based on metrics collected in the field or derived from the riparian setbacks from the habitat characteristic-based rubric (***Table*** 15***15***). The permanent habitat impacts within the LAA were quantified as outlined below.

III.2.5.3.1.1 Instream Habitats

To estimate the instream habitat for each segment, the GIS team applied the following rules:

- The channel width for each segment was established from the average bankfull widths collected in the field
- In cases of channel width = 0, an assumed width of 1 m was applied
- 115 segments in total had a zero-channel width; however, not all were located within the LAA
- Some of the short segments are classified as Class A or B streams and are located in the Project footprint, possibly within culverts.

- Instream area = 1.5 x channel width measure. The instream area was applied as a buffer in GIS to create an instream habitat polygon.
- If instream habitat polygons overlap, the polygon with the higher stream classification was prioritized. This rule prevents the underrepresentation of area loss in higher stream classes.
- Cases where the Stream Classification is listed as Ditch or <Null> were treated as "Class C".
- Each stream feature within a segment, including the instream habitat polygon, will be linked by the stream segment ID. This rule permits GIS users to access stream segment data from multiple sources more efficiently.

III.2.5.3.1.2 Riparian Habitats

To estimate the riparian area habitat for each stream segment, the GIS team applied the following rules:

- Riparian area = the assigned riparian setback from the habitat characteristic-based rubric (***Table*** 15***15***).
- The riparian area was applied as a buffer in GIS to create a riparian area polygon.
- If riparian area polygons overlap, the polygon with the higher stream classification was prioritized. This rule prevents the underrepresentation of area loss in higher stream classes.
- Cases where the Stream Classification is listed as Ditch or <Null> were treated as "Class C"
- Class C ditches did not receive riparian buffers.
- Each stream feature within a segment, including the instream area polygon, will be linked by the stream segment ID. This rule permits GIS users to access stream segment data from multiple sources more efficiently.

III.2.5.3.1.3 Wetland Habitats

The project team individually re-assessed existing wetland habitats, based on the design, to determine the extent of wetlands within the Project EAA. Once wetland boundaries were clarified through review of existing data sources and through orthophoto interpretation, riparian setbacks were assigned. Wetland riparian buffers were based on a 15 m setback for non-fish-bearing systems and a 30 m setback for fish-bearing systems.

Overlap with riparian/instream habitats associated with linear watercourses was removed to limit double counting, and this was completed prioritizing the higher classification, as above. Instream was prioritized over wetland, and instream riparian was prioritized over wetland riparian.

III.2.5.3.2 Summary of Habitat Loss

Once the existing stream areas had been created, the intersection of the Project footprint works with existing features was assessed, via the following process:

- Both instream and riparian polygons were cut to the LAA.
- Areas outside of the LAA were considered to remain intact during Project works.
- Instream and riparian area within the LAA = temporary or permanent loss, due to the extent of unavoidable impacts within these areas during construction.
    - ***Permanent habitat losses*** include areas within the highway footprint, extending to the limit of the toe of slopes on either side of the highway.

   - ***Temporary habitat losses*** extend between the outer clearing and grubbing limit and the toe of fill or cut slopes. These also include temporary staging areas not within the footprint of the highway and will include culvert impact areas extending beyond the cut / fill slopes.
- In cases of Project footprint overlap with a portion of a wetland, that portion only was counted as a loss, and the remainder of the wetland was considered to be unimpacted in the area accounting.
- Wetland and wetland riparian impacts were summarized by class.

III.2.5.3.2.1 Application of Scale Factors to Habitat Loss and Gain

In addition to the use of scale factors for losses, area gains were also applied using a prioritized vegetation assemblage approach, as follows:

- *Invasive species*: 1.3 multiplier for newly created riparian habitat in an area previously dominated by invasive species.

In the case of created habitats, new riparian habitat which was to be planted to create a forest ecosystem, or existing forest which was converted to riparian through the construction of a new adjacent aquatic habitat, were granted a 1:1 value in offsetting (i.e., provides a 100% areal credit towards the balance). If the new habitat was to consist of native shrubs only, it is counted at a ratio of 0.5:1. However, if a new riparian habitat consisted of invasive species or non-native grasses and was planned for rehabilitation to a native forest habitat, this area was granted a 1.3:1 credit in the habitat balance.

III.2.5.3.2.2 Summary of Habitat Gain

Habitat gains were evaluated by the lead biologist and GIS technician, based on the planned reconstruction of existing watercourses in-situ or the creation of new habitat in strategic areas in and around the alignment. In cases of permanent habitat loss (i.e., within the road toes footprint), recreation of habitat sought to be as close to the site of the loss as possible and this new created onsite habitat was added into the "gains" of the habitat balance. Where onsite habitat creation was not possible, offsite offsets were pursued, to ensure that "gains" offset all habitat loss. There were cases of habitat creation that warranted careful analysis, such as when existing habitat was expanded or where new habitat was created near existing habitat. We checked to not "double count" habitat at overlaps between existing riparian areas and new re-aligned riparian areas. Similarly, attention was paid to areas formerly occupied by instream habitat that were replaced by riparian area, and vice versa, in scenarios where there was a stream realignment. Temporary impacts to stream and wetland habitat included all cases where there was an in-situ recreation of habitat, such that the initial disturbance of habitat was temporary, as the same amount of habitat was recreated at that location.

PART IV - DESCRIPTION OF THE EXISTING ENVIRONMENT

IV.1 SITE CONTEXT

The Highway 1 widening project footprint (LAA) is 13 km long and is situated in southwestern BC approximately 74 km southeast of Vancouver (***Figure 1***). The alignment spans from 264 Street to Townline Road. The entire highway alignment is located within the Fraser Valley, which is characterized by fairly flat terrain, aside from small ravines located around streams (CMN, 2022). This footprint crosses the Township of Langley and City of Abbotsford municipal boundaries and includes four watersheds, including Salmon River, West Creek, Nathan Creek, and Fishtrap Creek, as well as three notable sub-catchments (Coghlan Creek, Enns Brook, and East Fishtrap Creek – west to east) (***Figure 20***; ***Table 16***; MOECCS 2022b). The watersheds have rain-dominated flow regimes with peak flows occurring during the winter months and low flows occurring during summer months, following patterns in rainfall (DFO, 1999). Aside from the Salmon River and West Creek, the streams within the Study Area are ungauged; therefore, specific values regarding mean annual discharge, peak flows, and summer low-flows are predicted.

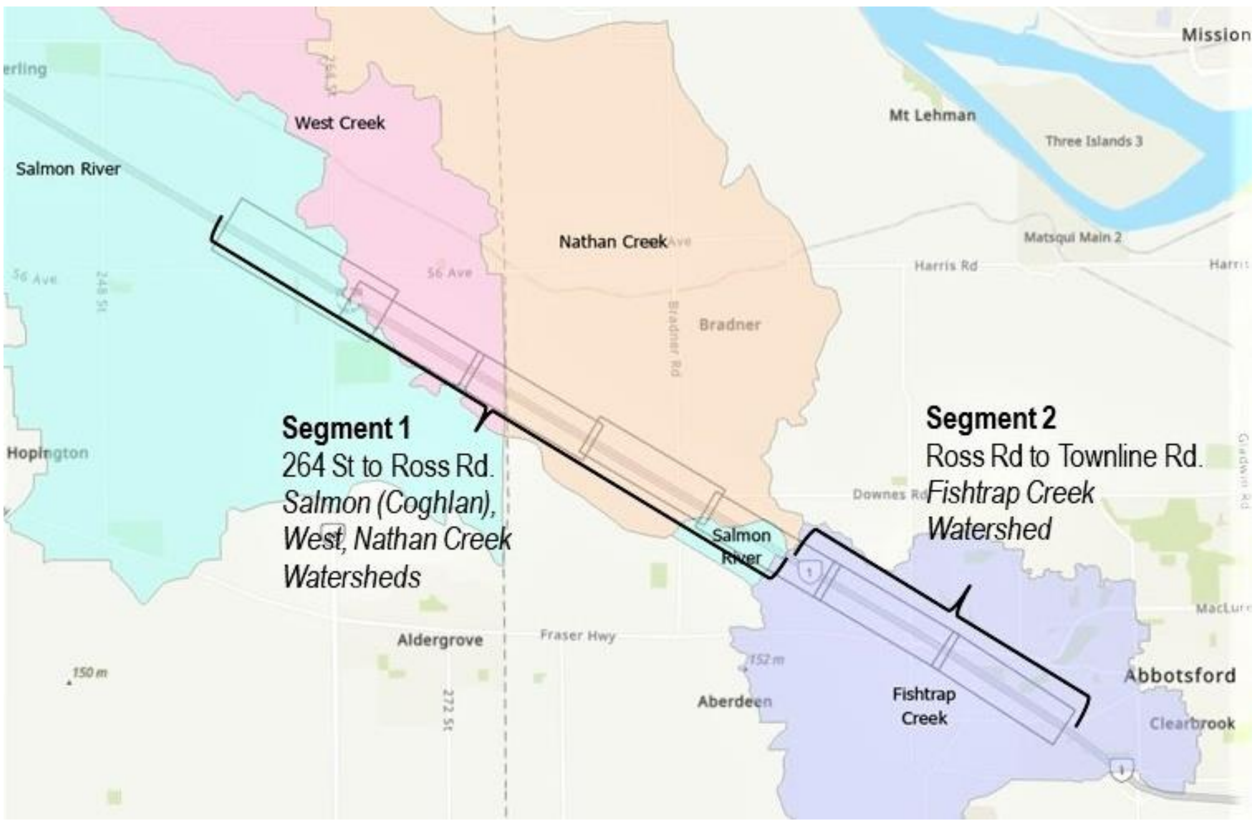


Figure 20. Watersheds affected by the two Project segments.

Table 16. List of watersheds by segment within the Project alignment.

Segment 1 (264 St to Ross Rd)	Segment 2 (Ross Rd to Townline Rd)
Salmon River Watershed	Fishtrap Creek Watershed
West Creek Watershed	Enns Brook (Sub-catchment of Fishtrap Creek)
Nathan Creek Watershed	East Fishtrap Creek (Sub-catchment of Fishtrap Creek)

IV.1.1 Watersheds

IV.1.1.1 Salmon River Watershed

The Salmon River watershed is the westernmost watershed in the alignment and occupies an area of 76.9 km^2 in total. The Salmon River headwaters are located approximately halfway through the Project alignment, and flow generally travels northwest before entering the Fraser River immediately west of Fort Langley. Most of the watershed lies within the Metro Vancouver Regional District, with a small eastern portion within the Fraser Valley Regional District (***Figure 20***). Although flow generally travels northwest in the watershed, flow in the uppermost extent of the watershed travels southwest. At its Highway crossing near Ross Road, the Salmon River runs adjacent to a larger forested area which contains tributaries and beaver ponds (Triton, 2021).

Coghlan Creek is the westernmost sub-catchment within the alignment, in the Salmon Creek watershed. It is situated in the northeast portion of Langley Township. It has an area of 13.7 km^2, with flow generally travelling west, and connects to a tributary of the Salmon River just northwest of the intersection for 64 Avenue and 238 Street. Approximately half of the Coghlan Creek sub-catchment is located on the north side of Highway 1. A tributary of Coghlan Creek flows south under the Highway roughly 1 km directly west of 264 Street, and Coghlan Creek flows north under the Highway at 1.6 km west of 264 Street. The headwaters are in a low-lying agricultural area, approximately 0.9 km west of the 264 Street overpass, just west of the LAA boundary (DFO, 1999). Coghlan Creek has previously been reported to completely dewater in sections due to water extraction, and encroachment by property owners has reduced channel stability (DFO, 1999). The upper reaches of Coghlan Creek adjacent to the Project footprint consist of wetland areas used by fish.

Over 75% of the Salmon River drainage area is agricultural land, with many poultry, produce, and cattle farms located along the main channel (~55% of total length) and its tributaries (DFO,1999). The Salmon River experiences notable summer low flows and flooding in its upper reaches, with the latter largely driven by a large catchment basin and the presence of beaver ponds (Triton, 2021).

IV.1.1.2 West Creek Watershed

West Creek is a tributary of the Fraser River, situated in the west end of the alignment and northeast portion of Langley Township. It has an area of 14.9 km^2, with flow travelling northwest before entering the Fraser River. Most of the catchment is located on the north side of Highway 1; however, the headwaters are located approximately 0.4 km west of the 48 Avenue and 272 Street intersection on the south side of Highway 1. West Creek crosses Highway 1 via a culvert approximately 0.8 km north of its headwaters, and it is mainly fed by groundwater release at the headwaters (DFO, 1999). Water had previously been retained near its headwaters via beaver dams, but the development of the adjacent industrial area (Gloucester Estates) led to their removal, which has reduced flows during the summer. There are beaver dams still present in the ditch on the north side of the highway (Triton, 2021). West Creek is considered a “Sensitive Stream” under the *Water Sustainability Act* (SBC, 2014 c. 15).

IV.1.1.3 Nathan Creek Watershed

Nathan Creek is a tributary of the Fraser River, immediately east of West Creek, and has a watershed area of 33.3 km^2. It is considered a “Sensitive Stream” as a tributary to the Fraser River, under the *Water Sustainability Act* (SBC, 2014 c. 15). The upper three-quarters of the watershed fall within the Fraser Valley Regional District boundary, with the lower quarter within the Metro Vancouver boundary. Flow in the watershed generally travels northeast before entering the Fraser River 0.8 km northeast of the 88 Avenue and 264 Street intersection. The final 2.7 km of the stream is an engineered channel that flows directly north before entering the Fraser River. A small portion of the watershed falls on the south side of Highway 1. The mainstem of Nathan Creek flows adjacent to the Bradner Rest Area and crosses Bradner Road north of the Highway 1 and Bradner Road crossing.

IV.1.1.4 Fishtrap Creek

Fishtrap Creek has a drainage area of 79.3 km^2, with approximately 33.5 km^2 located in Canada and the remaining area in Washington State, USA. Fishtrap Creek is in the eastern side of the Fraser Valley Regional District, with a portion (Enns Brook and East Fishtrap Creek) overlapping with the City of Abbotsford boundary. Flow generally travels south before entering the Nooksack River in Washington. The following section pertains to the watershed area excluding Enns Brook and East Fishtrap Creek, as they are considered more sensitive areas within the Study Area and are discussed in greater detail below.

Fishtrap Creek has a flow regime dominated by rainfall during the winter, with low flows during the summer. Fishtrap Creek crosses Highway 1 via culverts at two locations and most of the land use in this watershed is considered rural (***Appendix A: Figure 1***). Ross Road constrains the Study Area for a small portion south of Highway 1 and Automall Drive constrains a small portion north of the highway.

The Enns Brook sub-catchment of the Fishtrap Creek watershed has an area of 7.0 km^2 and is located on the western extremity of the City of Abbotsford. The sub-catchment is split by Highway 1, with the upper two-thirds of the watershed located north of the highway. The confluence of Enns Brook and East Fishtrap Creek is immediately north of the highway, directly east of the Gardner Park parking lot, with East Fishtrap Creek flowing from the northeast and Enns Brook flowing generally from the north. All water from these catchments is routed under Highway 1 via a culvert with a short daylit segment in the median (~14 m). South of Highway 1 the stream continues for approximately 22 km before its confluence with Waechter Creek.

Enns Brook headwaters are in the Townline Hill Park area, with the watercourse generally heading south in the upper extent and southeast in its lower extent before reaching Highway 1. Most of the land within this area is developed, except for the green spaces located in Gardner Park and the setback around Enns Brook. Within this sub-catchment, Livingstone Avenue constrains the Study Area on the north side of Highway 1 and South Fraser Way on the south side of the highway.

The East Fishtrap Creek sub-catchment of the Fishtrap Creek watershed has an area of 3.4 km^2 and is located at the western end of the City of Abbotsford. Most of the watershed is located north of Highway 1, with flow generally travelling south before joining Enns Brook and crossing Highway 1. The watershed is mainly single-family home zoning; however, a significant portion of the watershed comprises Fishtrap Creek Park and Maclure Park. Within this watershed, South Fraser Way constrains the Study Area south of Highway 1 and Livingstone Avenue north of the highway. East Fishtrap Creek has been altered for flood control resulting in wider and deeper channels; consequently, water temperatures in East Fishtrap Creek are recorded higher than most other locations within this system (DFO, 1999).

IV.2 LAND USE

Within the Project EAA, land use is comprised of agricultural land, including in BC's ALR, industrial land, commercial and residential land, and municipal green spaces in ***Appendix A: Figures 3A*** to ***3C.*** The Project area falls in the municipal jurisdiction of both the Township of Langley and the City of Abbotsford. The ALR and municipal green spaces constitute the pervious surfaces. Major green spaces include Fishtrap Creek Park and Gardner Park. Of the agricultural area, animal production includes poultry, produce, and cattle, in areas including streams and tributaries (DFO, 1999). Berries are a primary crop produced, particularly within the Coghlan Creek sub-catchment of the Salmon River watershed. Impervious areas consist mainly of single-family residences, industrial buildings and housing for farm workers and their families (Agricultural Land Commission Act, SBC 2002). In the western portion of the project area most of the land use on the north side of Highway 1 in the western part of Project area consists of small farms / country estates, whereas the area south of Highway 1 is primarily agricultural (SBC, 2002; ToL 1979). An exception to this is the Gloucester Industrial Park, located immediately northeast of where Highway 1 intersects with 264 Street, which is Industrial Land Use Designation and largely consists of impervious surfaces that occupies an area of approximately 2.9 km^2. North of the highway within the developed area, land use is primarily for single-family residence communities, whereas south of the highway, it is primarily industrial lots.

IV.3 AQUATIC RESOURCES

IV.3.1 Species at Risk

Two at-risk fish species occur within the Project alignment and connected watercourses: Nooksack dace (*Rhinichthys cataractae*) and Salish sucker (*Catostomus* sp. cf. *Catostomus*).

Nooksack dace is federally listed as Endangered[1] under SARA and red-listed[2] by the Conservation Data Centre (CDC), as the global distribution of this species is confined to the Fraser Valley and two drainages in Washington state. Human activities have, and continue to impact habitat quality and quantity, and limit distribution. Nooksack dace spawn at night in April and May and the female's sticky eggs adhere to the stream bottom. Important habitat types include streams with riffles less than 6 m wide for hunting invertebrates, stream riffles for spawning, and slow-moving areas and pools for juveniles (BC MOELP, 1995).

[1] Endangered: a wildlife species that is facing imminent extirpation or extinction.
[2] Red-listed: Any native species or ecosystem that is at risk of being lost (extirpated, endangered or threatened)

This species is present in the Fishtrap Creek watershed, including Enns Brook, which is considered critical habitat immediately north of the highway (***Figure 21***). Nooksack dace critical habitat does not occur within the Project alignment. Fishtrap Creek is also considered potential habitat for Nooksack dace downstream from the LAA (DFO, 2022). Due to their limited global distribution, and proportion of disturbed habitat, any further impacts proposed from the Project will be adequately compensated to reduce further impacts (DFO, 2019).

Salish sucker is listed as Threatened[3] by SARA and red-listed by the CDC. Although individuals have been captured at 24 cm they generally do not reach that size. Salish suckers are spring spawners with the majority of spawning occurring in April but some continue into mid-July. They prefer gravel bottoms with moderate flow and depths of 15 to 30 cm for laying eggs. Limited information is available on diet; however, the little work done supports that they rely on benthic invertebrates. Due to the Fraser Valley being heavily settled and the limited distribution of this species, this species requires swift and significant protection, or it will likely be extirpated from BC (BC MOELP, 1993).

This species is present in Fishtrap Creek, including East Fishtrap Creek and Enns Brook. Critical habitat occurs in East Fishtrap Creek north of Livingstone Avenue, and for a short segment of the channel within the LAA between Livingstone Avenue and Highway 1 (***Figure 21; Appendix E***).

The Class B wetland in the median west of Enns Brook culverts is connected to Class A watercourses north and south of the highway where both species at risk has been identified, however neither species have been collected in the median. Triton collected a single stickleback from the furthest western extent, eDNA sampling did not identify these species, the community Sensitive Habitat Inventory and Mapping (SHIM) Atlas does not confirm fish presence and there are no historical records of sampling there (Pearson pers comm, 2022; CMN, 2022). The wetland appears to be ephemeral, does not contain the characteristics needed for either Salish sucker or Nooksack dace and slopes towards the culverts (west to east) providing food and nutrients.

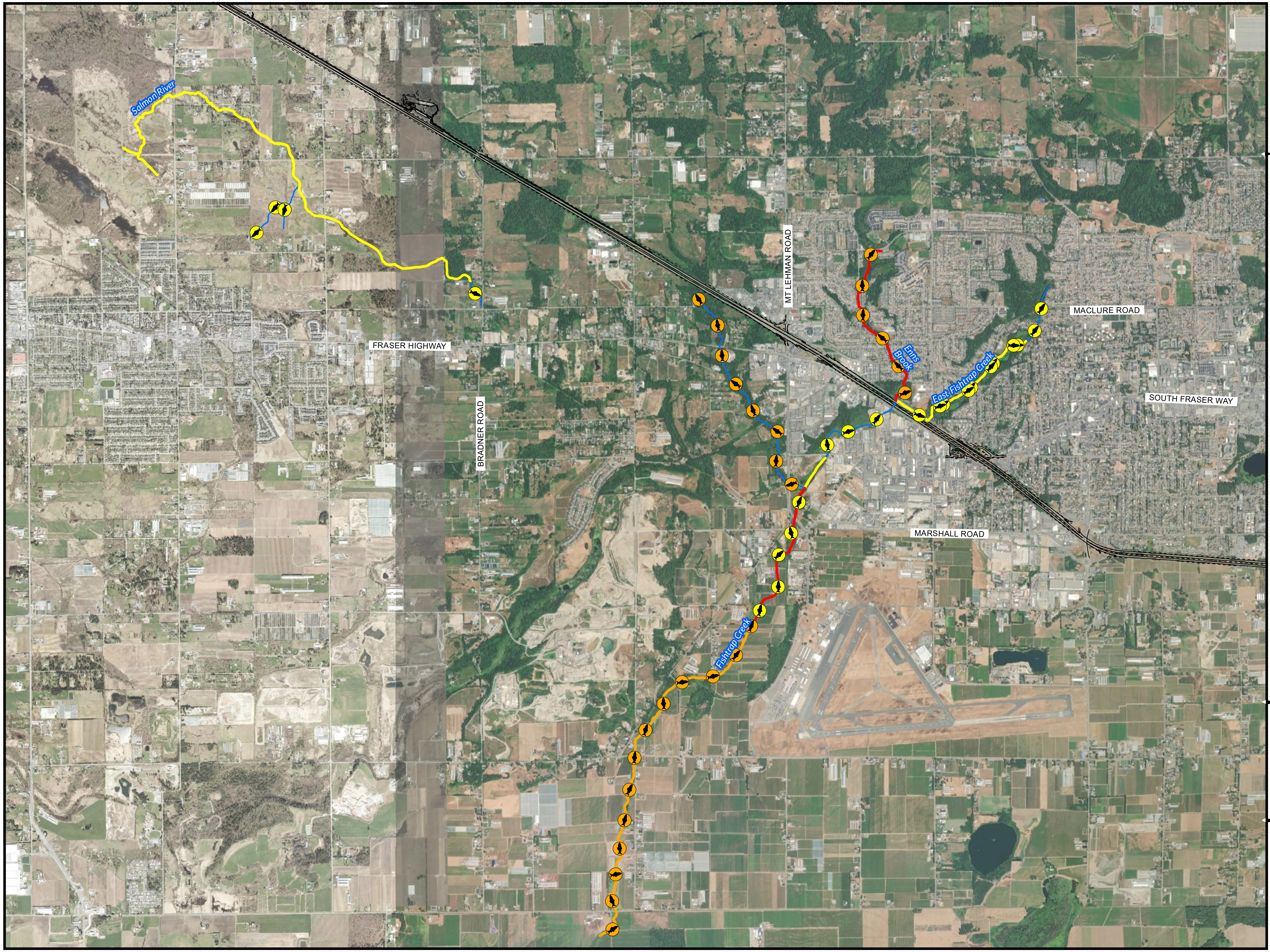
No species at risk or critical habitat occur within the portion of the Salmon River watershed situated within the LAA; however, large portions of the Salmon River and its tributaries located approximately 1.5 km downstream from the Project are considered critical habitat or possible habitat for Salish sucker. Proposed Salmon River offsets will impact the riparian area of Salish sucker critical habitat. These offsets have been designed to result in a net benefit to the habitat to improve conditions to support Salish sucker.

Information regarding the potential effects to aquatic species at risk resulting from the works, proposed mitigation measures to minimize these impacts, and specific monitoring requirements to be undertaken to ensure success of the mitigation measures are detailed in this report (***Table 177***).

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

Table 17. Summary of aquatic species at risk information that may be found in this report.

Key Component	Section in Report
Species Affected – Salish sucker and Nooksack dace.	IV.3.1
Purpose of the proposed works - Affecting the species is incidental to carrying out the activity. Works are proposed within critical habitat zones for Salish sucker, and in waterways with known or potential occurrence for Salish sucker and Nooksack dace.	I.1, I.3
Description of the proposed works – Construction activities and machinery and equipment to be used.	II.1 to II.3
Location of the proposed works – General location and site description.	I.2, IV.1
Date of proposed works – Anticipated construction schedule.	II.1
Effects of the proposed activity on the species – Changes the works may have on individuals, residences or habitat of the species.	V.1.2.1
Alternatives considered – Detailed alternatives to the proposed activity that were considered to avoid reducing the impact of the species.	***Appendix L***
Measures to minimize impacts – Measures that will be implemented to minimize impacts of the activities on the species, its habitat, or the residences of its individuals.	VI.3.3, VI.3.3.1
Monitoring – Monitoring the effects on species, and the effectiveness of the mitigation measures to minimize impacts to the species.	VI.4.7
Rationale for why the proposed activity will not jeopardize the survival or recovery of the species	V.1.2.1, VI.3.3.1, VI.5.4



Associated Environmental

BRITISH COLUMBIA

Ministry of Transportation and Infrastructure

Legend

Edge Of Pavement

Project Footprint (Toe)

Critical Habitat

Nooksack Dace

Salish Sucker

Salish Sucker And Nooksack Dace

Found Or Potentially Found

Salish Sucker

Salish Sucker And Nooksack Dace

Nooksack dace are also commonly found in Salish sucker critical habitat and vice versa.

N

0 200 400 600 800 1,000 m

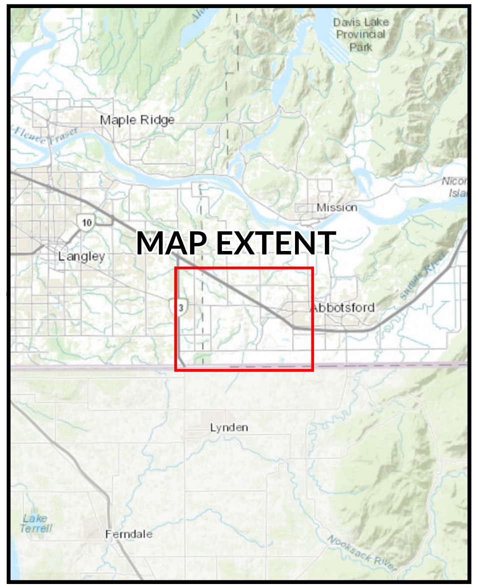


FIGURE 1

Ministry of Transportation and Infrastructure
Highway 1 - 264 Street to Whatcom Road

Species At Risk

AE PROJECT No.	2021-2305
DATE	2022 NOVEMBER
SCALE*	1:40,000
COORD. SYSTEM	NAD 1983 UTM Zone 10N
REV	00
DESCRIPTION	ISSUED FOR DRAFT
DRAWN BY	WL
CHECKED BY	KP

ESRI World Imagary: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

\\ae.ca\data\working\van\2021-2305-00\env\Environmental Assessment\GIS\Highway1_Mapping\ArcMap\SAR\Rev0\AE20212305_Fig1_SAR_221115.mxd

IV.3.2 Overall Fish Habitat

Detailed fish habitat inventories and photographs for each stream segment located within 50 m of the Project alignment are provided as ***Appendix E***. As stated in ***Part III.2.4.1.1,*** the following stream classification definitions were used:

- **Class A:** watercourses inhabited year-round or with potential for year-round fish presence given reasonable access enhancements.
- **Class A(O):** typically ephemeral watercourses that are inhabited by (or potentially inhabited by) fish during over-wintering period. These are often dry in summer, which limits utility.
- **Class B:** watercourses that are significant or potentially significant sources of food and nutrients to downstream fish populations. These watercourses are characterized by no fish presence and no reasonable potential for fish presence through flow or access enhancement.
- **Class C:** watercourses that provide an insignificant contribution of food or nutrients to downstream areas that support or potentially support fish populations.
- **Wetlands:** refers to a swamp, marsh, fen, or prescribed feature under the provincial *Water Sustainability Act.*
- **Unclassified:** Watercourses for which there is a lack of adequate fisheries or flow information to permit classification.

The following summarizes fish habitats by watershed.

IV.3.3 Salmon River

The percentage of classified watercourses within the EAA of the Salmon River watershed include: 8.3% Class A, 11.8% Class A(O), 12.9% Class B and 67.1% Class C ditches. Six existing Class A wetland areas are present within the EAA, accounting for a total area of approximately 68,780 m^2 of aquatic habitat and approximately 35,350 m^2 of riparian habitat.

The Salmon River flows parallel to Highway 1 and intercepts the Project alignment. It is primarily a low-gradient (~2-3%) watercourse ranging from 1.7 to 2.4 m wide with riffle pool habitat. Good spawning gravel and abundant overhanging vegetation are present in tributaries south of the highway. Lower productivity in the upper reaches of the Salmon River is largely driven by low amounts of spawning gravel caused by intense agricultural activity; however, large wetlands and beaver ponds in these sections provide good quality rearing habitat for fish (***Photo 1***; Triton, 2021).

The upper reaches of the Salmon River in the Study Area have a higher gradient (2-5%) with steeper banks, and more heterogenous riffle-pool habitat with substrate dominated by gravels and cobbles. AE observed a high degree of scouring on the south side of Highway 1 after the extreme flooding in November 2021. Triton had previously documented high-quality spawning gravel in this reach and AE noted that the subsequent scouring was due in part to the steep angle (>8%) of the culvert on this side of the highway.

Median ditches are Class B waterways with moderate overwintering and rearing habitat. Substrate is dominated by fines and grasses (***Photo 2***). Riparian habitat is dominated by invasive species such as reed canarygrass and tansy ragwort (*Jacobaea vulgaris*).

Mid-sections of the Salmon River Watershed, such as Coghlan Creek, are more productive than upper sections of the system (DFO, 1999). Coghlan Creek provides high quality spawning, rearing, and overwintering habitats for salmonids with access extending up to its headwaters (DFO, 1999), and a wetland complex on the north side of Highway 1 was noted in particular to provide for these uses (Triton, 2021). Coghlan Creek within the Study Area is primarily a low-gradient (>1%), wide (~5 m) meandering channel situated in floodplains characterized by deep, homogenous habitat (***Photo 3***). In the median, Coghlan Creek intercepts a wide Class A ditch that lacks suitable spawning habitat (***Photo 4***).

The riparian area along Coghlan Creek is primarily grasses and shrubs, and the dominant species is reed canarygrass (*Phalaris arundinacea*). Native riparian species surrounding the upper Salmon River include bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), salmonberry (*Rubus spectabilis*), pacific dogwood (*Cornus nuttallii*), pacific willow (*Salix lucida*), Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), hardhack (*Spirea douglasii*), and vine maple (*Acer circinatum*). Aside from reed canarygrass, invasive plant species include Himalayan blackberry (*Rubus armeniacus*), which is most prevalent in the median.

Photo 1. Class A habitat in the Salmon River watershed north of the highway.

Photo 2. Class B ditch in the highway median.

Photo 3. Class A habitat in Coghlan Creek north of the highway.

Photo 4. Class A channel that intercepts Coghlan Creek in the highway median.

IV.3.3.1 Fish Presence and At-risk Fish Species

No aquatic species at risk are documented within the portion of the Salmon River watershed in the Study Area, and no critical habitat is identified; however, large portions of the Salmon River and its tributaries approximately 1.5 km downstream from the Study Area (LAA) are considered critical habitat or possible habitat for the Salish sucker, which is listed as Threatened under the *Species at Risk Act* (SC, 2002 c. 29). Offsets for the Salmon River watershed will occur in the riparian area of critical habitat for Salish sucker. Although Salish sucker (Catostomus sp.) were believed to inhabit the forested portion of the stream immediately south of Highway 1, Triton detected no presence through eDNA sampling in this area; however, this does not preclude them from being present lower in the system (Triton, 2021).

Historical fish presence in the Salmon River watershed is presented in *Error! Reference source not found.**Table 188***. Results from Triton's fish inventory and eDNA sampling in the Salmon River watershed are provided in ***Table 199****.* Triton captured threespine stickleback (*Gasterosteus aculeatus*) in May 2021 via minnow traps and detected general fish presence at the median of the upper Salmon River crossing (ST-108) and the median of the Coghlan Creek crossing (WD-200). DFO had previously used this system as an index stream for coho salmon populations in the Lower Mainland, with high numbers of coho and steelhead still returning in recent years (DFO, 1999) (SRES, 2021).

Table 18. Historical fish presence in the Salmon River watershed (MOECCS 2022a).

Common Name	Scientific Name	Common Name	Scientific Name
American Shad	*Alosa sapidissima*	Pink Salmon	*Oncorhynchus gorbuscha*
Atlantic Salmon	*Salmo salar*	Prickly Sculpin	*Cottus asper*
Bass / Sunfish (General)	*Micropterus sp.*	Pumpkinseed	*Lepomis gibbosus*
Brassy Minnow	*Hybognathus hankinsoni*	Rainbow Trout	*Oncorhynchus mykiss*
Brown Catfish (formerly Brown Bullhead)	*Ameiurus nebulosus*	Redside Shiner	*Richardsonius balteatus*

Common Name	Scientific Name	Common Name	Scientific Name
Chinook Salmon	*Oncorhynchus tshawytscha*	Salish Sucker	*Catostomus sp. 4*
Chum Salmon	*Oncorhynchus keta*	Salmon (General)	*Oncorhynchus sp.*
Coastal Cutthroat Trout	*Oncorhynchus clarkii*	Sculpin (General)	*Cottus sp.*
Coho Salmon	*Oncorhynchus kisutch*	Signal Crayfish	*Pacifastacus leniusculus*
Cutthroat Trout	*Oncorhynchus clarkia*	Sockeye Salmon	*Oncorhynchus nerka*
Cutthroat Trout (Anadromous)	*Oncorhynchus clarkia*	Starry Flounder	*Platichthys stellatus*
Dolly Varden	*Salvelinus malma*	Steelhead	*Oncorhynchus mykiss*
Kokanee	*Oncorhynchus nerka*	Stickleback (General)	*Gasterosteus sp.*
Lamprey (General)	*Lampetra sp.*	Sturgeon (General)	*Acipenser sp.*
Largemouth Bass	*Micropterus salmoides*	Sucker (General)	*Catostomus sp.*
Largescale Sucker	*Catostomus macrocheilus*	Threespine Stickleback	*Gasterosteus aculeatus*
Nooksack Dace	*Rhinichthys cataractae – Chehalis lineage*	Western Brook Lamprey	*Lampetra richardsoni*
Northern Pikeminnow	*Ptychocheilus oregonensis*	Western Pearlshell Mussel	*Margaritifera falcata*
Pacific Lamprey	*Lampetra tridentata*	Westslope (Yellowstone) Cutthroat Trout	*Oncorhynchus clarkii lewisi*
Peamouth Chub	*Mylocheilus caurinus*		

Table 19. Fish inventory and eDNA sampling in the Salmon River watershed (Triton 2021).

Site	Date	Electro-fished	Minnow Trapped	eDNA	Fish Presence	Species Present	Comments
ST-011 Salmon River (FS02)	2021-05-20	No	Yes	No	Yes	Threespine Stickleback: 263 individuals	Two minnow traps set in residual pool; all other flow was dry during assessment.
WL-001B South Coghlan Creek	2021-08-10	No	Yes	No	Yes	Threespine Stickleback: 122 individuals	Two minnow traps set in wetland (possible beaver pond).
ST-002B South Coghlan Creek	2021-08-10	No	Yes	No	Yes	Threespine Stickleback: 49 individuals	Two minnow traps set in two residual pools adjacent to each other, all other flow was dry during assessment.
WD-200	2021-11-29	Yes	Yes	Yes	Yes	Unidentified fish species	Minnow traps and electrofishing detected no fish during survey. eDNA determined fish presence in the ditch.

Site	Date	Electro-fished	Minnow Trapped	eDNA	Fish Presence	Species Present	Comments
WD-201	2021-11-29	Yes	Yes	Yes	No	N/A	Minnow traps, electrofishing and eDNA detected no fish during survey.
ST-002B South Coghlan Creek	2021-11-29	Yes	No	No	Yes	Threespine Stickleback: 1 individual	Electrofishing detected one threespine stickleback during survey.
ST-011 Salmon River	2021-12-03	Yes	No	Yes	No	N/A	Electrofishing and eDNA detected no fish within median during survey.
ST-102	2021-12-03	No	No	Yes	Yes	Unidentified fish species	eDNA recorded trace fish presence with 12.5% of the tests positive for fish presence.
WL-003B	2021-12-03	No	No	Yes	No	N/A	eDNA detected no fish during survey.
ST-011 Salmon River (SAWQ)	2021-05-20	No	No	Yes	Yes	Coastal Cutthroat Trout	eDNA recorded trace fish presence with 8.34% of the tests positive for fish presence.

IV.3.4 West Creek

The percentage of classified watercourses within the EAA of the West Creek watershed include: 0% Class A, 5.1% Class A(O), 11.5% Class B and 83.4% Class C. Within the EAA, the West Creek watershed contains two existing Class A and A(O) wetland areas, accounting for a total aquatic area of approximately 4,820 m^2 and approximately 5,550 m^2 of riparian habitat.

Within the Study Area, West Creek consists primarily of low gradient (<1%), riffle-run habitat that generally provides moderate- to high-quality rearing and overwintering habitat, and low-quality spawning habitat. The section immediately north of Highway 1 is wider (~5 m) Class A habitat; however, much of the remaining watercourse is considerably narrower (***Photo 5***). Spawning habitat is not present in this portion of the watercourse, but rearing and overwintering habitat is considered to be high value. The stream contains run habitat with fine substrate over a low gradient. As the stream parallels the north side of the highway, it transitions into Class A(O) habitat that provides moderate-quality spawning, rearing and overwintering habitat. The stream here is comprised of low gradient (1%) riffle-run habitat with fines and gravel substrates (***Photo 6***Photo 6). Large woody debris (LWD), overhanging vegetation and undercut banks are abundant.

Only two Class B watercourses occur north of the highway. One is a narrow (0.5 m), low gradient (3%) ephemeral ditch (***Photo 7***). The second waterbody is a wider (3.2 m), low gradient (1%) ephemeral waterway with riffle habitat. South of the highway are two Class B watercourses, both of which are narrow (~0.2 m), 5% gradient channels with grasses and fines. Riffle habitat is present.

Watercourses within the median are primarily Class B and C watercourses. Median Class B watercourses consist of narrow (1.8 to 2.4 m), low gradient (0 to 2%) ephemeral ditches with substrate comprised of grasses and fines (***Photo*** 8 ***8***).

The riparian areas around Class A and A(O) watercourses within this watershed are largely a mixed young forest with moderate crown closure. Native species include western redcedar, red alder, black cottonwood (*Populus trichocarpa*), bracken fern (*Pteridium aquilinum*), trailing blackberry (*Rubus ursinus*), hardhack, osoberry (*Oemleria cerasiformis*), bigleaf maple, salmonberry, pacific dogwood, pacific willow, Douglas-fir, and vine maple. Invasive plant species include Himalayan blackberry and reed canarygrass.

The Class B ephemeral ditch north of the highway has dense Himalayan blackberry along the banks. South of the highway are two Class B watercourses, which are narrow channels with grasses and some deciduous and shrub species lining the banks. Reed canarygrass and Himalayan blackberry dominate the riparian vegetation composition.

Watercourses within the median are primarily Class B and C watercourses. Reed canarygrass and Himalayan blackberry are prolific.

Photo 5. Class A habitat located north of the highway that will be impacted during construction.

Photo 6. Class A(O) habitat located north of the highway that will be impacted during construction.

Photo 7. Class B habitat located north of the highway.

Photo 8. Class B watercourse located within the highway median.

IV.3.4.1 Fish Presence and At-risk Fish Species

No aquatic species at risk or critical habitat occur within the West Creek watershed (DFO, 2022).

Historical fish presence in the West Creek watershed is presented in ***Table 20***. Results from Triton's fish inventory in the West Creek watershed are provided in ***Table 211.*** Beaver ponds in the headwaters of West Creek retain water levels year-round allowing for fish use in downstream sections of the creek. These annual flows provide enough water for moderate spawning habitats between 84 Avenue and 264 Street for salmon, steelhead, and freshwater trout (DFO, 1999).

Table 20. Historical fish presence in the West Creek watershed (MOECCS 2022a).

Common Name	Scientific Name	Common Name	Scientific Name
Bass / Sunfish (General)	*Micropterus sp.*	Largescale Sucker	*Catostomus macrocheilus*
Black Crappie	*Pomoxis nigromaculatus*	Minnow (General)	--
Brassy Minnow	*Hybognathus hankinsoni*	Northern Pikeminnow	*Ptychocheilus oregonensis*
Brown Catfish (formerly Brown Bullhead)	*Ameiurus nebulosus*	Peamouth Chub	*Mylocheilus caurinus*
Carp (General)	*Cyprinus sp.*	Pink Salmon	*Oncorhynchus gorbuscha*
Chinook Salmon	*Oncorhynchus tshawytscha*	Prickly Sculpin	*Cottus asper*
Chum Salmon	*Oncorhynchus keta*	Pumpkinseed	*Lepomis gibbosus*
Coho Salmon	*Oncorhynchus kisutch*	Rainbow Trout	*Oncorhynchus mykiss*
Cutthroat Trout	*Oncorhynchus clarkia*	Salmon (General)	*Oncorhynchus sp.*
Cutthroat Trout (Anadromous)	*Oncorhynchus clarkia*	Sculpin (General)	*Cottus sp.*
Lamprey (General)	*Lampetra sp.*	Steelhead	*Oncorhynchus mykiss*
Largemouth Bass	*Micropterus salmoides*	Threespine Stickleback	*Gasterosteus aculeatus*

Table 21. Fish inventory in the West Creek watershed (Triton 2021).

Site	Date	Electrofished	Minnow Trapped	eDNA	Fish Presence	Species Present	Comments
ST-004 West Creek	2021-11-30	Yes	No	No	Yes	Threespine Stickleback: 1 individual	Electrofishing detected one threespine stickleback during survey.

IV.3.4.2 Designated Sensitive Stream

West Creek is a designated "Sensitive Stream" under Schedule B of the WSR, and requires specific measures when works are conducted in and around such streams (***Table 222***). Proposed works within West Creek are described in ***Appendix B*** as Sites 4, 5 and 6. The work involves replacing existing highway culverts with larger ones – culverts 7/8, 38/39 and 9/10. The stream classes for these three culverts are A(O), B and C. So, only culvert 7/8 is fish bearing and is being designed accordingly for fish passage.

Table 22. West Creek designated Sensitive Creek measures and mitigations.

Item	Information / Application Reference
Measures	
Fish Inventory of the stream	***Appendix E***
Flow/runoff analysis of stream, including flow measurements for correlation of data	Available upon request. No stream gauging was conducted.
Seasonal distribution of water demand from the sensitive stream	Not available
If there is a tributary or aquifer designated with the sensitive stream: provide the contribution to the sensitive stream of water from the tributary or aquifer, and the seasonal distribution of water demand from the tributary or aquifer.	Available upon request, if required.
An assessment of the fish habitat at the point of diversion, or proposed point of diversion, on the stream and in the area of the stream affected or that will be affected	***Appendix E***
The design of proposed works, including diversion structure and balancing and storage reservoirs	As shown on the drawings and referenced in Sites 4, 5 & 6 in ***Appendix B***. There is no diversion or storage.
If appropriate, any specific water conservation measures that the applicant will use to minimize the amount of water used	Water will not be used; it will remain in the stream.
Whether material is to be removed from the stream or stream channel in connection with the works	Material will be removed from around the existing culverts.
Proposed measures for the protection of natural materials and vegetation that contribute to the fish habitat of the stream and the stability of the stream channel	Riparian replanting will be completed at both ends of the culverts.
Whether substances, sediment, debris or other material is to be deposited in the stream or stream channel in connection with the works	No materials are to be deposited
Proposal for restoration of the worksite after the works have been completed	Channel armouring as designed.
Mitigations	
Timing of construction	Part II.1 – Phases and Schedule & Part VI.3.3 – Fish and Fish Habitat Protection
Practices to ensure stream bank and channel stability	Engineered design of the reshaped stream connections, as depicted in ***Appendix G*** – Design Drawings, ***Appendix I*** – Offsite Environmental Offset Designs, & ***Appendix J*** – Onsite Environmental Offset Designs

Item	Information / Application Reference
Practices for fish migration	Culvert 9/10 is being designed for fish passage, in accordance with Part II.2.1
Practices to ensure no harm to fish occurs from structures, pumping devices and construction	Part VI – Environmental Mitigations and Offsetting
Practices to maintain water quality in stream	Part VI – Environmental Mitigations and Offsetting
Restoration of stream channel to state prior to construction	Part VI.3.17 – Site Restoration
Environmental monitoring	Part VI.3.2, VI.3.3, VI.3.17
Measures to respect water conservation and report water use	Water will remain in the stream
Compensatory mitigation measures for providing the same type of habitat and an equal or larger area	***Appendix M*** – Habitat Balance & Part VI.5 – Residual Impacts and Offsetting

IV.3.5 Nathan Creek

The percentage of classified watercourses within the EAA of the Nathan Creek watershed include: 2.7% Class A, 13.2% Class A(O), 14.4% Class B and 69.7% Class C. Four existing Class A and A(O) wetlands are present in this watershed, within the EAA, and these account for approximately 1,140 m^2 of aquatic habitat and approximately 5,870 m^2 of riparian area.

The mainstem of Nathan Creek is a Class A(O) channel that intercepts Highway 1 flowing east. It is a wide channel (3.0 – 3.7 m) with a low-gradient (2-3%) comprising riffle pool habitat (***Photo 9***). Suitable spawning gravel and overhanging vegetation are abundant. The stream receives flow throughout the year from groundwater springs; however, some upper sections go dry during drought-like conditions leading to reductions in fish production (DFO, 1999). Field assessors documented chum and coho spawning in the mainstem northwest of the Bradner Road underpass, and northeast of the Bradner Rest Area during preliminary surveys.

Several tributaries of Nathan Creek run parallel to and/or intercept the highway. Nathan Creek tributaries consist of low gradient (1-3%) channels ranging from 0.5 to 5.1 m wide and are mostly riffle pool habitat.

Majority of the anticipated impacts to the Nathan Creek watershed will occur within Class A(O) and B waterbodies (***Photo 10***). Within the highway median, suitable spawning habitat in Class A(O) waterbodies is limited and only occurs in two locations, including the tributary west of Bradner Road and the main stem north of Layman Avenue. High quality rearing and overwintering habitat is only present north of Layman Avenue (***Photo 11***). Moderate value rearing and overwintering habitat is present south of Townline Road near 48th Avenue, west of Lefeuvre Road, and both east and west of Bradner Road. Several areas throughout the median contain no suitable spawning, rearing or overwintering habitat.

Within the impacted highway ROW but outside the median, habitat quality is generally low, with high quality rearing and overwintering habitat only occurring west of Lefeuvre Road. Moderate quality spawning habitat is also lacking but does occur in one area south of the highway east of Downes Road.

Class B watercourses within this watershed that occur within the Project alignment primarily consist of channelized ditches that convey seasonal stormwater. Substrate predominantly consists of fines, although gravel is occasionally present. Average channel width ranges from 0.5 to 3.5 m wide with a low gradient (<6%). Some segments consist of riffle, run and ditch habitat. Class B watercourses that occur within the highway median are typically narrow (0.8 to 1.3 m), low gradient (1 to 3%) with substrate dominated by fines and grasses (***Photo 12***). North and south of the highway, Class B ditches are relatively wider (2.7 to 3.5 m), low gradient (0.5 to 1%) ditches with fines and grasses.

Non-impacted Class B watercourses within this watershed primarily consist of channelized ephemeral ditches and riffles. Substrate is dominated by fines and grasses are typically present within the ditches. These ditches are low gradient (1 to 5%) and narrow (0.25 m to 3 m). Riparian area for Nathan Creek is a mixed young forest with moderate to high crown closure, allowing for water temperature regulation. Native species include western redcedar, salmonberry, bigleaf maple, swordfern (*Polystichum munitum*), dogwood, black cottonwood, and red alder. Invasive species include reed canarygrass, English holly (*Ilex auifolium*), English ivy (*Helix hedera*) Himalayan blackberry, and Himalayan balsam (*Impatiens glandulifera*). Tributaries of Nathan Creek are overgrown with reed canarygrass and Himalayan blackberry.

Class B watercourses within this watershed that occur within the Project alignment primarily consist of channelized ditches. Banks are dominated by grasses with intermittent shrubs and trees. Within the highway median, Class B watercourse have low quality riparian habitat, primarily consisting of grasses and shrubs. North and south of the highway, deciduous trees and shrubs are present along the ditch banks of Class B ditches.

Non-impacted Class B watercourses within this watershed primarily consist of channelized ephemeral ditches and riffles. Riparian vegetation consists of shrubs and mixed forest habitat.

Photo 9. Class A(O) habitat located in the highway median that will be impacted during construction.

Photo 10. Class A(O) habitat located immediately north of the highway that will be impacted during construction.

Photo 11. Class A(O) habitat with high quality rearing and overwintering located north of the highway.

Photo 12. Class B watercourse located within the highway median.

IV.3.5.1 Fish Presence and At-risk Fish Species

No fish species at risk nor critical habitat occurs within the Nathan Creek watershed (DFO, 2022).

Historical fish presence in the Nathan Creek watershed is presented in **Table 233**. *Table 23. Historical fish presence in the Nathan Creek watershed (MOECCS 2022a).*

Common Name	Scientific Name	Common Name	Scientific Name
American Shad	*Alosa sapidissima*	Northern Pikeminnow	*Ptychocheilus oregonensis*
Bass / Sunfish (General)	*Micropterus sp.*	Pacific Lamprey	*Lampetra tridentata*
Bluegill	*Lepomis macrochirus*	Peamouth Chub	*Mylocheilus caurinus*
Brassy Minnow	*Hybognathus hankinsoni*	Pink Salmon	*Oncorhynchus gorbuscha*
Bull Trout	*Salvelinus confluentus*	Prickly Sculpin	*Cottus asper*
Chinook Salmon	*Oncorhynchus tshawytscha*	Pumpkinseed	*Lepomis gibbosus*
Chum Salmon	*Oncorhynchus keta*	Rainbow Trout	*Oncorhynchus mykiss*
Coastal Cutthroat Trout	*Oncorhynchus 80larkia clarkii*	Redside Shiner	*Richardsonius balteatus*
Coho Salmon	*Oncorhynchus kisutch*	Sculpin (General)	*Cottus sp.*
Cutthroat Trout*	*Oncorhynchus clarkii*	Signal Crayfish	*Pacifastacus leniusculus*
Cutthroat Trout (Anadromous)	*Oncorhynchus clarkii*	Sockeye Salmon	*Oncorhynchus nerka*
Lamprey (General)	*Lampetra sp.*	Steelhead	*Oncorhynchus mykiss*
Largemouth Bass	*Micropterus salmoides*	Stickleback (General)	*Gasterosteus sp.*
Largescale Sucker	*Catostomus macrocheilus*	Threespine Stickleback	*Gasterosteus aculeatus*

Common Name	Scientific Name	Common Name	Scientific Name
Leopard Dace	*Rhinichthys falcatus*	Whitefish (General)	*Coregonus sp.?*
Minnow (General)	--		

*This system was stocked with cutthroat trout from 1981 to 1996.

Table 24. Fish inventory and eDNA sampling in the Nathan Creek watershed (Triton 2021).

Site	Date	Electro-fished	Minnow Trapped	eDNA	Fish Presence	Species Present	Comments
ST-010C	2021-12-02	No	Yes	Yes	Yes	Unidentified fish species	One minnow trap was set inside a culvert as this was the only location for a trap. No fish were captured. eDNA recorded trace fish presence with 12.5% of the tests positive with fish presence.
ST-005	2021-11-30	Yes	No	No	Yes	Threespine Stickleback: 1 individual	Electrofishing detected threespine stickleback during survey.
ST-007	2021-12-03	Yes	No	No	Yes	Coho Salmon: 1 individual	Electrofishing detected one coho salmon during survey.
ST-008	2021-12-02	No	No	No	Yes	Coho Salmon: 1 individual	Visual Observation: spawning coho salmon observed in stream.
ST-104	2021-12-02	No	No	No	Yes	Chum Salmon: 1 individual	Visual Observation: A late spawning female chum observed in median in stream burying eggs.
ST-108	2021-12-03	No	No	Yes	Yes	Unidentified fish species	eDNA eFish recorded fish presence at site.
ST-010A Nathan Creek	2021-05-02	No	No	No	Yes	Coho Salmon: 1 individual	Visual Observation: One adult coho salmon observed in the creek.

IV.3.5.2 Designated Sensitive Stream

Nathan Creek is a designated "Sensitive Stream" under Schedule B of the WSR, and requires specific measures when works are conducted in and around such streams (***Table 255***). Proposed works within Nathan Creek are described in ***Appendix B*** as Sites 9, 10 and 11. The work involves the following components:

- Culvert replacements crossing the highway east of Bradner Road within a tributary of Nathan Creek (Site 9). New replacement culverts will be built to a higher standard than the existing culverts. They will be upgraded to current flow capacity requirements with climate change allowance.
- Two offsite offsets are proposed in the headwaters of Nathan Creek near the highway (Sites 10 and 11). Works are intended to provide fish habitat enhancements that will improve fish life cycle use within Nathan Creek.

Table 25. Nathan Creek designated Sensitive Stream measures and mitigations.

Item	Information / Application Reference
Measures	
Fish Inventory of the stream	***Appendix E***
Flow/runoff analysis of stream, including flow measurements for correlation of data	Available upon request. No stream gauging was conducted.
Seasonal distribution of water demand from the sensitive stream	Not available. Watercourse is class A(O) in this location and typically dries out in the fall.
If there is a tributary or aquifer designated with the sensitive stream: provide the contribution to the sensitive stream of water from the tributary or aquifer, and the seasonal distribution of water demand from the tributary or aquifer.	Available upon request, if required.
An assessment of the fish habitat at the point of diversion, or proposed point of diversion, on the stream and in the area of the stream affected or that will be affected	***Appendix E***
The design of proposed works, including diversion structure and balancing and storage reservoirs	As shown on the drawings and referenced in Sites 9, 10 & 11 in ***Appendix B***. There is no diversion.
If appropriate, any specific water conservation measures that the applicant will use to minimize the amount of water used	Water will not be used; it will remain in the stream.
Whether materials are to be removed from the stream or stream channel in connection with the works	Material will be removed from around the existing culverts.
Proposed measures for the protection of natural materials and vegetation that contribute to the fish habitat of the stream and the stability of the stream channel	The offsets are designed to enhance the aquatic and riparian areas, as detailed in ***Appendices I*** and ***J***.
Whether substances, sediment, debris or other material is to be deposited in the stream or stream channel in connection with the works	Three boulder/concrete weirs and a culvert are to be installed to create ponds.
Proposal for restoration of the worksite after the works have been completed	Riparian planting and instream complexing are to be incorporated.
Mitigations	
Timing of construction	Part II.1 – Phases and Schedule & Part VI.3.3 – Fish and Fish Habitat Protection
Practices to ensure stream bank and channel stability	Engineered design of the reshaped stream connections, as depicted in ***Appendix G*** – Design Drawings, ***Appendix I*** – Offsite Environmental Offset Designs, ***Appendix J*** – Onsite Environmental Offset Designs
Practices for fish migration	Spawning gravel will be part of the offset substrate. Weirs have been designed to release pond water at low flows to avoid trapping fish.
Practices to ensure no harm to fish from structures, pumping devices and construction	Part VI – Environmental Mitigations
Practices to maintain water quality in stream	Part VI – Environmental Mitigations
Restore stream channel to state prior to construction	Part VI.3.17 – Site Restoration; stream channel is being reconfigured with the

Item	Information / Application Reference
	creation of backwatered ponds to enhance fish use.
Environmental monitoring	Part VI.3.2, VI.3.6, VI.3.17
Measures to respect water conservation and report water use	Water will remain in the stream.
Compensatory mitigation measures for providing the same type of habitat and an equal or larger area	***Appendix M*** – Habitat Balance & Part VI.5 – Residual Impacts and Offsetting

Results from Triton's fish inventory and eDNA sampling in the Nathan Creek watershed are provided in ***Table 244.*** Chinook salmon fry use Nathan Creek as a non-natal rearing stream (DFO, 1999). Triton detected fish presence via eDNA sampling in the tributary that passes under Bradner Road beneath the Highway 1 overpass and in the tributary immediately on the north side of the highway (Triton, 2021). Triton also detected fish presence in the median approximately 1.5 km west of Bradner Road. Coho spawners were observed in the mainstem of Nathan Creek just northwest of the Bradner Road underpass, as well as immediately northeast of the Bradner Rest Area. Coastal cutthroat trout, Chinook salmon, rainbow trout, and steelhead are known to inhabit the mainstem of Nathan Creek near the Bradner Rest Area and Bradner Road (MOECCS 2022a).

Table 23. Historical fish presence in the Nathan Creek watershed (MOECCS 2022a).

Common Name	Scientific Name	Common Name	Scientific Name
American Shad	*Alosa sapidissima*	Northern Pikeminnow	*Ptychocheilus oregonensis*
Bass / Sunfish (General)	*Micropterus sp.*	Pacific Lamprey	*Lampetra tridentata*
Bluegill	*Lepomis macrochirus*	Peamouth Chub	*Mylocheilus caurinus*
Brassy Minnow	*Hybognathus hankinsoni*	Pink Salmon	*Oncorhynchus gorbuscha*
Bull Trout	*Salvelinus confluentus*	Prickly Sculpin	*Cottus asper*
Chinook Salmon	*Oncorhynchus tshawytscha*	Pumpkinseed	*Lepomis gibbosus*
Chum Salmon	*Oncorhynchus keta*	Rainbow Trout	*Oncorhynchus mykiss*
Coastal Cutthroat Trout	*Oncorhynchus 83larkia clarkii*	Redside Shiner	*Richardsonius balteatus*
Coho Salmon	*Oncorhynchus kisutch*	Sculpin (General)	*Cottus sp.*
Cutthroat Trout*	*Oncorhynchus clarkii*	Signal Crayfish	*Pacifastacus leniusculus*
Cutthroat Trout (Anadromous)	*Oncorhynchus clarkii*	Sockeye Salmon	*Oncorhynchus nerka*
Lamprey (General)	*Lampetra sp.*	Steelhead	*Oncorhynchus mykiss*
Largemouth Bass	*Micropterus salmoides*	Stickleback (General)	*Gasterosteus sp.*
Largescale Sucker	*Catostomus macrocheilus*	Threespine Stickleback	*Gasterosteus aculeatus*
Leopard Dace	*Rhinichthys falcatus*	Whitefish (General)	*Coregonus sp.?*

Common Name	Scientific Name	Common Name	Scientific Name
Minnow (General)	--		

*This system was stocked with cutthroat trout from 1981 to 1996.

Table 24. Fish inventory and eDNA sampling in the Nathan Creek watershed (Triton 2021).

Site	Date	Electro-fished	Minnow Trapped	eDNA	Fish Presence	Species Present	Comments
ST-010C	2021-12-02	No	Yes	Yes	Yes	Unidentified fish species	One minnow trap was set inside a culvert as this was the only location for a trap. No fish were captured. eDNA recorded trace fish presence with 12.5% of the tests positive with fish presence.
ST-005	2021-11-30	Yes	No	No	Yes	Threespine Stickleback: 1 individual	Electrofishing detected threespine stickleback during survey.
ST-007	2021-12-03	Yes	No	No	Yes	Coho Salmon: 1 individual	Electrofishing detected one coho salmon during survey.
ST-008	2021-12-02	No	No	No	Yes	Coho Salmon: 1 individual	Visual Observation: spawning coho salmon observed in stream.
ST-104	2021-12-02	No	No	No	Yes	Chum Salmon: 1 individual	Visual Observation: A late spawning female chum observed in median in stream burying eggs.
ST-108	2021-12-03	No	No	Yes	Yes	Unidentified fish species	eDNA eFish recorded fish presence at site.
ST-010A Nathan Creek	2021-05-02	No	No	No	Yes	Coho Salmon: 1 individual	Visual Observation: One adult coho salmon observed in the creek.

IV.3.5.3 Designated Sensitive Stream

Nathan Creek is a designated "Sensitive Stream" under Schedule B of the WSR, and requires specific measures when works are conducted in and around such streams (***Table 255***). Proposed works within Nathan Creek are described in ***Appendix B*** as Sites 9, 10 and 11. The work involves the following components:

- Culvert replacements crossing the highway east of Bradner Road within a tributary of Nathan Creek (Site 9). New replacement culverts will be built to a higher standard than the existing culverts. They will be upgraded to current flow capacity requirements with climate change allowance.
- Two offsite offsets are proposed in the headwaters of Nathan Creek near the highway (Sites 10 and 11). Works are intended to provide fish habitat enhancements that will improve fish life cycle use within Nathan Creek.

Table 25. Nathan Creek designated Sensitive Stream measures and mitigations.

Item	Information / Application Reference
Measures	
Fish Inventory of the stream	***Appendix E***
Flow/runoff analysis of stream, including flow measurements for correlation of data	Available upon request. No stream gauging was conducted.
Seasonal distribution of water demand from the sensitive stream	Not available. Watercourse is class A(O) in this location and typically dries out in the fall.
If there is a tributary or aquifer designated with the sensitive stream: provide the contribution to the sensitive stream of water from the tributary or aquifer, and the seasonal distribution of water demand from the tributary or aquifer.	Available upon request, if required.
An assessment of the fish habitat at the point of diversion, or proposed point of diversion, on the stream and in the area of the stream affected or that will be affected	***Appendix E***
The design of proposed works, including diversion structure and balancing and storage reservoirs	As shown on the drawings and referenced in Sites 9, 10 & 11 in ***Appendix B***. There is no diversion.
If appropriate, any specific water conservation measures that the applicant will use to minimize the amount of water used	Water will not be used; it will remain in the stream.
Whether materials are to be removed from the stream or stream channel in connection with the works	Material will be removed from around the existing culverts.
Proposed measures for the protection of natural materials and vegetation that contribute to the fish habitat of the stream and the stability of the stream channel	The offsets are designed to enhance the aquatic and riparian areas, as detailed in ***Appendices I*** and ***J***.
Whether substances, sediment, debris or other material is to be deposited in the stream or stream channel in connection with the works	Three boulder/concrete weirs and a culvert are to be installed to create ponds.
Proposal for restoration of the worksite after the works have been completed	Riparian planting and instream complexing are to be incorporated.
Mitigations	
Timing of construction	Part II.1 – Phases and Schedule & Part VI.3.3 – Fish and Fish Habitat Protection
Practices to ensure stream bank and channel stability	Engineered design of the reshaped stream connections, as depicted in ***Appendix G*** – Design Drawings, ***Appendix I*** – Offsite Environmental Offset Designs, ***Appendix J*** – Onsite Environmental Offset Designs
Practices for fish migration	Spawning gravel will be part of the offset substrate. Weirs have been designed to release pond water at low flows to avoid trapping fish.
Practices to ensure no harm to fish from structures, pumping devices and construction	Part VI – Environmental Mitigations
Practices to maintain water quality in stream	Part VI – Environmental Mitigations
Restore stream channel to state prior to construction	Part VI.3.17 – Site Restoration; stream channel is being reconfigured with the

Item	Information / Application Reference
	creation of backwatered ponds to enhance fish use.
Environmental monitoring	Part VI.3.2, VI.3.6, VI.3.17
Measures to respect water conservation and report water use	Water will remain in the stream.
Compensatory mitigation measures for providing the same type of habitat and an equal or larger area	***Appendix M*** – Habitat Balance & Part VI.5 – Residual Impacts and Offsetting

IV.3.6 Fishtrap Creek

The percentage of classified watercourses within the EAA of the Fishtrap Creek watershed include: 13.4% Class A, 4.8% Class A(O), 10.4% Class B and 71.4% Class C ditches. Within the Fishtrap Creek watershed, one existing Class A wetland is present within the EAA, and this accounts for a total area of approximately 3,310 m^2 of aquatic habitat and approximately 4,440 m^2 riparian habitat. Six Class A(O) wetlands are also present and include approximately 55,130 m^2 of aquatic habitat and 32,570 m^2 of riparian habitat.

Fishtrap Creek is characterized by a moderate gradient (~3%), riffle-pool morphology, and a substrate composition dominated by gravel and cobble. This heterogenous habitat provides high-quality spawning, rearing, and overwintering habitat for salmon; however, DFO previously documented some downstream barriers (DFO, 1999). Heavy flooding in November 2021 caused the most western crossing of Fishtrap Creek to become deeply entrenched, resulting in several overhanging banks.

Associated tributaries of Fishtrap Creek are similar grade and morphology as the mainstem.

Watercourses within the LAA of Enns Brook are primarily deep and wide (5 to 8 m) engineered channels; however, Enns Brook is a naturally occurring, ephemeral Class A(O) watercourse that transitions to Class A in the median, with segments of subsurface flow where flows enter a tunnel network in sections (***Photo 13***). Enns Brook was dry during summer assessments (August 2022). All stream gradients within the area are low (0 to 2%), with substrates made up primarily of grass, fines, and some gravel.

High quality overwintering and rearing habitat and moderate quality spawning habitat is present within the small portion of Enns Brook, which is present in the median, between culverts. An east-west Class B wetland also drains east into Enns Brook through a wide (5 m) ditch (***Photo 14***). Overall habitat in this wetland and connecting ditch is low quality and degraded. The wetland is ephemeral and connectivity between Enns Brooks and the wetland may only occur during high flows, limiting fish passage. East of the Enns Brook crossing is a Class A watercourse that is only partially daylighted (***Photo 15***). No spawning habitat is present here, but overwintering and rearing habitat is of moderate quality.

High quality Class A fish habitat was observed north of the highway, where it is primarily deep and wide (5 to 8 m) engineered channels (***Photo 16***). Pearson Ecological (2008) determined that there was an undersized culvert under an old railway crossing approximately 1.5 km downstream of Highway 1 crossing. This culvert impedes fish passage during low flows and high flows, which can limit access to the spawning gravels upstream.

East Fishtrap Creek is a Class A watercourse characterized by well-defined wide (5 m), deep (1 m) ditches. Stream gradients are low (0.05 to 1%), with substrates made up primarily of grass, fines, and some gravel.

Watercourses within the East Fishtrap Creek sub-catchment are primarily deep and wide ditches. All stream gradients within the area are low (0.05 to 1%), with substrates made up primarily of grass, fines, and some gravel. Flow derives from a subsurface source at the western-most limit of the stream. Portions of this system consist of well-defined channels, while other areas fan out and persist more as wetland habitat. These ditches running parallel to the highway do not contain suitable spawning habitat but may provide moderate to high quality overwintering and rearing areas.

Riparian vegetation around Fishtrap Creek is primarily young deciduous forest. Native species include salmonberry, beaked hazelnut (*Corylus cornuta*), sword fern, red alder, bigleaf maple, black cottonwood, and mountain ash (*Sorbus americana*). Invasive species include Japanese knotweed (*Reynoutria japonica*) and Himalayan blackberry.

Associated tributaries of Fishtrap Creek have similar vegetation composition as the main stem. Riparian areas for Enns Brook are primarily in the shrub stage with some grass. Native species include bigleaf maple, red alder, salmonberry, hardhack, pacific dogwood, pacific willow, Douglas-fir, redcedar, and vine maple. Cattails occur in pockets throughout. Invasive plant species include Himalayan blackberry and reed canary grass, with blackberry being especially in the median.

Riparian areas for East Fishtrap Creek and associated tributaries are primarily in the shrub stage with some grass. Native species include red alder, salmonberry, hardhack, pacific dogwood, pacific willow, and Douglas-fir. Invasive plant species include Himalayan blackberry and reed canary grass.

Photo 13. Class A habitat located in the highway median that will be impacted during construction.

Photo 14. Class B habitat located in the highway median that will be impacted during construction.

Photo 15. Class A habitat located in the highway median that will be impacted during construction.

Photo 16. Class A watercourse and critical habitat for Salish sucker, located north of the highway.

IV.3.6.1 Fish Presence and At-risk Fish Species

Species at risk presence in the Fishtrap Creek watershed includes Nooksack dace and Salish sucker. Critical habitat for Salish sucker occurs within the LAA immediately north of the highway in East Fishtrap Creek (DFO, 2021). Additionally, Nooksack dace occur, or have the potential to occur, in Enns Brook north of Livingstone Avenue outside the LAA. Enns Brook is considered critical habitat for Nooksack dace. Critical habitat and potential presence for both species occur south of the highway and construction should be managed to prevent downstream impacts to these species. No recent observations of Salish sucker or Nooksack dace have been documented in this system. Triton conducted eDNA sampling to verify potential species at risk presence within the Fishtrap Creek watershed; however, no Nooksack dace or Salish sucker were found during sampling efforts (Triton, 2021).

Historical fish presence for Fishtrap Creek (including Enns Brook and East Fishtrap Creek sub-catchments) is presented in (***Table 266***). No fish observations were identified for East Fishtrap Creek; populations are assumed to match Enns Brook due to their proximity to one another (MOECCS 2022a). Results from Triton's fish inventory and eDNA sampling in the Fishtrap Creek watershed are provided in ***Table 277.***

Table 26. Historical fish presence in the Fishtrap Creek Watershed (MOECCS 2022a).

Common Name	Scientific Name	Fishtrap Creek	Enns Brook	East Fishtrap Creek
Black Crappie	*Alosa sapidissima*	✓		
Brown Catfish	*Ameiurus nebulosus*	✓	✓	✓
Chinook Salmon	*Oncorhynchus tshawytscha*	✓		
Coho Salmon	*Oncorhynchus kisutch*	✓	✓	✓
Cutthroat Trout	*Oncorhynchus clarkii*	✓	✓	✓
Lamprey (General)	*Lampetra sp.*	✓	✓	✓
Largemouth Bass	*Micropterus salmoides*	✓	✓	✓

Common Name	Scientific Name	Fishtrap Creek	Enns Brook	East Fishtrap Creek
Largescale Sucker	*Catostomus macrocheilus*	✓		
Nooksack Dace	*Rhinichthys cataractae - Chehalis lineage*	✓	✓	✓
Peamouth Chub	*Mylocheilus caurinus*	✓		
Pumpkinseed	*Lepomis gibbosus*	✓	✓	✓
Rainbow Trout	*Oncorhynchus mykiss*	✓	✓	✓
Salish Sucker	*Catostomus sp.*	✓	✓	✓
Steelhead	*Oncorhynchus mykiss*	✓		
Stickleback (General)	*Gasterosteus sp.*	✓	✓	✓
Threespine Stickleback	*Gasterosteus aculeatus*	✓	✓	✓
Western Brook Lamprey	*Lampetra richardsoni*	✓	✓	✓

Table 27. Fish inventory and eDNA sampling in the Fishtrap Creek watershed (Triton 2021).

Site	Date	Electro-fished	Minnow Trapped	eDNA	Fish Presence	Species Present	Comments
ST-014 West Enns Brook, West Fishtrap Creek, Enns Brook, Fishtrap Creek	2021-05-19	No	Yes	No	Yes	Threespine Stickleback: 4 individuals	Two minnow traps were set. Spawning colouration was observed in the threespine stickleback.
ST-015 East Fishtrap Creek	2021-05-20	No	Yes	No	Yes	Threespine Stickleback: 1 individual	Two minnow traps were set. The East Fishtrap Creek traps had poor effectiveness when set to Salish sucker standards, however traps were set well to capture wildlife species and insects at surface.
ST-015C	2021-11-30	Yes	No	No	Yes	Threespine Stickleback: 1 individual, Unidentified fish species: 2 individuals	Electrofishing captured one threespine stickleback and two unidentified fish were observed. Stream was very difficult to net due to its size and some locations were overgrown with reed canarygrass.
WL-203	2021-11-30	Yes	No	No	No	N/A	No fish were captured.
ST-013	2021-11-30	No	Yes	No	No	N/A	Three minnow traps were set.
ST-114	2021-11-30	Yes	Yes	No	No	N/A	Minnow traps and electrofishing detected no fish during survey.

Site	Date	Electro-fished	Minnow Trapped	eDNA	Fish Presence	Species Present	Comments
ST-016A	2021-12-01	Yes	Yes	Yes	Yes	Unidentified fish species	Minnow traps and electrofishing detected no fish during survey. eDNA recorded some fish presence upstream of site.
ST-112	2021-12-01	Yes	Yes	Yes	No	N/A	Minnow traps, electrofishing and eDNA detected no fish during survey.
ST-205/WD	2021-12-01	Yes	Yes	Yes	Yes	Unidentified fish species	Minnow traps detected no fish during survey. eDNA recorded trace DNA. Amphibian presence may have impacted this trace detection.
ST-012 West Enns Brook, West Fishtrap Creek, Enns Brook, Fishtrap Creek	2021-08-12	No	No	Yes	Yes	Unidentified fish species	eDNA recorded fish presence.
ST-015A East Fishtrap Creek	2021-05-20	No	No	Yes	Yes	Coastal Cutthroat Trout, Coho Salmon, Unidentified fish species	eDNA recorded trace fish presence with 25% of the tests positive for fish presence.

IV.3.7 Hydrology / Water Resources

Kerr Wood Leidal (KWL) carried out a hydrotechnical study. AE reviewed the highway drainage requirements to support the drainage and hydrotechnical design. The drainage design criteria and methodology used in the design drawings are based on the KWL Report and the BC Supplement to TAC Geometric Design Guidelines, 2019 (BC TAC Guidelines). These criteria and a summary of KWL's report are outlined in ***Appendix N.***

Below is a summary of the hydrotechnical work that has been completed for this Project:

- Design criteria developed for culvert sizing and stormwater storage.
- Climate change analysis determining trendline analysis and return period estimation of previous storm events.
- KWL model updated with detail discussing the model's calibration.
- East Fishtrap Creek Bridges and hydraulic structure designed to meet the 200-year return period event estimated water levels, low flow considerations, and impacts to downstream water license holders.
- Stormwater storage hydrographic analysis of stormwater runoff with the aim of matching current peak flows with the estimated proposed flows.

IV.4 TERRESTRIAL VEGETATION RESOURCES

IV.4.1 Ecological Communities

The Project is located in the eastern variant of the Very Dry Maritime subzone of the Coastal Western Hemlock (CWHxm1) biogeoclimatic zone (MoF, 2016). The Coastal Western Hemlock (CWH) forest is characterized by its cool mesothermal climate, mild winters, and, on average, is the rainiest biogeoclimatic zone in the province (Pojar et al., 1991). The CWHxm subzone is characterized by warm, dry summers and moist, mild winters with relatively little snowfall (UBC, 2022a). Mean annual precipitation in the CWHxm subzone ranges from 1100 to 2721 mm and mean annual temperature ranges from 7.8°C to 10.7°C (Green & Klinka, 1994). Forests in this zone are characterized by dominant Douglas-fir (*Pseudotsuga mensiezii*) with a sparse herb layer and predominance of moss species. Other tree species that are common in this subzone are western hemlock (*Tsuga heterophylla*), western redcedar, red alder, and bigleaf maple.

Within the EAA, there is a complex mix of urban development, agricultural land, and natural areas of varying ages and species compositions. Urban development within the landscape includes a wide range of uses including residential, commercial, and industrial, as well as recreational facilities (e.g., golf courses and playing fields). Natural areas here have been confirmed to consist of broad ecosystem types including both young and mature forests, riparian fringes, and wetlands. Within the Highway 1 median, small, disconnected stands of shrubs and trees are separated by large areas of mowed grass and/or invasive plant species (e.g., Himalayan blackberry). Proportions of these broad ecosystem types vary across the Project alignment (***Table 288*; *Appendix O: Figures 1A*** through ***1E***). The western portion of the Project area contains the largest natural areas within the footprint of the Project (LAA), and these are primarily contained within the median, by area.

Table 28. Summary of broad ecosystem types in the LAA.

Habitat Type	Area (ha)
Urban	270
Natural	117
Agricultural	65
Total area:	452

The western extent of the Project area is dominated by development, including a large industrial park bordered mostly by agricultural land, but the eastern end and the vicinity around the Bradner Road Rest Area includes large areas of mature forest. The Highway 1 median consists of several tree and shrub strands, with the largest stands located between 264 Street and 272 Street and near Bradner Road.

The eastern portion of the Project area consists mostly of developed landscapes including commercial, light industrial, and low-density housing developments, with interspersed areas of agricultural land and forest habitat. Ecosystem types include small, young forest habitat north and south of the highway, at the east end of the Project area and dense urban development along the west portion.

IV.4.2 Sensitive Ecosystems

Metro Vancouver's Sensitive Ecosystem Inventory was conducted from 2010 to 2012 (updated 2020) in Metro Vancouver and the City of Abbotsford to identify and map relatively unmodified ecosystems, as well as ecosystems that have been modified by humans and still retain ecological value and importance to biodiversity (Meidinger, Clark, & Adamoski, 2014) (Clark & Meidinger, 2020). Unmodified and modified natural ecosystems have been mapped within the LAA.

Within the EAA, the MVSEI identified several natural ecosystem polygons comprising both modified and unmodified potentially sensitive ecosystems (***Table 299***). Based on a desktop review of aerial imagery and supported by field review, AE updated the mapping to encompass the entire EAA based on the ecosystem classifications identified in the MVSEI. The updated SEI along the project footprint is represented in ***Appendix O: Figures 1A*** to ***1E***.

Expanding on the MVSEI categories (2020), the EAA contains the following modified and unmodified natural ecosystem types:

- **Riparian**: associated with and influenced by fresh water. Within the Project this typically occurs as narrow fringes along rivers, streams, and creeks, comprising young forest, which is most often deciduous or mixed. Common species noted include bigleaf maple, red alder, western redcedar, and salmonberry. While narrow, these areas of riparian vegetation were present in all segments of the Project.
- **Wetland**: ecosystems where “soils are saturated by water for enough time that the excess water and resulting low oxygen levels influence the vegetation and soil”. Within the Project, these are often historically disturbed, and consist primarily of herbaceous species, occasionally with a fringe of shrubs and trees. These commonly contained red alder, salmonberry, red-osier dogwood (*Cornus sericea*) and occasional hardhack. Both ephemeral and non-ephemeral wetlands were observed. Wetlands were observed within all three segments.
- **Young Forest**: forest stands that are generally between 30 and 80 years old. These also typically comprised western redcedar, red alder, bigleaf maple, salmonberry, and sword fern. These were found throughout in the western part of the project area, including the Bradner Road Rest Area, and to a lesser extent in the eastern portion of the project area. Patches of deciduous young forest less than 5 ha in area constitute the primary ecosystem type impacted by the project.
- **Freshwater Reservoirs**: reservoirs that have had their natural hydrology modified, but still provide important freshwater habitat. This small portion of a larger reservoir is located south of Watson Road and will not be impacted by project works. It is fed by Nathan Creek.

Table 29. Summary of natural ecosystem types in the Highway 1 Local Assessment Area.

Habitat Type	Area (ha)
Riparian	3.7
Wetland	11.5
Young Forest	101.1
Freshwater Reservoir	0.3
Total area:	**116.6**

IV.4.3 Ecological Communities at Risk

A search for publicly available occurrences of ecological communities at risk mapped within RAA did not return any results in iMapBC (CDC, 2022b), and this was confirmed by fieldwork completed for the preliminary assessment (Triton, 2021). A total of 25 ecological communities are listed as at-risk within the CWHxm1 including 10 wetland types. Nearly all of the late seral site series for CWHxm1 are provincially listed, however, all habitats within the LAA are disturbed. Wetland classification has not been completed; however, these landscapes are generally also post-disturbance due to location adjacent to either cleared or agricultural areas.

IV.4.4 Invasive Species

Based on a search of the provincial Invasive Alien Plant Program (IAPP) mapping tool (MOECCS, 2022e) and data collected in the field, there are 32 invasive plant species and noxious weeds documented along and adjacent to the highway corridor, including four priority species mapped by the Fraser Valley Invasive Species Society (Green K. M., 2022) (***Table 30***).

Table 30. Invasive plant species and noxious weeds documented along the Highway 1 Study Area.

Common Name	Scientific Name	Status[1]	Field Observed?
Bohemian Knotweed	*Reynoutria x bohemica*	Provincially noxious; MOTI priority species	Y
Bittersweet (Climbing) Nightshade	*Solanum dulcamara*	Invasive plant of concern	N
Bull Thistle	*Cirsium vulgare*	Invasive plant of concern	N
Bur Chervil	*Anthriscus caucalis*	Provincially noxious	Y
Burdock Species	*Arctium spp.*	-	Y
Canada Thistle	*Cirsium arvense*	Provincially noxious	N
Chervil	*Anthriscus spp*	-	Y
Common Reed	*Phragmites australis subsp. australis*	Provincially noxious; MOTI priority species	Y
Common Tansy	*Tanacetum vulgare*	-	N
Common / Yellow Toadflax	*Linaria vulgaris*	Provincially noxious	N
Cutleaf (Evergreen) Blackberry	*Rubus laciniatus*	-	N
English Holly	*Ilex aquifolium*	-	N
English Ivy	*Hedera helix*	-	N
Field Bindweed	*Convolvulus arvensis*	Invasive plant of concern	N
Giant Hogweed	*Heracleum mantegazzianum*	Provincially noxious	Y
Giant Knotweed	*Reynoutria sachalinensis*	Provincially noxious; MOTI priority species	N
Hedge Bindweed	*Calystegia sepium subsp. sepium*	Regionally invasive plant of concern	N
Himalayan Blackberry	*Rubus armeniacus*	-	Y

Common Name	Scientific Name	Status[1]	Field Observed?
Japanese Knotweed	*Reynoutria japonica*	Provincially noxious; priority species	Y
Old Man's Beard	*Clematis vitalba*	-	N
Perennial Sow Thistle	*Sonchus arvensis*	Provincially noxious	N
Policeman's Helmet	*Impatiens glandulifera*	Invasive plant of concern	Y
Queen Anne's Lace	*Daucus carota*	-	N
Scotch Broom	*Cytisus scoparius*	Invasive plant of concern	Y
Shiny Geranium	*Geranium lucidum*	Priority species	Y
Spotted Knapweed	*Centaurea stoebe*	Provincially noxious	Y[3]
Spurge	*Euphorbia sp.*	Provincially noxious[4]	Y
Tall Hawkweed	*Pilosella piloselloides*	-	N
Tansy Ragwort	*Senecio jacobaea*	Provincially noxious	N
Wild Chervil	*Anthriscus sylvestris*	Regionally noxious (Fraser Valley); MOTI priority species	Y
Yellow Archangel	*Lamiastrum galeobdolon*	-	N
Yellow Flag Iris	*Iris pseudacorus*	Provincially noxious	N

[1]Source: Field Guide to Noxious Weeds and other selected Invasive Plants of British Columbia (2019)
[2]Knotweeds were not identified to species level.
[3]Knapweed was observed in the EAA but was not identified to the species level. It is likely to be spotted knapweed (*Centaurea stoebe* ssp. *micranthos*).
[4] Some species within the *Euphorbia* genus are designated as noxious weeds; however, observations were not identified to species level.

Geospatial data provided by MoTI identified and mapped 25 individual polygons containing four high priority and former early detection rapid response invasive plant species, with a total area of 2.4 hectares in the LAA (***Table 311***). Three of these four species are designated as noxious weeds by the BC *Weed Control Act* (RSBC, 1996, c. 487) (BC, 1996b) and the associated *Weed Control Regulation* (BC Reg. 66/85). Section 2 of the *Weed Control Act* requires that the occupier of a property has a duty to control noxious weeds growing or located on land occupied by that person. FVISS has mapped the extent of four priority species / species groups within the LAA (MoTI, 2022):

- Knotweed species (Japanese, giant, bohemian, and Himalayan): large, woody, bamboo-like shrub, present in isolated patches along the corridor. Primarily spread by rhizomes, also by seed.
- Common reed (Phragmites): a perennial grass up to 5 m tall with hollow stems, flat pointed, dark green leaves and large feathery flowers, found in a single patch. Spreads primarily by rhizomes but can also spread by seed.
- Shiny geranium: an annual herbaceous plant with brittle red stems, round or kidney shaped, shiny leaves with 5-7 lobes, and small pink flowers. Distributed sporadically across Segments 1 and 2 . Spreads primarily by seed, which can also be transported in soil.
- Wild chervil: an upright plant with deep taproot, fern-like glossy leaves divided into leaflets, and white flowers on 2 cm long stalks arranged in umbrella-like clusters. Extensive infestation mapped in both segments. Spreads primarily by seed, which can also be transported in soil.

The distribution of each of the priority species is illustrated in ***Appendix O: Figures 2A*** to ***2E*** and summarized in ***Table 311***.

Table 31. Summary of invasive plant species mapped by FVISS within the Extended Assessment Area.

Common Name	Scientific Name	Noxious[1]	Area (ha)	Number of Polygons
Japanese Knotweed	*Reynoutria japonica var. japonica*[2]	Y	0.132	8
Shiny Geranium	*Geranium lucidum*	N	0.182	2
Wild Chervil	*Anthriscus sylvestris*	Y	2.10	14
Common Reed	*Phragmites australis ssp. australis*	Y	0.009	1
		Total	**2.4**	**25**

Notes:

- Plant species designated by the Weed Control Regulation as noxious either in all regions of the province (Schedule A, Part I) or within the boundaries of the Fraser Valley regional district (Schedule A, Part II).
    - Japanese knotweed (*Reynoutria japonica* var. *japonica*) is also commonly referred to as *Fallopia japonica*.

IV.4.5 Traditional Use Plants

Traditionally used plants are anticipated to occur in the RAA.

IV.4.6 Plant Species at Risk

In the absence of targeted surveys, rare plant species with the potential to occur within the LAA were identified (***Table 322***) (CDC, 2022a). Preliminary rare plant surveys conducted in June 2021 did not find any evidence of rare plants in the Highway 1 Study Area (Triton, 2021).

Table 32. Rare plant species with the potential to occur within the RAA.

Common Name	Scientific Name	BC List Status	SARA Status
Vancouver Island Beggarticks	*Bidens amplissima*	Blue	Special Concern
Phantom Orchid	*Cephalanthera austiniae*	Red	Threatened
Washington Springbeauty	*Claytonia washingtoniana*	Red	n/a
Yellowseed False Pimpernel	*Lindernia dubia var. dubia*	Blue	n/a
Streambank Lupine	*Lupinus rivularis*	Red	Endangered
Leafless Wintergreen	*Pyrola aphylla*	Blue	n/a
Henderson's Checker-mallow	*Sidalcea hendersonii*	Blue	n/a
Tall Bugbane	*Actaea elata var elata*	Red	Endangered
Cut-leaved Water Parsnip	*Berula erecta*	Blue	n/a
Roell's Brotherella	*Brotherella roellii*	Red	Endangered
Peacock Vinyl Lichen	*Scytinium polycarpum*	Yellow	Special Concern
Silver Hair Moss	*Fabronia pusilla*	Red	Endangered

Common Name	Scientific Name	BC List Status	SARA Status
Leafy Miterwort	*Mitellastra caulescens*	Blue	n/a

Marked known occurrences of plant species at risk and proposed critical habitat within or adjacent to the project are as follows (***Appendix O: Figures 3A*** to ***3C***):

- ***Vancouver Island beggarticks*** (*Bidens amplissima*): recorded within 2 km of the LAA in 2000. A subsequent study in 2008 did not find any plants and the blue-listed species is now ranked as "possibly extirpated" by the BC CDC (CDC, 2022a).
- ***Roell's brotherella*** (*Brotherella roellii*): one area of proposed critical habitat for mapped within a Department of National Defense property in Aldergrove, BC, approximately 2 km south of the LAA. This species is listed as endangered under SARA.

While no rare plants were noted during Project surveys, the wetted ditches and wetlands within the footprint provide potential habitat for several rare plants, specifically Henderson's checker-mallow, Vancouver Island beggarticks, and cut-leaved water parsnip (*Berula erecta*).

IV.5 WILDLIFE RESOURCES

IV.5.1 Wildlife and Wildlife Habitat

Wildlife habitat in the LAA consists of mixed broadleaf and coniferous forest habitat, riparian vegetation, watercourses, wetland areas, park areas, agricultural land and built-up areas, all of which support a diversity of wildlife. Mixed forest habitat exists as relatively large contiguous areas throughout the western portion of the Project area and near the center of the alignment. Throughout both segments, there are numerous smaller, disconnected patches of mixed forest habitat both on the margins of Highway 1 and within the highway median. Mixed forest habitat is characterized by broadleaf and coniferous trees of varying age classes, dense shrubs, and other forbs. Substantial riparian and wetland habitats also occur within the LAA, as several disconnected patches distributed throughout the Project area. Within the Highway 1 median, the remainder of the habitat consists largely of low shrubs and grasses that are regularly mowed.

This complex mosaic of highly valuable habitat in the LAA benefits amphibians, reptiles, small and medium sized mammals, and birds through a range of life requisites (e.g., foraging, breeding, overwintering). Amphibian habitats include wetlands and slow-moving streams, which provide breeding opportunities, supported by adjacent upland forest habitats for foraging and overwintering. Wetted depressions, which are low-lying areas that collect and retain rainwater and surface runoff may also provide suitable breeding habitat for amphibians.

Bird species occupy a variety of trees and shrubs, which support nesting. Wildlife trees with sloughing barks, cracks or crevices provide nesting opportunities for cavity-nesting birds as well as suitable roosting habitat for bats. Wetland forest habitats likely attract many flying insects, which provide suitable foraging opportunities for bats as well.

Mammals likely use the forest and riparian corridors for foraging, denning, breeding and as travel corridors between pockets of suitable habitat in the Lower Mainland and Fraser Valley. Wildlife dens and beaver lodges were noted along the corridor, both within the median and north of the highway ***(Appendix O: Figures 4A*** to ***4E***). Throughout the LAA, there are extensive temporary encampments set up by the unhoused, which contributes to a level of semi-disturbance in many of the mixed forest habitat areas.

Agricultural land and landscaped parkland in the LAA provide foraging and nesting opportunities for birds, including raptors. Stick nests were observed throughout all the habitat types along the highway corridor. Small mammals are likely found throughout the fallow agricultural land, old field margins and in the landscaped grass park areas.

IV.5.2 Wildlife Use

Wildlife likely to be using watercourses, wetlands and riparian habitat in the LAA are discussed in further detail below, with a specific focus on wildlife that is dependent on these habitat types for all or part of their life cycle.

IV.5.2.1 Amphibians & Reptiles

Several species of native and invasive amphibians and reptiles were observed in the LAA. Northwestern salamander (*Ambystoma gracile*) egg masses were observed in multiple locations in the Project area, while both adult northwestern salamanders and egg masses were observed in the eastern portion of the Project. Two invasive amphibian species, American bullfrog (*Lithobates catesbeianus*) and green frog (*Lithobates clamitans*) were observed. Most observations of American bullfrog and green frog occurred near the western end of the alignment; however, green frogs were also observed on Ross Road, approximately 100 m north of Highway 1.

One occurrence of northern red-legged frog was observed in wetland habitat in the median, approximately 400 m west of 272 Street. Northern red-legged frog is a species at risk which is provincially Blue-listed, and federally designated as Special Concern.

Gartersnakes (*Thamnophis* sp.) were observed at three locations within the Project. Red-eared slider (*Trachemys scripta*) turtle, an invasive species in BC, was observed in a ditch along the north side of the highway within the Project area.

IV.5.2.2 Mammals

American beaver (*Castor canadensis*) sign and carcasses were observed in multiple locations in the western half of the Project area, and near Gardner Park in the eastern portion of the Project. (***Appendix O: Figures 4A to 4E****)*. Mole (*Scapanus* sp.) excavation mounds were found throughout the median and grassy shoulders along within the EAA.

IV.5.2.3 Birds

No targeted bird surveys were conducted; however, water-associated birds were observed routinely during other surveys in the LAA, including bald eagle (*Haliaeetus leucocephalus*), great blue heron (*Ardea herodias*) and various ducks. All riparian habitat has the potential to support nesting for numerous bird species. A compiled list of bird observations documented within the RAA is presented in ***Appendix O***, as compiled from citizen science datasets (Cornell, 2022).

IV.5.2.3.1 Raptor Nests

Seven nests were confirmed or suspected to be raptor nests based on indications such as the large size of the nests and/or the presence of another active or known raptor nest in the vicinity (i.e., alternate nest), adult raptors perching or circling in the vicinity, and potential adult raptors sitting low in the nests that could not be visually confirmed (***Table 333***; ***Appendix O: Figures 4A*** to ***4E***). The City of Abbotsford documented ten active or potentially active raptor nests from December 30, 2004, to July 25, 2017, two of which were confirmed by AE in 2021 or 2022. Potential buffer setbacks for all seven potential or known raptor nests observed in the field overlap with proposed instream works.

Table 33. Raptor nests found within the Highway 1 Study Area.

Source	Nest ID	Common Name	Status	Date Documented
AE	1W-N-003	Unknown raptor (suspected)	Unknown	November 25, 2021
	1W-N-008	Red-tailed Hawk (suspected)	Unknown	March 31, 2022
	1E-N-018	Unknown raptor (suspected)	Unknown	December 9, 2021
	1E-N-019 (R204-010)	Red-tailed Hawk (suspected)	Active	November 24, 2021
	1E-N-022	Red-tailed Hawk (suspected)	Active	April 4, 2022
	2W-N-027	Red-tailed Hawk	Active	March 18, 2022
	2W-N-021 (N/A)	Bald Eagle	Active	November 23, 2021
City of Abbotsford	N/A (2W-N-021)	Bald Eagle	N/A	July 25, 2017
	R204-127	Red-tailed Hawk	Tree Standing	April 6, 2005
	R204-007	Red-tailed Hawk	N/A	January 4, 2005
	R204-022	Red-tailed Hawk	N/A	January 4, 2005
	R204-035	Red-tailed Hawk	Tree Standing	March 29, 2005
	R204-010 (1E-N-019)	Red-tailed Hawk	N/A	January 4, 2005

IV.5.2.4 Wildlife Species at Risk

The BC Conservation Data Centre online database (CDC, 2022a) was queried and refined according to species known ranges, population extents and habitat requirements. Results indicated 28 species at risk have the potential to occur in the EAA (***Appendix O***), of these, 10 species are associated with watercourses, wetlands and riparian areas for all or some of their life requisites and are not highly mobile, including (***Table 344***):

- 5 species at risk with known occurrences.
- 5 critical habitat polygons within the RAA, of which 3 occur in the LAA.

Critical habitat polygons included barn owl (*Tyto alba*), Oregon spotted frog (*Rana pretiosa*), painted turtle (*Chrysemys picta*), pacific water shrew (*Sorex bendirii*) and Oregon forestsnail (***Appendix O: Figures 3A*** to ***3C***). These species are discussed in detail below. Of these documented occurrences, only northern red-legged frog and Oregon forestsnail have been confirmed in the LAA during surveys carried out for this Project or assessed as likely to occur based on the presence of suitable habitat (***Appendix O: Figures 5A*** to ***5E***). Remaining species are considered either to have a low likelihood of occurring in the LAA or are unlikely to interact with the Project.

Table 34. Wildlife species at risk with the potential to occur in the RAA.

Group	Common Name	Scientific Name	SARA	COSEWIC Status	BC List	MKO within 2 km (Y/N)
Mammals	Pacific Water Shrew	*Sorex bendirii*	1-E (2003)	E (2016)	Red	Y
	Trowbridge's Shrew	*Sorex trowbridgii*	-	-	Blue	Y
	Townsend's Mole	*Scapanus townsendii*	1-E (2005)	E (2014)	Red	Y
Amphibians and Reptiles	Northern Red-legged Frog	*Rana aurora*	1-SC (2005)	SC (2015)	Blue	Y
	Oregon Spotted Frog	*Rana pretiosa*	1-E (2003)	E (2011)	Red	N
	Western Toad	*Anaxyrus boreas*	1-SC (2018)	SC (2012)	Yellow	N
	Painted Turtle, Coast pop. 1	*Chrysemys picta* pop. 1	1-E (2007)	T (2016)	Red	Y
Invertebrates	Oregon Forestsnail	*Allogona townsendiana*	1-E (2005)	E (2013)	Red	Y
	Threaded Vertigo	*Nearctula* sp. 1	1-SC (2012)	SC (2010)	Red	N
	Western Thorn	*Carychium occidentale*	-	-	Blue	N

Adapted from Triton 2021

IV.5.2.4.1 Barn Owl

Critical habitat for barn owl has been identified all along the Highway 1 corridor throughout both Project segments (***Appendix O: Figures 3A*** to ***3C***). Barn owl requires both foraging habitat and enclosed or protected cavities for nesting and roosting, all in relatively close proximity (ECCC, 2021). Foraging habitat typically consists of open fields, meadows or marshland with an abundance of their preferred prey, the Townsend's vole (*Microtus townsendii*). Areas that do not provide these biophysical attributes are excluded as critical habitat, including "running surfaces of existing roads" (ECCC, 2021). Suitable foraging habitat for this species exists all along the highway corridor with large expanses of agricultural lands as well as some meadows and marshland habitat. Open riparian habitat along the highway corridor has the potential to provide foraging habitat for this species. Old barns and buildings and potentially some of the forest habitat adjacent to the highway provide nesting and roosting opportunities in the EAA. On average, one to two owls are struck by vehicles each year along the highway corridor within the Project alignment, however, these appear to be predominantly great horned owl (*Bubo virginianus*).

IV.5.2.4.2 Oregon Forestsnail

Oregon forestsnails have been observed in mixed forest habitat at several locations north and south of the LAA (CDC, 2022b). Critical habitat for Oregon forestsnail has been mapped north of Highway 1 Study Area at Glen Valley Regional Park (***Appendix O: Figure 3A***). Oregon forestnails were observed:

- Along Nathan Creek, east of the rest area in April and May 2022,
- Near the Bradner Road underpass in 2022 (***Appendix O: Figure 5C***),

- At several locations between Bradner Road and Ross Road (***Appendix O: Figure 5D***),
- In two separate locations in the Fishtrap Creek riparian corridor (***Appendix O: Figure 5E***), and
- Near Mt. Lehman Road (***Appendix O: Figure 5E***).

Oregon forestsnail is a Red-listed species that is also federally designated as Endangered (CDC, 2022a). Oregon forestsnail is strongly associated with broadleaf and mixed forests that contain bigleaf maple and stinging nettle (ECCC, 2013). A thick leaf litter or moss layer is also required for cover. Oregon forestsnails found during field surveys completed for this Project were associated with leaf litter from mature bigleaf maple stands and patches of stinging nettle. Within the EAA, mixed forest habitat suitable for Oregon forestsnail is present in the central portions of the assessment area, especially near the Bradner Road underpass, and extending east toward Ross Road. Suitable habitat exists in a mature forest stand that stretches from the southwest side of the Mt. Lehman interchange and extends approximately 1 km to the west, as well as within a nearby stand on the north side of Highway 1 (***Appendix O: Figure 5E***).

IV.5.2.4.3 Northern-Red Legged Frog

Two documented occurrences of northern red-legged frog occur west and southwest of the EAA (***Appendix O: Figure 3A and Figure 3B***) (CDC, 2022b). Adults were observed in both deciduous and mixed forest habitats adjacent to wetland and marsh habitat and within the wetland itself. Northern red-legged frog is a provincially Red-listed species that is also federally designated as a species of Special Concern (CDC, 2022a). Suitable habitat for this species includes the vicinity of permanent waters of stream pools, marshes, ponds, and other quiet bodies of water. Adults regularly occur in damp woods and meadows some distance from water, especially during wet weather (CDC, 2008), and therefore have the potential to occur in the wet forest habitat surrounding the rest area. One northern red-legged frog was observed in the Highway 1 median (near 272 Street) during field surveys conducted by Triton in 2021 (***Appendix O: Figure 5B***) (Triton, 2021). AE conducted additional amphibian surveys in 2021 and 2022 but did not observe any northern red-legged frog.

IV.5.2.4.4 Oregon Spotted Frog

Critical habitat for Oregon spotted frog has been mapped along the Salmon River, south of the highway corridor, crossing the LAA just west of Ross Road. As of 2017, the Aldergrove population is considered extirpated (CDC, 2022). This species is highly aquatic and is associated with large marshes within forested landscapes (COSEWIC, 2011). Spotted frogs have three distinct activity seasons, breeding, summer foraging and over-wintering periods, which requires shallow warm waters and abundant aquatic vegetation for oviposition and foraging. In winter, these frogs use deeper water where they bury themselves in silty bottom substrate or aquatic vegetation (COSEWIC, 2011). This species is only known to occur at a few sites in Maria Slough, Mountain Slough, Morris Valley and McLennan Creek (CDC, 2022a), none of which occur in the LAA.

IV.5.2.4.5 Painted Turtle

Critical habitat for painted turtle Pacific Coast Population (*Chrysemys picta* pop. 1) has been mapped along the majority of the Project alignment including Coghlan Creek, Nathan Creek, Salmon River and Fishtrap Creek (***Appendix O: Figure 3A***, ***Figure 3B, Figure 3C***). Painted turtle – Pacific Coast Population is a provincially Red-listed species that is also federally designated as Threatened (CDC, 2022a). Similar to northern red-legged frog, suitable habitat for painted turtle includes wetlands and streamside edges, along with roadside ditches and forest ponds (MOE, 2017). However, the watercourse reaches within the LAA appear to lack some of the biophysical attributes of critical habitat for painted turtle, including deep areas for daily movement, aquatic plants, warm water with silty or sandy substrate for breeding, and deeper waters with floating vegetation or large wood, rocks, etc., for basking (BC, 1996b) (WPTRT, 2016). While painted turtles are unlikely to use habitat in the LAA for their critical life requisites, they may use the watercourse and riparian area as travel corridors between pockets of highly suitable habitat. No painted turtles were observed in the EAA during field assessments.

IV.5.2.4.6 Pacific Water Shrew

Pacific water shrew was captured in 2014 in riparian forest habitat along a tributary of Bertrand Creek, approximately 2 km south of the LAA (CDC, 2022b). Critical habitat occurs along a tributary of the Salmon River, southwest of the LAA (***Appendix O: Figure 3A***) (CDC, 2022b). Pacific water shrew is provincially red-listed and federally designated as Endangered (CDC, 2022a). Suitable habitat for this species in BC is found in riparian habitats associated with streams, creeks, and wetlands in mature coniferous or deciduous forests (CDC, 2011). Nathan Creek was rated as highly suitable for pacific water shrew and the LAA has the potential to support this species. Field surveys completed for this Project identified a number of additional watercourses with moderate to high suitability as pacific water shrew habitat, including:

- West of 264th / Highway 1 interchange (***Appendix O: Figure 5A***),
- North and south sides of Highway 1 west of 272 Street (***Appendix O: Figure 5B***),
- Between Lefeuvre Road and Bradner Road (***Appendix O: Figure 5C***), and
- West of Ross Road (***Appendix O: Figure 5D***).

A number of watercourse reaches were also identified as moderately suitable habitat. These watercourses were generally connected to or in the general vicinity of watercourses mapped as high-suitability (***Appendix O: Figure 5A*** **through** ***Figure 5D***). Habitat was identified in the vicinity of Fishtrap Creek and East Fishtrap Creek (***Appendix O: Figure 5E***).

Three waterways in the LAA were sampled for pacific water shrew eDNA: Salmon River, West Enns Brook and Fishtrap Creek (Triton, 2021b). No pacific water shrews were detected in any of the systems.

IV.5.2.4.7 Townsend's Mole

Townsend's mole is provincially red-listed and federally designated as Endangered (CDC, 2022b). Highly suitable habitat for this species exists in the LAA where open pastures and shrub habitats with heavier soils occur. While mole mounds were detected in some riparian areas, this species is not strictly tied to riparian habitat. Field surveys did not detect any mole tunnels large enough to support Townsend's mole, and therefore there was no evidence to suggest that mole mounds encountered within the LAA were created by anything other than the common coast mole (*Scapanus orarius*). Further, mole carcasses were found within the Project alignment, and their body measurements were indicative of the coast mole. While the results of the mound surveys suggests that coast mole is most active in the Study Area, the presence of Townsend's mole cannot be precluded (CDC, 2022b).

PART V ASSESSMENT OF IMPACTS ON ECOLOGICAL VALUES

V.1 CONSTRUCTION IMPACTS TO AQUATIC RESOURCES

Based on the information review and field assessments, valued components within the Project footprint that could be affected through project design and construction were examined. Environmental effects are any changes that the design, construction, and operation of the Project may have on the existing environmental condition. Environmental effects potentially resulting from the Project are categorized as:

- Permanent changes where the Project footprint increases compared to the baseline condition.
- Permanent changes where a watercourse will be altered outside of the Project footprint to accommodate the Project.
- Temporary changes or effects during site preparation and construction.

Aquatic effects were classified as instream when below the high-water mark. Riparian impacts are considered for vegetation up to 30 m above the high-water mark. Details of potential impacts are discussed below.

The Project activities and phases will interact with biophysical components in the receiving environment on a multitude of levels. Error! Reference source not found.***35*** summarizes the progressive phases of the P roject and lists project activities that are anticipated to interact with biological systems, physical systems, and atmospheric conditions. This summary table lays the foundation of understanding as to how certain activities can interact with a variety of systems, so that appropriate mitigation measures can be selected. Throughout this Section, a more detailed account of recommended mitigations measures is presented.

Table 35. Potential environmental effects of Project activities including preparation, construction, operation and maintenance phases.

	Biological Systems					Physical		Atmospheric	
PROJECT PHASES / COMPONENTS	Aquatic Species/ Watercourses and Wetlands	Vegetation/ Ecosystems	Wildlife / Wildlife Habitat	Species at Risk	Invasive Species	Surface Water Quality	Surface Water Quantity	Air Quality (dust)	Acoustic Environment (noise)
Site Preparation									
Clearing and Grubbing	x	x	x	x	x	x	x	x	x
Stripping	x	x	x		x	x	x	x	x
Preload / Surcharge of Highway Median and Infrastructure Locations		x	x	x	x	x	x	x	
Temporary Access	x	x	x	x	x	x	x	x	
Staging Areas		x	x		x	x		x	
Demolition of Existing Structures	x			x				x	x
Construction									
Excavation	x		x	x	x	x		x	x
Grading	x		x	x		x		x	x
Cuts and Fills	x		x	x	x	x		x	x
Pit Development for Granular Materials		x	x	x	x	x		x	x

	Biological Systems					Physical		Atmospheric	
PROJECT PHASES / COMPONENTS	Aquatic Species/ Watercourses and Wetlands	Vegetation/ Ecosystems	Wildlife / Wildlife Habitat	Species at Risk	Invasive Species	Surface Water Quality	Surface Water Quantity	Air Quality (dust)	Acoustic Environment (noise)
Culverts Removal & Installation	x	x			x	x	x		
Gravel Road Base Installation					x			x	
Asphalt Primer and Paving	x					x		x	
Retaining Wall Construction			x					x	x
Overpass Replacement			x					x	x
New Bridge Construction	x		x			x	x	x	x
Rest Area Improvements			x		x			x	x
Landscaping		x	x		x			x	
Pile Driving	x		x	x					x
Operation									
Annual Debris and Litter Removal					x				
Mowing and Invasive Plant Management		x	x		x	x			x
Snow Removal							x		
Ice Prevention	x		x			x			
Accidents and Malfunctions (Incident Response)	x	x	x			x		x	
Maintenance									
Annual Pavement Repair								x	x
Annual Shoulder Gravelling						x		x	
Annual Drainage Maintenance	x					x			
Pavement Markings Management								x	
Sign Maintenance									
Fence Maintenance									
Asphalt Replacement (5 years)	x					x		x	
Bridge Deck and Pilings Maintenance	x					x			
Rest Area Maintenance		x			x				
Restoration									
Stream Bed Restoration, and Armouring to Protect from Scour	x			x		x	x		
Plantings for Habitat Restoration		x	x	x	x				
Stream Bank Stabilization of Disturbed Soils with Hydroseeding	x	x	x	x	x				

V.1.1 Temporary Impacts to Aquatic and Riparian Habitats

Temporary construction impacts have been accounted for. Temporary impacts are defined as areas within riparian or aquatic habitats which require some degree of modification to facilitate construction. Types of temporary impacts that have been accounted for are construction / impact zones for access roads, culvert jacking or receiving areas and other culvert or bridge construction disturbance zones.

GIS mapping of these predicted temporary impacts are graphically outlined in ***Appendix A: Figure 2***. The GIS calculations indicate the following temporary disturbance and reinstatement areas (***Table 36***).

Table 36. Temporary impacts per watershed for each watercourse classification.

	Salmon River		West Creek		Nathan Creek		Fishtrap Creek	
	AQUATIC Temp Total (m²)	RIPARIAN Temp Total (m²)	AQUATIC Temp Total (m²)	RIPARIAN Temp Total (m²)	AQUATIC Temp Total (m²)	RIPARIAN Temp Total (m²)	AQUATIC Temp Total (m²)	RIPARIAN Temp Total (m²)
Class A	6016	4808	8	16	95	494	473	3335
Class AO	132	856	862	402	274	1578	335	1731
Class B	658	1347	98	196	115	299	918	2594
Class C	628	705	0	0	0	37	256	302
Watershed Total:	**7434**	**7716**	**969**	**615**	**485**	**2409**	**1982**	**7963**

V.1.2 Fish and Fish Habitat

Project works have the potential to cause fish mortality, and fish may be directly affected by loss or alteration of instream habitats, changes to water quality, and the loss or alteration of nutrient sources and riparian habitat. Key activities impacting fish habitat are widening of the highway, infilling of the median waterways, and installation of long culverts. To a large degree, these losses will affect “lower quality” habitats which can be characterized as those that are either severely degraded due to a long history of anthropogenic activities within the alignment or drainage features that may be opportunistically utilized by fish (i.e., ecological sinks).

Impacts to fish and fish habitat through Project-related activities may include:

- ***Changes to water quality*** – may result from the removal of riparian vegetation leading to increased water temperatures or sediment and erosion deposition causing turbidity. Construction may lead to the introduction of deleterious substances or a change contaminant concentration that can cause bioaccumulation or biomagnification. Such impacts can alter fish growth, reproductive success, competitive abilities, and may result in increased predation and potential mortality.
- ***Loss or alteration of habitat*** – will occur through changes to both instream and riparian habitats during vegetation removal, culvert installation, infilling of the median, etc. Construction may result in loss of cover, changes in bank stability, increased risk of erosion and sedimentation, impacts to habitat diversity, and restriction of habitat connectivity.
- ***Loss or alteration of nutrient sources*** – any changes to the riparian area will alter the nutrient input into a watercourse. An excess of nutrifying elements or mineral compounds can lead to eutrophication causing low dissolved oxygen concentrations, which may cause fish and other organisms to relocate and/or die. Reduced nutrient input into the watercourse may change food supply for fish and other aquatic species.
- ***Direct impacts to species physiology and/or behaviour*** – includes an individual / species response to potential disturbance stimuli such as undetected metabolic changes, vocalizations, and dispersion away from the source of disturbance. Elevated noise levels (e.g., from machinery and people within close proximity), olfactory stimuli, visual stimuli and subsurface vibrations (e.g., from compacting) constitute various types of disturbance stimuli.

- ***Direct mortality*** – may cause harm or death to fish, eggs or ova from physical disruption from construction equipment.

This complex network of habitats has been characterized (***Part VI.3.3***), with their varying degrees of quality, mitigated and offset accordingly to achieve a net balance to fish habitat (***Part VI.6***). Proposed works have been carefully designed to minimize overall impacts to fish and fish habitat, and efforts to avoid and minimize impacts are described in greater detail in the Alternatives Design Memo found in ***Appendix L***. Where these impacts were unavoidable, mitigative measures have been proposed to neutralize losses. Additionally, temporary impacts to fish habitats are planned to be fully remediated following Project works. A contextual map which highlights project impacts to existing habitat and proposed mitigations is provided in ***Appendix A***. If further detail is required with respect to any individual watercourse, such details are provided in the ***Appendix E*** stream habitat inventory.

V.1.2.1 Fish Species at Risk

Nooksack dace and Salish sucker are known to be historically present in Enns Brook and East Fishtrap Creek, within the Project area. Additionally, areas downstream, upstream, and within the Project area are designated as critical habitat for both Salish sucker and Nooksack dace (***Figure 21***). Offsetting works for the Salmon River watershed involve off-channel habitat to Salish sucker critical habitat, which will impact the riparian area of the critical habitat. These impacts will be mitigated through design to result in a net benefit to Salish sucker habitat.

Sampling efforts to date have included electro-fishing, minnow trapping and eDNA analysis, and these have shown a lack of Salish Sucker and Nooksack Dace presence within the LAA. Expected impacts to fish habitat are loss or alteration of habitat. Potential for fish mortality exists, but more likely fish may be affected by loss or alteration of instream habitats, changes to water quality, and loss or alteration of nutrient sources and riparian habitat.

V.1.2.2 Culvert Impacts to Fish

Culvert installation and replacement has the potential to impact fish species directly or indirectly. Potential impacts include permanent (e.g., culvert installation) and temporary loss of habitat (e.g., during dewatering and culvert replacement works), changes to water quality (e.g., during installation), fragmentation of habitat (i.e., interruption of travel corridors), and mortality either through stranding or from contact with machinery.

Culverts have been designed to minimize risks to fish and fish habitat. Design elements are described in detail in ***Part II.3.3***. Additionally, BMPs (e.g., salvages, screened intakes, etc.) will be employed during culvert installation (***Part VI.3.3***), and temporary disturbances are to be restored to return the site to its pre-disturbance condition (***Part VI.3.17***).

V.1.3 Hydrology / Water Resources

A summary of hydrological impacts anticipated across the Project alignment includes:

- Reduced flooding potential at culvert inlets and reduced culvert barrel velocities resulting from replacement of two undersized culverts with a single larger culvert designed for the required design flow.

- The new culverts, which are designed for climate change and current MoTI hydraulic capacities, during major storm events will initially let more water through than the existing culverts. Existing culverts surcharge and create a form of short-term attenuation with ponding upstream. This will not occur with the new culverts. However, after the short-term surcharge period, downstream flows will be the same. Improved fish passage at crossings during high and low flow conditions resulting from new culvert design on fish-bearing watercourses.
- Reduced erosion of sediments to downstream reaches through incorporation of erosion protection on channel banks and bottom.
- Increased water volume leaving the site will result from extra paving during highway widening, and through the installation of culverts, which will remove choke points. However, flow rates will be controlled and mitigated through improved drainage to be determined during the detailed design stage.

Construction of the two bridges at East Fishtrap Creek are not anticipated to modify the watershed's functioning in terms of quantity of flow, as the hydraulic structure downstream of the bridge controls the overall hydrology of the watershed.

At proposed offset locations, the addition of ponds will slightly attenuate flows, holding back water at high flow periods and releasing water at low flow periods, which is an advantage to fish habitat. The ponds have a larger aquatic area and will therefore infiltrate more water to the ground. The water table could rise in the vicinity of the weirs. However, this is within the stream and will surcharge to groundwater below the stream further downstream. Hydrological impacts are highlighted on a site-by-site basis in ***Appendix B***.

V.2 CONSTRUCTION IMPACTS TO TERRESTRIAL VEGETATION RESOURCES

The primary impact to terrestrial ecosystems is through clearing for project works, which is primarily a temporary impact. To facilitate future maintenance of the culverts, access roads and staging pads will be in some cases retained as permanent infrastructure to support culvert functionality.

Rare plants also have the potential to occur in sensitive ecosystems within the LAA (e.g., wetlands and riparian areas) and are vulnerable to vegetation clearing in these areas. Construction activities may also result in soil compaction or erosion, which can affect the quality of vegetation or ecosystems. Soil compaction limits the ability of native species to grow, and erosion can result in the loss of fertile soils for vegetation to germinate. Additionally, equipment moving within the construction area has potential to spread invasive plants or their seeds (***Part III.2.5.1***) to new areas, including native ecosystems located adjacent to the LAA, resulting in potential reductions to ecosystem quality.

V.3 CONSTRUCTION IMPACTS TO WILDLIFE AND WILDLIFE HABITATS

The LAA was found to provide habitat for amphibians, reptiles, birds, small and medium-sized mammals, and habitat connectivity for larger mammals with some browsing opportunities. Impacts to wildlife and wildlife habitat through Project-related activities may include:

- ***Changes in habitat*** – any changes to the area that do not necessarily render the habitat unusable or unsuitable but may decrease the quality of the habitat or result in a permanent or temporary change in use.

- ***Changes to the quality of habitat*** – may occur in areas within and adjacent to the development footprint and may include creation of edges, habitat fragmentation, and increased susceptibility to invasive species distribution and abundance.
- ***Loss of habitat*** – refers to the long-term or permanent removal of wildlife habitat (i.e., clearing / grubbing). Habitat loss along the highway corridor, associated with culvert replacements and upgrades, will include both aquatic/riparian habitat. Wildlife dens and beaver lodges were noted along some of the watercourses and wetlands, and these significant wildlife features may be lost during construction.
- ***Changes in wildlife habitat use*** – noise and vibration resulting from construction activities may cause habitat avoidance or movement deflections during seasons where movements are important to certain wildlife species. Wildlife may disperse temporarily or permanently from areas of disturbance.
- ***Direct impacts to species physiology and/or behaviour*** – an individual / species response to potential disturbance stimuli includes undetected metabolic changes, vocalizations, and dispersion away from the source of disturbance. Elevated noise levels (e.g., from machinery and people within close proximity), olfactory stimuli, visual stimuli and subsurface vibrations (e.g., from compacting) constitute various types of disturbance stimuli.
- ***Direct mortality*** – potential for injury / mortality to species, including collisions with construction machinery.

V.3.1 Culvert Impacts to Wildlife

The magnitude and extent of impacts on wildlife associated with culvert replacement along the corridor will vary based on several site-specific factors. These factors include the suitability of the watercourse for wildlife species and / or species groups (e.g., amphibians, painted turtle, pacific water shrew), how easily wildlife can divert around the temporary works, the construction methods used, the implementation of BMPs during construction (e.g., salvage and/or timing windows), and the suitability of the culvert for wildlife passage post-construction.

Most of the existing culverts along the highway corridor are undersized and subject to high flows. While many of the new and replacement culverts will exceed 25 m in length, they have been designed for fish passage including embedment and baffles, both features that are likely to facilitate aquatic wildlife passage. Further, culverts are being upsized to handle higher flows, and this larger diameter will create more openness (i.e., cross-sectional diameter divided by length) in the crossing. The openness of a culvert is more likely to affect the willingness of wildlife to use it rather than a single structural dimension (i.e., length alone) (Utah, 2012). Further, culverts can be designed and/or retrofitted to facilitate wildlife passage where practical (e.g., installation of a shelf or dry passage).

V.3.2 Impacts to Birds

The Project has the potential to disturb nesting birds including raptors. There are three suspected and three confirmed raptor nests with buffers overlapping the LAA. Vegetation clearing during the general bird breeding window (i.e., March 12 to August 17), or earlier for raptors (i.e., February 1 to September 15), can displace nesting birds and result in mortalities if active nests are cleared. Clearing may also increase vulnerability of nests by increasing exposure, increasing predation risk, and decreasing the availability of suitable nest trees. Breeding birds may respond to disturbance stimuli by vocalization, undetected metabolic changes and dispersion, which may lead to nest abandonment and/or nest predation.

Wildlife trees are common in the riparian areas within the LAA. The removal or disturbance of large diameter (e.g., >60 cm diameter) standing dead or decaying trees will result in fewer available perching or nesting locations for birds that rely on this type of habitat (e.g., owls, woodpeckers, or raptors). Cavities in these trees provide suitable nesting habitat for woodpeckers and owls. Birds using tree cavities for nesting are at risk of mortality if these trees are removed when they are occupied by adults or young.

V.3.3 Impacts to Aquatic and Semi-Aquatic Wildlife

Instream works have the potential to affect aquatic and semi-aquatic wildlife utilizing the watercourses in the LAA to carry out all or part of their life requisites, including as travel corridors between areas of suitable habitat. Potential impacts include permanent (e.g., clear and grubbing) and temporary loss of habitat (during dewatering and culvert install), fragmentation of habitat (i.e., interruption of travel corridors), and mortality either through stranding or from contact with machinery.

Native salamanders are likely present in most of the aquatic and wetland habitat in the LAA. They were confirmed in several roadside ditches and wetlands along the alignment. Infilling of these watercourses, wetlands, and roadside ditches along the alignment represent a loss of habitat for amphibians, the majority of which will be “replaced” following site restoration and offsite compensation. Culvert replacements will also result in the temporary disturbance of aquatic habitat. Green frogs and bullfrogs were the dominant frog species observed within the LAA and wetlands in the highway median are not highly suitable for our native frogs. The loss of this habitat is not anticipated to affect local native amphibian populations.

Aquatic and semi-aquatic wildlife along the corridor may use existing culverts as crossings under the highway. Suitability of culverts as road crossings can be influenced by length (which can affect lighting/visibility and temperature in the culvert), embeddedness, and magnitude of flows (i.e., strong currents). Amphibians and reptiles are reluctant to use structures longer than 25 m (ECCS, 2020). Wildlife, including amphibians, reptiles and small mammals, require access to surface oxygen. Subsequently, submerged culverts do not function as effective crossings.

Lastly, a new bridge crossing is being proposed for Fishtrap Creek from south of Gardner Park and will replace the existing crossing comprised of four culverts. Northwestern salamander egg masses and a garter snake were observed within/adjacent to the creek on the south side of the highway. Converting these four culverts to a bridge crossing will facilitate wildlife passage, connecting a valuable riparian corridor north and south of the highway and facilitating wildlife movement in the RAA.

V.3.4 Wildlife Species at Risk

Field investigations in the LAA targeted species at risk with the understanding that effects on these species would be representative of anticipated effects on the species groups in general.

Habitat within the LAA, especially within the Highway median, is disturbed to some extent, and Project effects are anticipated to be incremental in these areas of predominantly low-quality habitat. Construction-related effects, including disturbance, will be mitigated with standard BMPs and site-specific mitigation, as described in ***Part VI.3***.

V.3.4.1 Oregon Forestsnail

Oregon forestsnails were detected in the deciduous riparian forest habitat along West Fishtrap Creek, at both the culvert inlet / outlet, north and south of the highway, and south of the highway at Fishtrap Creek (habitat on the north side was inaccessible). Several live specimens were detected within a very small patch of riparian forest in the median west of Ross Rd with the Salmon River sub-catchment.

Habitat loss north and south of the alignment is incremental, and snails detected within the immediate footprint can be moved to suitable habitat within the same contiguous forest patch.

V.3.4.2 Northern Red-legged Frog

Northern red-legged frog was confirmed at one location along the alignment, at a wetland in the median in the West Creek 1 sub-catchment. With the exception of this wetland, green frogs and bullfrogs were the dominant frog species observed within the LAA and especially along the median.

V.3.4.3 Painted Turtle

There are two structural watercourse culverts proposed to convey water from Coghlan Creek (C2/3) and from Nathan Creek West Tributary (C11/12) across the highway and two tributaries of Fishtrap Creek, all of which, along with their tributaries, are mapped as critical habitat for painted turtle.

No painted turtles were observed in the LAA during field assessments and habitat within the LAA is not highly suitable for this species. However, they may use the watercourses and riparian areas north and south of the highway as travel corridors between pockets of highly suitable habitat outside the LAA. Painted turtles in BC have been documented using culverts (MOECCS, 2020f). Instream works should consider the potential for painted turtle on a site-specific basis, particularly where works occur in the Salmon River, Coughlan Creek, Nathan Creek and Fishtrap Creek. As is the case with native amphibians, wetlands in the highway median are not suitable for painted turtle and the loss of this habitat is not anticipated to affect local populations. Proposed offsetting plans for Nathan Creek will be designed to incorporate mitigation strategies benefiting painted turtle populations.

V.3.4.4 Townsend's Mole

Mole mounds were documented along the entire alignment through the EAA, primarily in the median, and including riparian areas. Field investigations concluded that there was no evidence to suggest the presence of anything other than the common coast mole; however, the presence of Townsend's mole in the LAA cannot be precluded. If present in the LAA, specifically along the center median, there is an increased risk of mortality for this species as it cannot easily escape construction activities.

V.3.4.5 Pacific Water Shrew

Many watercourses in the LAA have been assessed as providing moderate to high suitability habitat for pacific water shrew, with many of the remaining ditches likely providing at least low-quality habitat. All works in and around watercourses, wetlands and ditches should consider the potential for pacific water shrew and assess on a site-specific basis. The risk to this species should be considered in the context of current site conditions, timing of proposed works and the scope of activities, and the requirement for sweep and / or salvage determined.

Habitat loss for pacific water shrew is considered temporary as roadside ditches will be replaced, and aquatic/wetland habitat replaced.

V.3.4.6 Barn Owl

Suitable habitat for this species exists in the LAA, and owls may use suitable riparian habitat for foraging. However, works in and around watercourses primarily associated with culvert replacements are not anticipated to affect this species.

V.3.5 Critical Habitat

Mapped critical habitat for barn owl, painted turtle, and Oregon spotted frog overlaps the LAA. Suitable habitat for these species within the LAA was not identified during baseline studies, however, where critical habitat occurs, site-specific clearing plans should consider potential for these species and mitigation required.

PART VI ENVIRONMENTAL MITIGATIONS AND OFFSETTING

VI.1 ENVIRONMENTAL MITIGATION HIERARCHY

The provincial mitigation hierarchy for environmental values is described in four levels:

1. Avoid.
2. Minimize.
3. Restore onsite.
4. Offset (offsite or onsite).

Table 37. Hierarchy of measures.

Hierarchy of Measures		How the Measure was Implemented
1	**Avoid** (measures to avoid) the occurrence of adverse effects	Several design alterations were made to better accommodate environmentally sensitive areas throughout the alignment, as detailed in the Alternative Design Memo (***Appendix L***).
2	**Minimize** (measures to mitigate) the extent of the death of fish and wildlife and adverse effects on fish and wildlife habitat resulting from the proposed work	Several measures to protect the environment have been considered, which include BMPs for Instream Works, preparation of a Construction Environmental Management Plan (CEMP), and consideration of sensitive timing windows and construction staging and schedule to address potential lag times in ecological form and function associated with habitat loss and associated offsets. Additionally, proposed works have been designed to maintain and improve fish and wildlife passage and restore instream and riparian fish and wildlife habitat onsite.
3 & 4	**Offset** this loss of habitat **through positive contributions to the aquatic and riparian ecosystems** (measures to restore and offset) – via **Onsite** and **Offsite Offsetting.**	Several habitat enhancement offsets have been designed in and around the alignment to yield a net surplus of aquatic and riparian habitat.

VI.2 AVOIDANCE THROUGH PROJECT DESIGN

As indicated throughout this report, the design team has implemented a mitigation hierarchy of measures for the conservation and protection of the environment, with the ultimate goal to avoid or minimize residual effects. Measures to avoid and minimize Project impacts start early in design when the environmental features are identified and the design is modified to avoid those features. As this Project is an expansion and upgrade to existing linear infrastructure, there are spatial limitations to what can be moved to avoid impact. An alternative design memo has been prepared to illustrate the design considerations utilized to avoid and minimize impact in the design phase (***Appendix L***). The highway has primarily been widened into the existing median, to limit impacts to streams, impacts to ALR lands, and need for private land acquisition. Proposed infrastructure experienced significant design evolution, notably the Bradner Rest Area expansion, which was relocated to avoid high quality habitat, and Fishtrap Creek Bridge, which was redesigned to improve habitat quality for fish species at risk. Other infrastructure changes included: culvert redesigns to improve fish passage, reduced temporary detour impacts through use of existing lanes for traffic diversion, and sound wall placement decisions.

VI.3 MINIMIZE VIA ENVIRONMENTAL MITIGATION MEASURES

Impacts are minimized during the Project design, construction, operation, and restoration phases via use of best management practices (BMPs). In addition to the MoTI Standard Specifications for Highway Construction, Volumes 1 and 2, the following guidelines and BMPs were used to develop appropriate avoidance and mitigation measures:

- DFO Policy for applying measures to offset adverse effects on fish and fish habitat under the *Fisheries Act* (DFO, 2019)
- Develop with Care Environmental Guidelines for Wetland Protection and Conservation in British Columbia (MOECCS, 2014)
- DFO Measures to Protect (DFO, 2019) and Standards and Codes of Practice (DFO, 2021)
- Requirements and Best Management Practices for Making Changes In and About a Stream in British Columbia (GoBC, 2022a)
- A User's Guide for Changes In and About a Stream in British Columbia (GoBC, 2022b)
- Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in British Columbia (WSP, 2009)

A variety of environmental protection and mitigation measures for the Project are proposed to minimize harmful effects to wildlife and the environment. The expected required measures employed per Project phase are summarized in ***Table 38*** and detailed in ***Parts VI.3.1*** to ***VI.3.17*** below.

Table 38. Mitigation measures intended for wetlands, Class A, A(O), and B watercourses, and Class C drainages.

Environmental Mitigation Measures	Phase			
	Design	Construction	Operation	Restoration
CEMP	✓	✓	✓	✓
Environmental Monitoring		✓	✓	✓
Fish and Fish Habitat Protection		✓		
Erosion and Sediment Control		✓	✓	✓
Concrete Works		✓		
Spill Control and Emergency Response		✓		✓
Vegetation Management		✓		✓
Wildlife and Wildlife Habitat Protection		✓		✓
Species at Risk Management	✓	✓		✓
Soil Management		✓		✓
Water Management		✓		
Hazardous Materials Management		✓		
Dust and Emissions Control		✓		

Environmental Mitigation Measures	Phase			
	Design	Construction	Operation	Restoration
Noise and Vibration Management		✓		
Waste Management		✓		✓
Pile Driving Plan		✓		
Restoration Plan				✓

Repairs to habitat may be necessary due to unforeseen events such as flooding, erosion, or drought conditions. As a contingency to mitigation measures, the contractor will also provide planned secondary strategies that can be implemented in the unlikely event that planned avoidance and mitigation measures do not meet their objectives. Contingency measures are to be facilitated and implemented by considering the following:

- Access roads needed for construction of habitat are to remain in place and accessible for the monitoring period.
- Planting for access areas will include vegetation types so tree clearing is not required if repairs are necessary.
- Additional habitat enhancement materials such as habitat boulders, woody debris, root wads, and embedment materials are to be stockpiled close to the offsetting site so repairs can be made quickly.
- Additional spawning gravels are to be stockpiled close to habitat or within the wetted perimeter of channels to allow for hand placement and ease of distribution.
- All contingency measures are to be done within reduced risk windows and/or under Approval to minimize impacts to habitat.

VI.3.1 Construction Environmental Management Plan (CEMP)

Environmental protective measures and mitigation strategies will be implemented during Project works to minimize potential effects. The contractor will retain an AQP with environmental experience related to linear developments to develop a Construction Environmental Management Plan (CEMP). The Standard Specifications for Highway Construction - Protection of the Environment (SS 165; MoTI, 2020) requires that the CEMP include location-specific environmental procedures for activities such as works below the high-water mark and fish and wildlife salvages and demolition of existing structures. Under the CEMP, the contractor's responsibility includes clear demonstration of understanding for elements relating to protection of the environment. The CEMP is a living document, updated as conditions change, and will be available to the MoF and affected First Nations communities in advance of construction.

The CEMP will incorporate measures outlined in SS 165.02.03 and is to include:

- Air Quality and Dust Control Plan
- Archaeology Management Plan
- Clearing and Grubbing Plan

- Concrete Waste Management Plan
- Construction and Waste Management Plan
- Environmental Incident Reporting Plan
- Environmental Monitoring Plan
- Erosion and Sediment Control Plan
- Invasive Plant Management Plan
- Reclamation Plan
- Spill Contingency Plan

VI.3.2 Construction and Environmental Monitoring

Also described in SS 165, the Contractor's AQP will conduct environmental monitoring during environmentally sensitive works (e.g., instream work site isolations, culvert installations, riprap placement below the high-water mark). Monitoring frequency will correspond to the sensitivity of the location and the nature of the works occurring in each location and will comply with any permit or contract requirements, SS 165 requirements and the AQP's recommendations outlined in the CEMP. The AQP will provide the contractor and MoTI with routine environmental monitoring reports documenting construction activities, implemented mitigation measures, any environmental issues observed, and recommended corrective actions. The AQP will have written authority to modify and/or halt any construction activity if deemed necessary for the protection of fish and wildlife populations or their habitats.

VI.3.3 Fish and Fish Habitat Protection

Instream works will aim to adhere to the reduced risk instream works window for the respective fish species occurring along the alignment (***Table*** 39***39***). Given the variety of species, August 1 to September 15 (ENV, 2006) is the period with the reduced risk as it avoids the spawning and incubation periods of most fish species in the waterbodies impacted by the Project.

Table 39. Reduced risk timing windows for fish species that may be encountered in watercourses within the Project alignment (ENV 2006; Pearson 2015a, Pearson 2015b).

Species	Reduced Risk Window
Rainbow, Steelhead, Cutthroat	August 1 – October 31
Dolly Varden, Bull Trout	June 15 to August 31
Kokanee	June 1 to August 15
Pacific Salmon	July 15 to September 15
Salish Sucker, Nooksack Dace (spawning habitat)	August 15 to October 15
Salish Sucker, Nooksack Dace (critical habitat and potential/confirmed presence)	August 1 to October 15
Salish Sucker (overwintering habitat)	July 1 to October 15

All BMPs and mitigation measures prescribed within the provincial Change Approval, federal DFO Authorization, other regulators' permit conditions, and the accepted CEMP will be implemented by the Contractor. Works will be completed as quickly as possible once instream works have commenced, and will be completed, where possible, during favourable weather and low water conditions. Where works cannot be completed within the reduced risk instream works window, additional mitigation will be implemented by the Contractor, such as, but not limited to more intense monitoring. If works are to be completed outside of the reduced risk instream works window, discussions with the AQP are required to adequately prepare.

The Contractor will be required to follow their AQP's Environmental Procedure for instream works (included in the CEMP) to avoid changes to downstream water quality, and to avoid direct disturbance to fish and aquatic habitat: SS 165 requires the contractor to follow BMPs outlined in their procedures for stream isolation and channel diversions. Such work may include:

- Install exclusion measures to isolate fish and amphibians from the instream and riparian work areas.
- Isolate instream work areas without impeding flow to downstream portions of the watercourse at any time during construction. If required, divert flowing water around the worksite using appropriate equipment. If a pump is used, the intake of the pump used for withdrawing the water from the upstream end of the work area will be screened as outlined in the Interim Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO, 1995).
- Complete salvages following the salvage guidelines for the Salish sucker and Nooksack dace (Pearson 2015a, 2015b) and Standards and Best Practice for Instream Works (MOECCS, 2016). All works will be completed with valid fish collection permits from MoF and DFO, including a SARA permit. Fish salvages within Enns Brook and East Fishtrap Creek should be completed using a variety of passive methods before attempting more potentially harmful active methods (e.g., electrofishing) due to the presence of federally listed species.
- Follow proper handling procedures, equipment sterilization, and timing windows prior to the salvage and avoid riffle disturbance. Salvaged specimens will be relocated outside the isolated work area but within the same waterbody.
- Employ appropriate fish handling techniques to minimize the potential for damage or injury to fish, amphibians or invertebrates captured during salvage.
- Implement sediment containing measures (e.g., silt curtain) during excavation works.
- Implement best practices for pile driving (BC MPDCA, 2003).
- Minimize removal of vegetation, natural woody debris, rocks, or other materials from the banks and instream areas, and restore, replace, and enhance accordingly as per approved plan.

VI.3.3.1 Aquatic Species at Risk Management

Proposed works for the Fishtrap Creek Bridge occur in critical habitat for Salish sucker. Nooksack dace are also found upstream and downstream of the LAA and works must be managed appropriately to minimize impacts to species distribution and critical habitat. The current species distribution includes four culverts that cross Highway 1. These closed culverts limit light, and likely have depositional sediments and limited complexity for either species to use efficiently. As such, both aquatic species at risk will likely only use the culverts for movement across the highway.

The new channel and bridge will be built prior to removal of the culvert, to the west of the existing culvert alignment (i.e., within the footprint of the existing disturbance). This staged approach to construction will reduce impacts to fish species at risk and their habitat, as it avoids the need for diversion. As such, construction here is not limited by the reduced risk window for these sensitive species. Channel connection to Fishtrap Creek will take place within the reduced risk window and will be done so to ensure minimal sedimentation and disturbance. Best practice and salvage procedures will be conducted at the tie-in location and for decommissioning of the existing culverts following guidelines for Salish sucker and Nooksack dace (Pearson 2015a, 2015b).

Salish sucker BMPs for salvage include:

- Attempt to clear Salish sucker from the site prior to capture efforts.
    - Install a seine net at one end of the isolated stream segment then starting from the stop net and working outwards, sweep the channel with a beach or pole seine to clear the area of fish.
- Isolate the site from the watercourse by installing a second seine net no more than 100 m from the previously installed stop-net.
    - Water removed from the isolated area must be released in a manner that prevents sediment and erosion, with flow bypass creating continuous downstream flow and prevent release of sediment-laden water or deleterious substances.
- Capture the remaining Salish sucker within the area by setting one Feddes trap and one Gee trap every 10 m. If the water level is too low for Feddes traps, set one Gee trap per five metres of stream segment.
    - Conduct one overnight trapping set; or, if daytime dissolved oxygen is less than 2.5 mg/L, set traps for a minimum of six daylight hours on two consecutive days and repeat trapping until no Salish sucker are captured.
- Electrofish the reach if the isolated section can be waded and water temperature is at least 5°C and use dip nets to remove the species of interest.
    - Use the minimum effective voltage of straight DC current or gated bursts of current and continue electrofisher passes until no Salish sucker are captured in two consecutive passes.
- Handle any captured Salish sucker gently and follow recovery release procedure.
- Release captured individuals following recovery into the closest suitable habitat where they are unlikely to be re-captured. Salish sucker have small home ranges and it is best practice to release any captured within 200 m of the isolated site.

The Nooksace Dace is very difficult to capture. Gee traps and seining are preferred methods; however, electrofishing is often the most feasible. This species is also delicate and could perish with excess handling. It is recommended that an aquatic species at risk plan be written by an AQP with Nooksace dace salvage experience, to outline BMPs as referenced by *Guidelines for the Capture, Handling, Scientific Study, and Salvage of the Nooksack Dace* (Pearson 2015a).

VI.3.4 Erosion and Sediment Control

The AQP will develop an Erosion and Sediment Control (ESC) Plan as described in SS 165.04.01 prior to construction for inclusion within the CEMP. The ESC Plan will include details of the measures, both temporary and permanent, to minimize the potential for soil erosion within the Project area. An example of the methods used in an ESC plan may include:

- Minimize the amount of shrub and ground vegetation clearing in the work area to minimize exposed soil.
- Complete clearing and ground disturbance immediately prior to construction activities to decrease the duration of soil exposure.
- Install ESC measures (e.g., silt fencing and catch basin liners) prior to construction activities, including detour routes. Silt fence should be properly installed at the top-of-bank of any watercourses, ditches. Catch basins in the vicinity of construction works should be lined with approved catch basin liners. ESC measures should be routinely inspected and maintained throughout the construction period.
- Halt construction activities if sediment is observed to be moving into a waterbody.
- Locate any stockpiled soil or spoil material at least 30m from any watercourses, cover with an impermeable material (e.g., polyethylene sheeting), and install silt fencing as needed between the pile and waterbodies.
- Re-vegetate graded and disturbed soils with a suitable erosion control mix of seed emphasizing native species and apply mulch or other stabilizer on slopes to minimize erosion until vegetation establishes.
- Implement standard BMPs for ESC, spill prevention, and emergency response to prevent release of deleterious substances into the aquatic and terrestrial habitats.

VI.3.5 Concrete Works

Concrete pours in and around a stream require an Environmental Procedure in the CEMP. A variety of measures including the ones mentioned below may be used by a contractor:

- Isolate and contain cement pouring using an impermeable material (e.g., polyethylene sheeting).
- Cover recently poured concrete with the impermeable material until concrete is fully cured if rain is expected.
- Wash off tools, pumps, pipes, hoses, and trucks used for finishing, placing, or transporting fresh cement to prevent the wash water and excess concrete from entering adjacent watercourses. The wash water then should be contained and disposed of upland in an environmentally acceptable manner.
- Have access to a CO_2 tank and regulator, hose, and gas diffuser during cement pours and curing, and crews trained to use it.
- Monitor water in contact with concrete for acceptable pH levels (MoTI, 2020). If the pH levels are outside the allowable limits (6.5 – 8.0 pH units), it is recommended to contain and neutralize (introduction of CO_2) the contact water prior to release to the environment or removed and disposed of off site.

- Monitor pH in watercourses during all cement pouring. The AQP will likely collect and analyze water samples upstream of the construction area (control) and as close as possible to concrete works (impact). Implementation of emergency measures (introduction of CO_2) is recommended if pH levels are outside the allowable limits (6.5 - 8.0 pH units).

VI.3.6 Spill Control and Emergency Response

A comprehensive Spill Response Plan and Emergency Response Plan (SS 135) will be developed by the AQP prior to construction and included in the CEMP. The plan will specify the following measures to prevent introduction of deleterious substances into any watercourses:

- Except for excavation and ground improvements, prohibit all other equipment and machinery from operating below the high-water mark at any time.
- Inspect construction equipment and machinery daily to verify it is in good working order and free of leaks.
- Refuel and service equipment at least 30 m from any watercourse.
- Store all fuel and/or hazardous materials in trucks or containment areas that are at least 30 m from any watercourse.
- Keep emergency spill kits on site and train crews in their proper application.
- Keep emergency contact information on site with all Project personnel and government agency phone numbers to be contacted in the event of a spill.

VI.3.7 Vegetation and Invasive Plant Management

The Contractor's CEMP may include a vegetation and invasive species management plan to prevent, minimize, or manage potential effects on vegetation, specifically within the mature mixed forest, low-bench floodplain, riparian areas, and groves. Where construction activities and schedule allow, the following practices may be included.

General Vegetation Protection:

- Restrict clearing and grubbing to areas required to complete construction activities.
- Delineate the work area using a physical barrier (e.g., snow fencing) to limit clearing and grubbing to areas in the Project footprint and areas required to complete construction activities.
- Restrict fill placement to only those areas where this is required to complete construction activities.

Rare Plants:

- Conduct rare plant surveys in sensitive habitat (e.g., undisturbed wetlands and riparian areas) at the appropriate time of year, in advance of clearing and grubbing. If a rare plant species is encountered, develop a site-specific mitigation and / or salvage and translocation plan.

Invasive Species:

- Identify areas of invasive plants within the Project area, remove with root structures and dispose of off-site (incineration is preferred).
- Source seed mixes that are free of weeds or invasive species.

- In order to minimize the spread of invasive species during the advanced site preparation phase and restoration phase of the Project, guidance from the "Best Practices for Managing Invasive Plants on Roadsides" (MoTI, 2019a) will be incorporated in the CEMP and implemented by the contractor.

VI.3.8 Wildlife and Wildlife Habitat Protection

Under SS 165, Contractors are obligated to adhere to all provincial and federal legislation and regulations protecting wildlife and habitat for wildlife. The CEMP implemented by the Contractor will aim to prevent, minimize or manage potential effects on wildlife within and adjacent to the construction footprint:

- Avoid disturbing wildlife (BC, 1996a). Construction work may need to be rescheduled if wildlife is using habitats scheduled for construction, or a permit under the *Wildlife Act* may need to be obtained to move or disturb the animals.
- Culvert replacements and installation should be timed to avoid amphibian migration periods or when individuals might be clustered around the inlet / outlet (e.g., breeding), and also avoid the overwintering period when amphibians and reptiles bury themselves in the soft substrate.
- Conduct a wildlife salvage consistent with the Environmental Procedures in the CEMP, focusing on locations identified in ***Appendix O: Figures 5A*** to ***5E*** (Craig, Vennesland, & Welstead, 2010).
    - Salvage for Oregon forestsnail in advance of construction at sites with documented presence (***Appendix O: Figures 5C*** to ***5E***) (SCCP, 2018).
  - Salvage amphibians and reptiles in wetted areas, riparian habitat and upland forests as habitat dictates (***Appendix O: Figures 4A*** to ***4E***) (MoF, 2016).
  - Salvage for northern red-legged frog in confirmed habitat (i.e., wetland in median in Segment 1) in advance of construction (***Appendix O: Figure 5B***) (MoF, 2016).
- Where species at risk critical habitat overlaps the Project footprint, prepare a site-specific species management plan based on extent, presence of species' biophysical attributes, and construction activities and/or methods.
- To minimize human-wildlife conflicts, ensure that the construction site and site facilities remain free of wildlife attractants.
- Schedule work consistent with the constraints around bird nesting windows (ECCC 2018).
- Identify any active raptor (e.g., eagle, red-tailed hawk) or other non-migratory bird (e.g., heron) nests prior to construction, and provide an appropriate disturbance buffer around the feature, as determined by a QEP, to protect the individuals using the nests from sensory disturbance. A site-specific nest management plan may be required depending on the recommendations of the QEP.
- Consider retention of large diameter (>60 cm), decaying trees whenever possible to retain suitable habitat for other cavity nesting birds such as western screech owls or woodpeckers.

VI.3.8.1 Timing Windows

Where present, construction will adhere to the reduced risk windows for the following species and/or species groups (***Table 40***).

Table 40. Reduced-risk timing windows for species or species groups.

Species or Species Group	Reduced Risk Timing Window	Comments
Passerines	August 18 – March 12	
Raptor (general)	September 16 – January 31	
Bald Eagle	September 1 – December 31	
Northern Red-legged Frog	October 1 – January 31	*Salamanders may have individuals present year-round in aquatic breeding sites
Painted Turtle	November 1 – February 28 (overwintering period)	Optimal time for ***riparian*** works; individuals present year-round in aquatic breeding sites
Oregon Forestsnail	None	Present year-round; but salvages should be conducted between late March and end of June when snails are most active. *snails hibernate during cold periods in the winter (November – mid-March) and aestivate during dry periods in the summer (July – August)

VI.3.8.2 Species at Risk Management

In order to prevent, minimize or manage potential effects on species at risk within and adjacent to the construction footprint, BMPs from the following documents will be incorporated into the CEMP and implemented by the contractor as a requirement of SS 165 and the Special Provisions:

- Best Management Practices Guidelines for Pacific Water Shrew in Urban and Rural Area (Craig, Vennesland, & Welstead, 2010)
- Best Management Practices for Amphibian and Reptile Salvages in British Columbia (MoF, 2016);
- Standard Operating Procedures: Hygiene Protocols for Amphibian Fieldwork (MOE, 2008)
- Inventory Methods for Pond-breeding Amphibians and Painted Turtle (Standards for Components of British Columbia's Biodiversity No. 37 Version 2.0 (RIC, 1998)
- Guidelines for Amphibian and Reptile Conservation During Road Building and Management Activities in British Columbia (ECCS, 2020)
- Oregon Forestsnail Best Management Practices Guidebook (SCCP, 2018)
- Section Five (Species and Habitats) in Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia (MOECCS, 2014)
- Guidelines for the Capture, Handling Scientific Study, and Salvage of the Salish Sucker (*Catostomus* sp.) (Pearson, 2015a)
- Guidelines for the Capture, Handling Scientific Study, and Salvage of the Nooksack Dace (*Rhinicthys cataractae)* (Pearson, 2015b)

VI.3.9 Water Management

During construction excavation, it is possible that zones of previously unidentified contamination will be intersected. Contaminated water management measures will be included as a component of the Waste Management Plan of the CEMP. The plan may specify the following measures to manage water from the work areas to prevent contaminated water from entering any watercourses in the Project area.

- Implement work area isolation and fisheries protection measures.
- Pump construction water (e.g., dewatering from excavations) to an onsite water containment and treatment system.
- Conduct water quality testing and analysis (by an AQP) to confirm that water treated and intended for discharge to watercourses is within provincial and federal water quality criteria for the protection of aquatic life.
- Ensure that water that has the potential to be deleterious to aquatic life is not discharged. Provide additional treatment to achieve water quality standards, or if water quality standards are not achievable through onsite treatment, offsite disposal at an approved facility licensed to accept this water may be required by the AQP.

VI.3.10 Waste Management

The following measures may be implemented by the Contractor to prevent, minimize, or manage potential effects to human health and the environment and are consistent with environmental regulatory requirements.

- Educate personnel on the management of their own waste (e.g., proper food storage and disposal).
- Have wildlife-proof waste disposal facilities (i.e., bear-proof garbage bins).
- Keep the work site clean and tidy.
- Strategically place porta potties in accessible locations close to work areas set back from sensitive habitats.
- Recycle and reuse materials where possible.
- Locate and manage stockpiles in accordance with the Surface Water Quality and ESC Plan.
- Undertake vegetation clearing on the Project in a manner that reduces waste generation and ensures proper management prior to subsequent beneficial use or disposal.

VI.3.11 Hazardous Materials Management

Several sections of the Standard Specifications for Highway Construction 165 [Protection of the Environment] apply directly to fuel storage, handling and transport, and hazardous waste disposal for concrete, petroleum, and pesticides. In accordance with these specifications, the CEMP will incorporate the following:

- Keep onsite storage of hazardous materials to the bare minimum by coordinating the arrival of hazardous materials to match an imminent onsite need.
- Dispose of all hazardous waste in accordance with the applicable regulations.
- Label all onsite hazardous materials, controlled hazardous products, and wastes properly as per WHMIS.
- Transport hazardous materials and wastes only by appropriately licensed transporters and transportation will be carried out in accordance with relevant regulations, in appropriate containers.
- Establish environmentally sound procedures for refueling, painting, staining, chemical application and/or transfer, and storage of hazardous materials including petroleum products.

VI.3.12 Dust and Emissions Control

SS 165 requires the CEMP to include an Air Quality and Dust Control Plan for the construction site to mitigate potential impacts on human health and biota. Some mitigative measures may include:

- Avoid idling unless indicated otherwise.
- Remove soil, or mud deposited on public roads.
- Suppress dust onsite with water trucks as and when required.

VI.3.13 Archaeological and Heritage Resources

The following measures will be incorporated into the CEMP as an Archaeology Management Plan and implemented by the Contractor to assist in the responsible management of heritage sites and resources:

- If suspected heritage objects or sites (either intact or disturbed) are encountered, stop work within 30 m of the find and secure the area.
- Do not undertake further work that could disturb the site, including the movement of soil and/or spoil.
- Immediately inform the MoTI site representative or Project contact of the discovery.
- The MoTI representative will contact the Archaeology Branch (MoF) and a professional archaeologist. They will advise on the next steps. A field visit to examine suspect soils or artifacts may be appropriate.

VI.3.14 Contaminated Sites

A Spill Response Plan will be incorporated into the CEMP and implemented by the contractor to assist in the handling/disposal procedures and/or remediation in the event contamination is encountered, or an accidental release or other accident occurs resulting in soil, groundwater, or surface water contamination. The plan may include:

- Identifying and managing known and suspected contaminated sites in compliance with applicable provincial and federal legislation and regulations.
- Ensuring coordination between this plan, the Health and Safety Plan, Emergency Response Plan, the Surface Water Quality and Sediment Control Plan.
- Developing and implementing a health and safety plan consistent with SS 135 Construction Site Safety.

Contaminated soil management measures will be developed by the AQP prior to construction and will be included as a component of the Waste Management Plan of the CEMP. The plan will specify measures to manage sediment from major watercourses, and soil either identified or caused during construction activities. The following measures will be implemented by the Contractor at minimum to prevent, minimize, or manage potential effects on sediments and soils:

- Stopping work immediately if unexpected soil contamination is encountered and consult the contaminated sites specialist(s) for direction.
- Implementing sediment and/or soil containing measures during excavation works.

- Appropriately disposing the excavated sediment and/or soil in accordance with the BC Environmental Management Act, its regulations (Contaminated Sites and Hazardous Waste regulations)

VI.3.15 Noise Management

The CEMP will include a noise mitigation plan. Such a plan may include:

- Post signage to inform the public of periods of noisy activity.
- Ensure machinery is in good condition prior to construction and that contractors do not excessively use noisy equipment. Carry out regular maintenance on all equipment, including lubrication and replacement of worn parts, especially exhaust systems.

VI.3.16 Pile Driving Plan

Pile driving monitoring requirements may be specified in regulatory permit conditions. The applicability of such specifications, which may include hydro acoustic monitoring, will be evaluated by the project AQP on a site-by-site basis. Pile driving will follow SS 165.07.04 and BMPs for safe pile driving. Measures are likely to include:

- Ensure equipment is maintained, in good working order, and is clean and free of excess grease.
- Store fuels and petroleum products in proper containment with safe operating procedures (SS 165.13).
- Keep emergency spill kits onsite and accessible.
- Recover pile cut-offs, waste and other unused materials for safe disposal or offsite storage.
- Position water-borne equipment in a manner to reduce risk of harm or disturbance to fish and fish habitat.
- Isolate the work site using Environmental Procedures identified in the CEMP.

VI.3.17 Restoration of Temporary Impacts

Areas of temporary impact (***Appendix A: Figure 2***) will be reinstated in the same location, and restoration plans will be forthcoming for each of these areas. Elements to be included in restoration plans are further detailed in ***Section VI.4.5***. Temporary impacts rehabilitation will seek to return the area to original pre-disturbed condition or better.

The following measures will be incorporated into the CEMP and implemented by the contractor to improve the success of temporary impact restoration:

- Avoid compaction of topsoil especially where replaced over root networks.
- Restore full extent of riparian and aquatic disturbance footprint to similar or enhanced habitat condition with adequate vegetative cover to prevent erosion, in accordance with the contract.
- Stabilize disturbed banks using coconut fibre matting, erosion control blanket, hydro-seed, or other stabilization methods.
- Re-vegetate cleared riparian areas, consistent with the contract.
- Follow the Invasive Plant Management Plan in the CEMP.
- Follow the ESC Plan in the CEMP. See ***Part VI.3.4*** for further detail.

- Removal of instream materials shall only be completed for flood relief or as necessary for stream habitat function.
- Remove all temporary ESC BMPs once no longer necessary, and any excess non-biodegradable materials are to be disposed of at an appropriate location.
- Post-construction monitoring is to be undertaken by the Ministry to assess vegetation establishment and site stability. See ***Part VI.4.7.1*** for further detail.

VI.4 OFFSETTING PLAN

Project works will result in permanent residual impacts to the environment (***Part VI.5***). A residual effect is an effect that remains when mitigation measures cannot be applied or cannot fully address a stressor. Such impacts are to be mitigated through habitat enhancement and offsetting to achieve a net balance in habitat loss versus gains. Where onsite habitat compensation could not be located due to spatial constraints, offsite offsetting was proposed. Restoration Plans have been drafted to offset areas of permanent impact, both onsite within the Project footprint and in offsite locations (***Appendices I*** and ***J***). These will be further refined with additional detail and input from First Nations and other stakeholders during the final stages of design, prior to construction. These habitat compensation locations have been selected and designed based upon property availability, proximity to the Project watersheds, topographic integration with the streams, effectiveness of habitat enhancement, contribution to the required habitat balance and future maintenance and monitoring considerations. In the event of significant change, redesign of offsetting areas may be required. Should the previously identified sites for onsite or offsite offset areas prove to be unfeasible, alternative sites outside of the highway corridor have been previously identified by MoTI and may be relied upon to offset the impacts from the project.

VI.4.1 Geographic Locations

The offset locations are:

- Salmon River – three ponds and one riparian enhancement area – as documented in Site 19 of the Application Sites ***Appendix B***.
- Bradner North – ponded instream area and one new backwatered tributary – as documented in Site 10 of the Applications Sites ***Appendix B***.
- Nathan Creek East – ponded instream area and one class B/C pond and nutrient stream – as documented in Site 11 of the Applications Site ***Appendix B***.
- 264th Interchange onsite – four ponds in the northwest and one pond in the southeast.
- Culvert 7/8 easterly wetland extension within the northerly freeway ditch area.
- Culvert 14/15 easterly ditch enhancement along the south side of the freeway contiguous with Watson Road.

VI.4.2 Methods for Offset Construction

The proposed offsets mostly involve creation of a new aquatic area or pond, surrounded by a new planted riparian zone. We intend to excavate these ponds in isolation from existing streams and provide the necessary culverts, bank protections and backwatering riffles or weirs. Once largely completed the new aquatic areas would be connected to the existing stream, typically during a reduced risk window.

There are two types of offset configurations:

- ***Side Ponds*** are built outside of the stream, largely finished and then opened or connected to the stream in a controlled manner and during a reduced risk window. In this way, most of the work on the new habitat can be built with little risk of stream sedimentation and away from the active stream. The side pond approach has been applied for the offsets along the Salmon River.
- ***Instream Ponds*** involve weirs or boulder riffles within the stream to backwater the upstream area, creating more aquatic habitat. This is combined with stream complexing, spawning gravel beds and/or new or repaired replanted riparian zones. The instream approach has been applied for the offsets on Nathan Creek, near the Bradner Rest Area.

Similar to the culvert construction (***Part II.3.3***), offset construction will require heavy equipment operation adjacent to the streams. Where a pond is built off-line, disconnected from instream habitat, equipment can move about the pond, until such time as the pond is connected to the stream.

VI.4.2.1 Plans and Specifications

Technical drawings for the offset designs are located in ***Appendices I*** and ***J***, and individual offsetting sites are described in further detail in ***Part VI.5*** (onsite locations) and ***Part VI.7*** (offsite locations). Specifications will be the well-established MoTI Standard Specifications for Highway Construction, Volumes 1 and 2. Of particular relevance for offsets will be the following sections:

- 165 – Protection of the Environment
- 200 – Clearing and Grubbing
- 201 – Roadway and Drainage Excavation
- 215 – Bridges
- 303 – Culverts
- 407 – Foundation Excavation
- 751 – Topsoil and Landscape Grading
- 754 – Planting of Trees, Shrubs and Ground Covers
- 757 – Revegetation Seeding

The standard specifications will be augmented with Special Provisions prepared at the end of detailed design. There will be special provisions related to riparian planting, management of adverse effects and construction environmental management.

VI.4.3 Timeline of Implementation Plan

Offsetting will be implemented according to the Project schedule outlined in ***Part II.1***. We have planned the construction sequence to minimize the ecological lag between fishery impacts and their replacements or offsets:

- Primarily, our Class A and A(O) replacements are with offsite offsets (*Error! Reference source not found.**1***). This allows us to build the replacement habitat as early works and before those impacts occur, during the main construction contract. Class A/A(O) offsets represent a high percentage of the impacts. Being the most important fish habitat, Class A and A(O) waterbodies are intended to be replaced in advance.

Table 41. Replacement habitat to be completed in advance of highway construction.

	Stream (% by area)		Wetland (% by area)	
Class A and A(O) Impacts	Instream	Riparian	Instream	Riparian
	52%	60%	87%	70%

- Class B impacts are typically highway ditches that lead to A and A(O) streams. They represent the remainder of the fishery impact areas (*Error! Reference source not found.**2***).

Table 42. Replacement habitat to be completed concurrent with highway construction.

	Stream (% by area)		Wetland (% by area)	
Class B Impacts	Instream	Riparian	Instream	Riparian
	48%	40%	13%	30%

To minimize the ecological lag in the Class B replacement, several construction practices are proposed:

- Requiring the contractor(s) to maintain the integrity and stability of vegetated ditches and slopes for temporary drainages, by following practices outlined in the Project ESC plan.
- Requiring the contractor(s) to seed, plant, and maintain the final Class B vegetated ditches as soon as reasonable upon their construction.
- Applying the MoTI Standard Specifications and the contractor's CEMP to control siltation from those Class B or temporary ditches to the Class A and A(O) streams and wetlands.

Therefore, we expect a substantial proportion of those Class B ditches to be relatively functional early in the main highway construction contract.

- To further mitigate the unavoidable short period lag in the Class B streams we have achieved a surplus in our Class A and A(O) offsets. This surplus is to be built in advance as Class A and A(O) habitat and is more valuable to fish than the Class B habitat.

VI.4.4 Habitat Design

Site restoration plans will detail the habitat goals, any special application required to restore the site, and timing of works.

Instream design will include habitat elements appropriate to the priority fish species for that stream and may include creating riffle pool habitat to benefit various life stages of fish. Stream re-instatement design includes:

- Cross-section.
- Depth.
- Bed material.
- Large woody debris and/or boulder placement.
- Armouring to protect from scour.

Riparian habitat rehabilitation will consist of revegetation of constructed riparian areas with a mix of native tree and shrub species appropriate to site ecology. Riparian area design and management will include:

- Planting instructions (species, sizes, planting method, density, timing, and location).
- Placement of coarse woody debris and any other specific habitat features.
- Any additional stability measures and/or hydroseeding.
- Removal and management of invasive species.
- Infill of interstitial spaces within placed riprap with the appropriate substrate.
- Remove construction equipment, supplies and waste from the footprint upon completion of works.

Salish sucker and Nooksack dace recovery strategies describe key mitigations for managing effects, which will be incorporated into species-specific restoration efforts for Fishtrap Creek. Riparian habitats are to include abundant vegetation contiguous and wide enough to reduce sedimentation, prevent bank erosion and provide temperature buffering to the watercourse, large and small woody debris. Riparian area width will vary from 5 to 30 m, depending on the watercourse, based on application of RAPR methodology.

Salish sucker critical aquatic habitat features include (DFO, 2016):

- ***Deep pool habitat***: moderately deep ponds and marshes with mud or silty substrates. Preferred reaches include one or more deep pool >70 cm deep and at least 50 m long.
- ***Riffle habitat***: gravel or cobble riffle habitat interspersed with deep pool habitat provides suitable locations for spawning and incubation.
- ***Shallow pool and glide habitats***: shallow ponds <40 cm deep within reaches, with >50 m of continuous deep pools provide nursery habitat.
- ***Riparian habitats***: abundant vegetation that is both continuous and wide (>5 m) reduces sedimentation, helps store nutrients and buffers stream temperatures.

Nooksack dace critical aquatic habitat features include (DFO, 2020):

- ***Stream reaches***: include one or more deep pools >30 cm deep.
- ***Riffle habitat***: loose cobble, gravel, or boulder substrate and water velocity exceeding 25 cm/s.
- ***Shallow pool and glide habitats***: adjacent to riffle habitat, sand, mud or leaf litter substrates for emergency fry and gravel or cobble substrate for first summer young, <10 cm deep within reaches.

VI.4.5 Adverse Effects from Offsetting Implementation and Measures to Avoid

We have identified the potential adverse effects due to implementing the offsets and describe possible ways to avoid them (***Table 43)***.

Table 43. Adverse effects from offsetting implementation and measures to avoid.

Offset Component	Adverse Effect	Measures to Avoid
Connecting channel	Siltation or infilling	• Design connection to streams to locations at the sides of reaches or bends that are not creating • Provide maintenance access should repairs with equipment be needed • Conduct instream works, such as tie-ins to existing streams, during the reduced risk window
Aquatic banks	Sloughing or erosion	• Create gentler side slopes that are vegetated, where feasible • Develop geotechnical design criteria during detailed design • Use hydraulic modelling to determine expected velocities, surfacing, aggregate sizing or planting to resist erosion • Maintain planted vegetation and ground covers through monitoring period
Riparian zone	Return of invasive species	• Monitor riparian areas regularly • Manage invasive species using physical, biological or chemical treatments • Mound replacement plantings to provide competitive advantage against tall reed canary grass
Riparian zone	Mortality of plantings	• Select plantings to suit location • Outline planting specifications to ensure success • Water plantings during the initial periods
Riparian zone	Damage to plantings from beavers or other wildlife	• Apply protective mesh • Plant graze-tolerant or non-preferred plant species • Monitor plantings during the monitoring period and apply treatment as necessary
Ponds	No fish utilization	• Conduct inventory work at proposed offset sites • Confirm life cycle habitat needs • Add habitat complexing
Ponds	Lack of dissolved oxygen	• Design wetlands in locations and/or with sufficient grading to allow for low velocity flow, to promote water circulation.
Ponds	Temperature increase	• Plant riparian vegetation to enhance shade
Ponds	Siltation or infilling	• Install sediment traps if needed during monitoring period • Create gentler side slopes that are vegetated
Ponds or channels in Class A(O)	Trapping of fish	• Design self-draining ponds and weirs on A(O) streams • Conduct monitoring and intervention during the monitoring period • Shape aquatic inverts to drain toward a central channel and then downstream

Offset Component	Adverse Effect	Measures to Avoid
Weirs or Riffles	Damage due to storms	• Provide maintenance access should repairs with equipment be needed • Size boulders to resists expected flows • Install engineered foundations below scour depth • Install vee-shaped armouring to keep channel central
Streams (General)	Scour or undermining	• Provide maintenance access should repairs with equipment be needed • Armour where warranted • Design for Q_{200} plus climate change
Streams and Culverts	Minimum water depth	• Conduct hydraulic modelling • Install bottom baffles in steeper culverts • Consolidate water sources • Create backwatering where feasible • Install weirs and riffles
Culverts	Flow velocity and fish passage	• Flatten culvert grade • Install baffles • Include embedment • Create backwatering where feasible
Culverts	Blockage and debris	• Provide maintenance access should repairs with equipment be needed • Install oversized culverts with headroom • Install grizzlies or inlet grills if debris is expected or found to be a problem
Culverts	Loss of embedment substrate	• Install subgrade armouring at inlets and outlets • Install hidden lower baffles within the substrate to retain aggregates during high flows • Install minimum sizing of substrate aggregate

VI.4.6 Offsetting Equivalency Ratios

We have applied the following offsetting equivalency ratios:

- Offsite offsets, to be built before the main construction contract as early works:
  - Based on habitat characteristics, these were assigned a 1:1 or 1.3:1 ratio. The latter is based on sites which are grass or blackberry-dominated, which will be rehabilitated with both trees and shrubs.
- Onsite offsets, to be built concurrent with the main construction contract:
  - Based on habitat characteristics, these were assigned a 0.5:1, or 1:1 ratio. The latter is based on sites which will be rehabilitated with both trees and shrubs, and the former just shrubs, based on existing riparian condition.

- Temporary construction impacts, to be reinstated with similar conditions – 1:1.

The calculations of habitat balance are summarized in ***Part VI.6*** and are detailed in ***Appendix M***.

VI.4.7 Monitoring Measures

The impacts outlined in ***Part V.3*** require habitat offsetting to compensate for the loss of habitat resulting from Project works. Habitat offsetting is a requirement of the MoF, under Section 11 of the *Water Sustainability Act*. Offsetting for permanent Project impacts consists of creating similar habitat at or near the Project. Based on the known environmental considerations likely to interact with Project components, we propose the following environmental management plan. Habitat offsetting, long-term post-construction monitoring, and adaptive management are common to MoTI infrastructure projects, and the habitat enhancement measures outlined represent a full commitment to offsetting Project impacts. Planned onsite and offsite habitat restoration works are outlined in ***Part VI.5*** and detailed offsetting plans are provided as ***Appendices I*** and ***J***.

VI.4.7.1 Post-Construction Environmental Monitoring

Offsetting monitoring is to be conducted to evaluate the effectiveness of constructed habitats. Post-construction effectiveness monitoring of offsetting will be conducted following installation of onsite mitigation and offsite compensation areas, and timing of monitoring will be based on the habitat goals for the site. The applied monitoring requirements for these offset habitats will include bi-annual surveys over a 5-year post-construction monitoring period to evaluate habitat conditions. An AQP will complete monitoring and will seek to confirm that habitat measures are stable and functioning as intended in years 1, 2, 3, and 5, including documentation of:

- Fish sampling results in all Class A / A(O) streams, upstream of newly installed culverts or within constructed compensation habitats, to confirm fish presence
  - Site visits under low and high flow conditions to confirm habitat stability and function.
  - Measures for determining performance of the offsets include:
  - ***Class A/A(O) aquatic ponds*** –usable by fish when present, primarily for overwintering.
  - ***Class A/A(O) connecting channels*** – usable by fish when present for passage and connecting offsetting ponds to the existing streams.
  - ***Class A/A(O) riparian zones*** – stable banks and vegetation for food, nutrients and shade.
  - ***Class B ditches/streams*** – connectivity with Class A/A(O) streams.
  - ***Class B riparian zones*** – stable slopes and vegetation for food and nutrients.
- Planted stock condition, survivorship, and any other impediments to growth of stock, such as predation. Monitoring is to include:
  - Documentation at the end of the growing season.
  - Survivorship of 80% annually at each site, based on a site stocking goal of 1 plant (tree / shrub) per m^2.
- Presence and extent of invasive species.
- Physical stability of aquatic and terrestrial habitat elements.

- Water quality.
- Size of the habitats (to ensure compliance with the compensation area required).

Annual monitoring summary reports are to be prepared for each monitoring year. These will summarize the results of the above field documentation, to assess effectiveness of the mitigation and compensation sites. Reporting will include management recommendations as needed, to meet site habitat targets. If plantings do not meet the 80% annual survivorship requirement or are not likely to meet the final survivorship target at the 5-year mark, additional planting may be required at the site. Invasive species are recommended to receive monthly treatment for the first growing season, across the entire site, followed by treatments three times during the growing season for subsequent years, to ensure successful establishment of planted stock.

VI.5 ONSITE RESTORATION AND OFFSETTING

Onsite restoration and offsetting are proposed at the following locations:

- Salmon River Watershed: Site C-4/5 East
- West Creek Watershed: West Creek Drainage, Class B Ditch Reconstruction
- Nathan Creek Watershed: Nathan Creek Drainage, Class B Ditch Reconstruction
- Fishtrap Creek Watershed: Fishtrap Creek Open Channel Bridges, Fishtrap Creek Drainage

Detailed descriptions are provided below for onsite offset locations within each watershed, and design drawings are provided in ***Appendix J***.

VI.5.1 Salmon River Watershed

VI.5.1.1 Site C-4/5 East

This proposed Class B wetland will connect with a Coghlan Creek tributary to the northwest and the interchange stormwater system. Its principal ecological functions will include baseflow recharge for Coghlan Creek tributary, enhanced food and nutrient sources, treatment of road runoff, and improved wildlife habitat. This will primarily be a standing water wetland of emergent vegetation for treatment and upland planted riparian habitat comprising various tree species and understory shrubs. The proposed wetland will be approximately 2,025 m^2 in area with a surrounding riparian area of 2,204 m^2.

VI.5.2 West Creek Watershed

VI.5.2.1 West Creek Drainage – East of 264 Street Interchange

Offsetting will include an extension of the existing wetland along the north side of the highway, adding 742 m^2 of Class A(O) wetland. It would provide recharge for West Creek and off-channel seasonal rearing habitat. The design would match the existing wetland treatment as part of road widening works, with likely some scour protection, instream complexing of woody debris, boulder clusters, and vegetation. The riparian area (2,370 m^2) would fringe the roadside with typical native tree and shrub species.

VI.5.2.2 Reconstruction of ditches

Ditch reconstruction for Class B watercourses in the West Creek Watershed will account for gains of 834 m^2 of aquatic habitat and 3,184 m^2 of riparian habitat*Error! Reference source not found.*.

VI.5.3 Nathan Creek Watershed

VI.5.3.1 Nathan Creek Drainage (North of Watson Road on the south side of Highway 1)

This narrow 773 m roadside channel will collect road runoff and convey flow across the highway north, making it Class B, as it would provide food and nutrients downstream. This would be planted with emergent vegetation and willow (*Salix* spp.). Total area would be 1,546 m^2 instream with 7,280 m^2 of riparian area.

VI.5.3.2 Reconstruction of Ditches

Ditch reconstruction of Class B watercourses within the Nathan Creek watershed will result in gains of 1,200 m^2 of aquatic habitat and 6,318 m^2 of riparian habitat.

VI.5.4 Fishtrap Creek Watershed

VI.5.4.1 Fishtrap North and South (Open Channel – Bridges)

The enhancement proposed for the Fishtrap Creek watershed includes replacement of two highway-spanning, closed-bottom circular culverts which convey flows of Enns Brook and Fishtrap Creek with two clear-span bridges. Accompanying improvement includes opening up the stream cross section below the new bridges thereby introducing a natural channel dynamic in this area. We anticipate that this new channel segment will provide new rearing and overwintering space for critical species including the Salish sucker and Nooksack dace.

Construction of the Fishtrap Creek Bridges will be conducted completely independent of the existing watercourses, therefore avoiding impacts on fish or their habitat. This approach allows for the tie-in to the existing habitat to occur within the reduced risk window for the SAR, also limiting impacts. The tie-in will need to be staged to minimize turbidity and flows; these are considered temporary and water quality conditions will return to normal quickly. This phased approach will limit impacts to fish populations should they be present.

The new bridge structure provides a much wider, more complexed and deeper channel (minimum 70 cm depth in low flow conditions), with more light for plant growth and insect development. Structurally the channel under the bridge will be riprap lined, but the instream portion will be filled with a mixture of cobble, gravel and sands to provide a foraging substrate. The upper riprap portions will also be infilled with an “ecoblanket” type of fill for planting. This should provide consistent form and function of the new channel as outlined in the federal recovery strategies.

VI.5.4.2 Fishtrap Creek Drainage (Median east and west of Fishtrap Creek Bridge)

Ditch reconstruction for Class B watercourses in the Fishtrap Creek watershed will account for gains of 4,813 m^2 of aquatic habitat and 10,100 m^2 of riparian habitat.

VI.6 RESIDUAL IMPACTS

Where there is an environmental deficit following mitigations and implementation of onsite offsets, residual impacts will be compensated through offsite offsetting to neutralize losses. The combined amounts of recreated habitats throughout the alignment will yield in overall net gains of fish habitat across all stream classes (***Table 44***; ***Figure 22*** and ***Figure 23***). A global perspective of habitat balance across the entire

Project is provided in a comprehensive table, found in ***Appendix M***. The habitat balance quantifies the instream and riparian gains and losses for the entire Project, divided by stream class and watershed. A contextual map which highlights Project impacts to existing habitat and proposed mitigations is provided in ***Appendix A: Figure 4***. Further detail with respect to any individual watercourse is provided in the ***Appendix E*** stream inventory.

Table 44. Net habitat balance across the Project alignment.

Habitat Class	Instream Area Net (m^2)	Riparian Area Net (m^2)
Total Class A:	**1,593**	**1**
Total Class A(O):	**-191**	**3,390**
Total Class B:	**1,193**	**11,505**

For a project of this size and scope, there is inherent complexity that may result in changes during further design and, ultimately, construction. Therefore, and while the design has been advanced to a stage where substantive changes are no longer anticipated, some flexibility may be required to allow for adaptations with respect to design, particularly during the construction stage.

The following sections describe habitat losses and gains, with offsetting sites included, on a watershed-by-watershed basis. Offsite offsetting locations are summarized in ***Part VI.7***. Design drawings for each of these described enhancements are provided in ***Appendix I.***

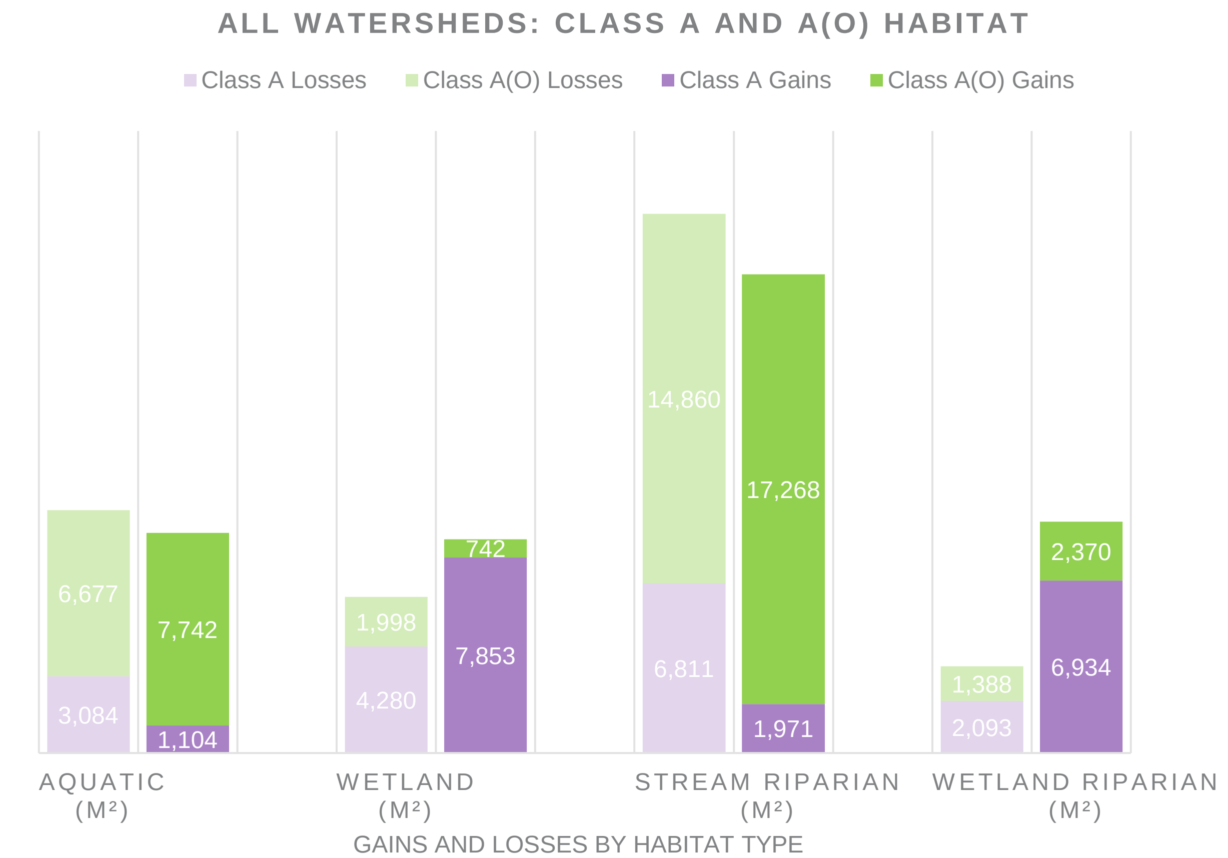


Figure 22. Impacts and offsets to instream, riparian and wetland habitats for all Class A and A(O) watercourses and wetlands within the Project area.

The habitat balance quantifies the instream and riparian gains and losses for the entire Project, after the proposed offsetting measures are undertaken, divided by stream class and watershed.

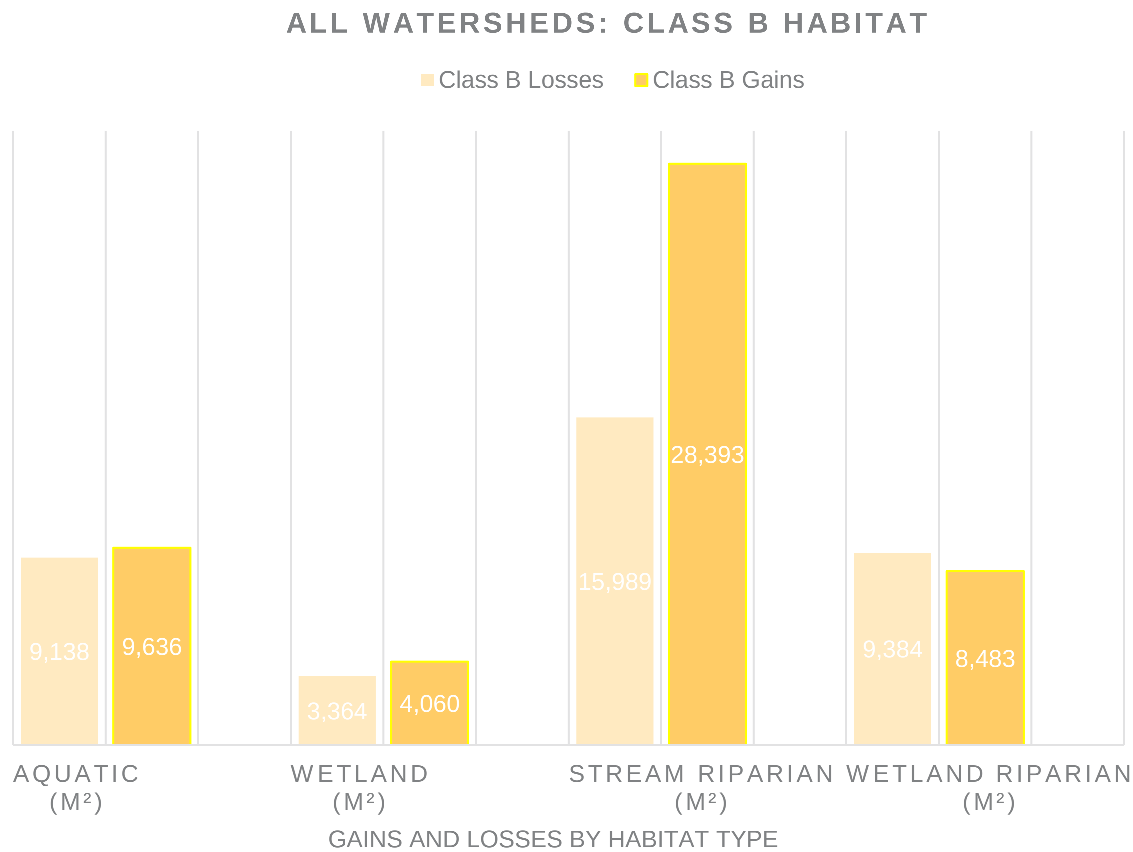


Figure 23. Impacts and offsets to instream, riparian and wetland habitats for all Class B watercourses and wetlands within the Project area.

VI.6.1 Salmon River Watershed

In summary of Salmon River watershed impacts, a quantitative net surplus of Class A instream area of 1,109 m^2 and net loss of -854 m^2 riparian will result (***Figure 24***; ***Table 45***). There is a quantitative net loss of Class A(O) instream habitat of -3,617 m^2 and -3,451m^2 riparian.

The Salmon River watershed contains all proposed offsets for all Class A habitat – these are described in greater detail in ***Part VI.6.1***. And while this watershed carries a surplus of Class A aquatic habitat, we identify that, due to several constraints, the offsets for the net Class A(O) losses must be provided for in the nearby Nathan Creek watershed. These offsets were carefully selected for their potential for high-value return with respect to fishery productivity – further details provided in the Nathan Creek watershed section (***Part VI.6.3***).

Table 45. Habitat balance for Class A, A(O) and B habitats in the Salmon River watershed.

Stream	Stream – Instream			Stream – Riparian			Wetland – Instream			Wetland – Riparian			AQUATIC Net (m²)	RIPARIAN Net (m²)
	Loss (m²)	Gain (m²)	Net (m²)	Loss (m²)	Gain (m²)	Net (m²)	Loss (m²)	Gain (m²)	Net (m²)	Loss (m²)	Gain (m²)	Net (m²)		
Salmon River														
Class A	2631	0	-2631	6324	0	-6324	4113	7853	3740	1464	6934	5470	*1109*	*-854*
Class AO	3617	0	-3617	3451	0	-3451	0	0	0	0	0	0	*-3617*	*-3451*
Class B	3477	1242	-2235	6551	5773	-778	567	3209	2642	438	5009	4571	*407*	*3793*

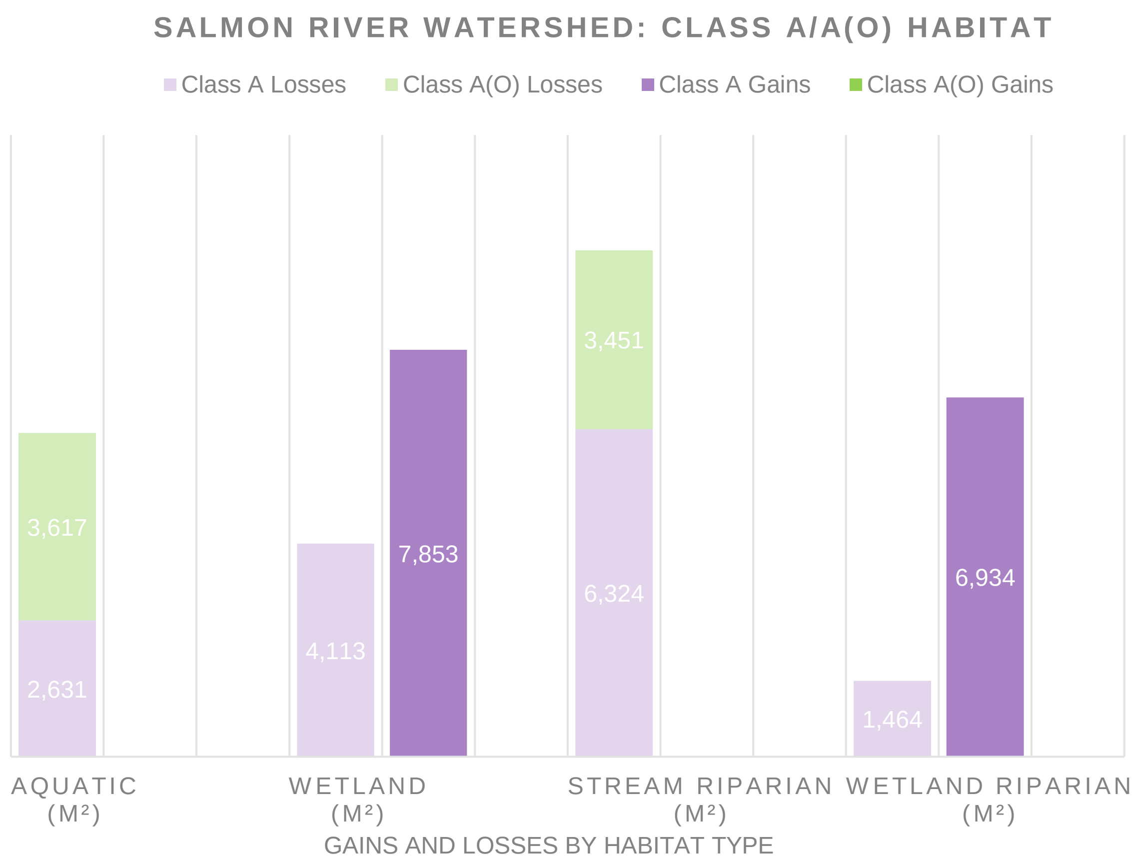


Figure 24. Impacts and offsets to instream, riparian and wetland habitats for Class A and A(O) watercourses and wetlands within the Salmon River Watershed.

Proposed offsetting measures will result in gains of 4,451 m² of aquatic habitat and 10,782 m² of riparian habitat for Class B watercourses and wetlands within the Salmon River Watershed (***Figure 25***).

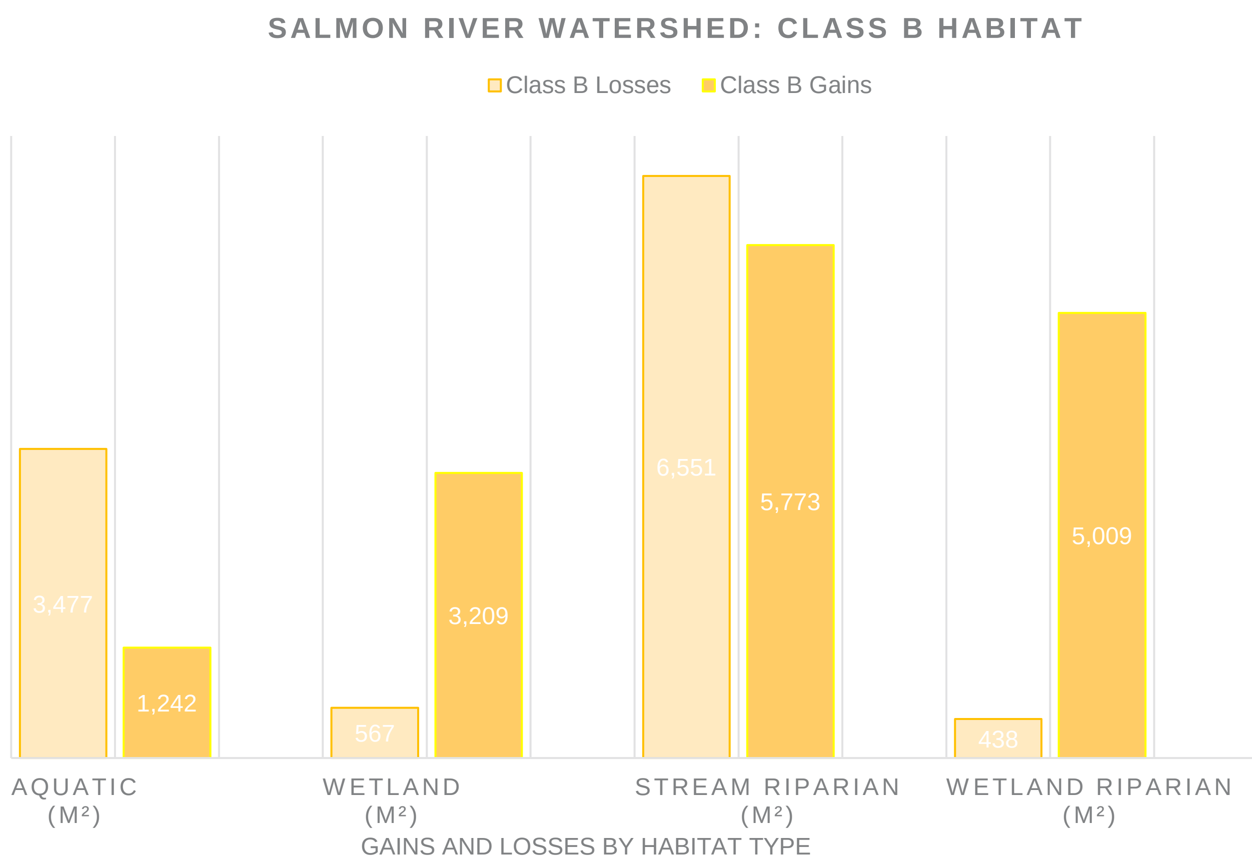


Figure 25. Impacts and offsets to instream, riparian and wetland habitats for Class B watercourses and wetlands within the Salmon River Watershed.

VI.6.2 West Creek Watershed

Total net values for impacts and proposed offsetting measures will result in a loss of 2,120 m^2 of aquatic habitat and 459 m^2 of riparian habitat in Class A and A(O) waterbodies and wetlands within the West Creek Watershed (***Figure 26***;***Table 46***).

In summary of West Creek watershed impacts, 23 m^2 of aquatic habitat and 52 m^2 of riparian habitat will be lost in Class A watercourses resulting from Highway 1 widening construction. No impacts to Class A wetland habitat will occur. Impacts to Class A(O) watercourses and wetlands will result in losses of 2,096 m^2 of aquatic habitat and 511 m^2 riparian habitat.

Due to several constraints, the offsets for the net Class A / A(O) losses must be provided for offsite in the nearby Nathan Creek watershed. These offsets were carefully selected for their potential for high-value return with respect to fishery productivity – further details provided in the Nathan Creek watershed section (***Part VI.6.3***).

Table 46. Habitat balance for Class A, A(O) and B habitats in the West Creek watershed.

Stream	Stream – Instream			Stream – Riparian			Wetland – Instream			Wetland – Riparian			AQUATIC Net (m^2)	RIPARIAN Net (m^2)
	Loss (m^2)	Gain (m^2)	Net (m^2)	Loss (m^2)	Gain (m^2)	Net (m^2)	Loss (m^2)	Gain (m^2)	Net (m^2)	Loss (m^2)	Gain (m^2)	Net (m^2)		
West Creek														
Class A	23	0	-23	52	0	-52	0	0	0	0	0	0	*-23*	*-52*
Class AO	840	0	-840	1081	610	-471	1998	742	-1256	1388	2370	982	*-2096*	*511*
Class B	1782	834	-947	1936	1871	-65	531	0	-531	2048	0	-2048	*-1478*	*-2113*

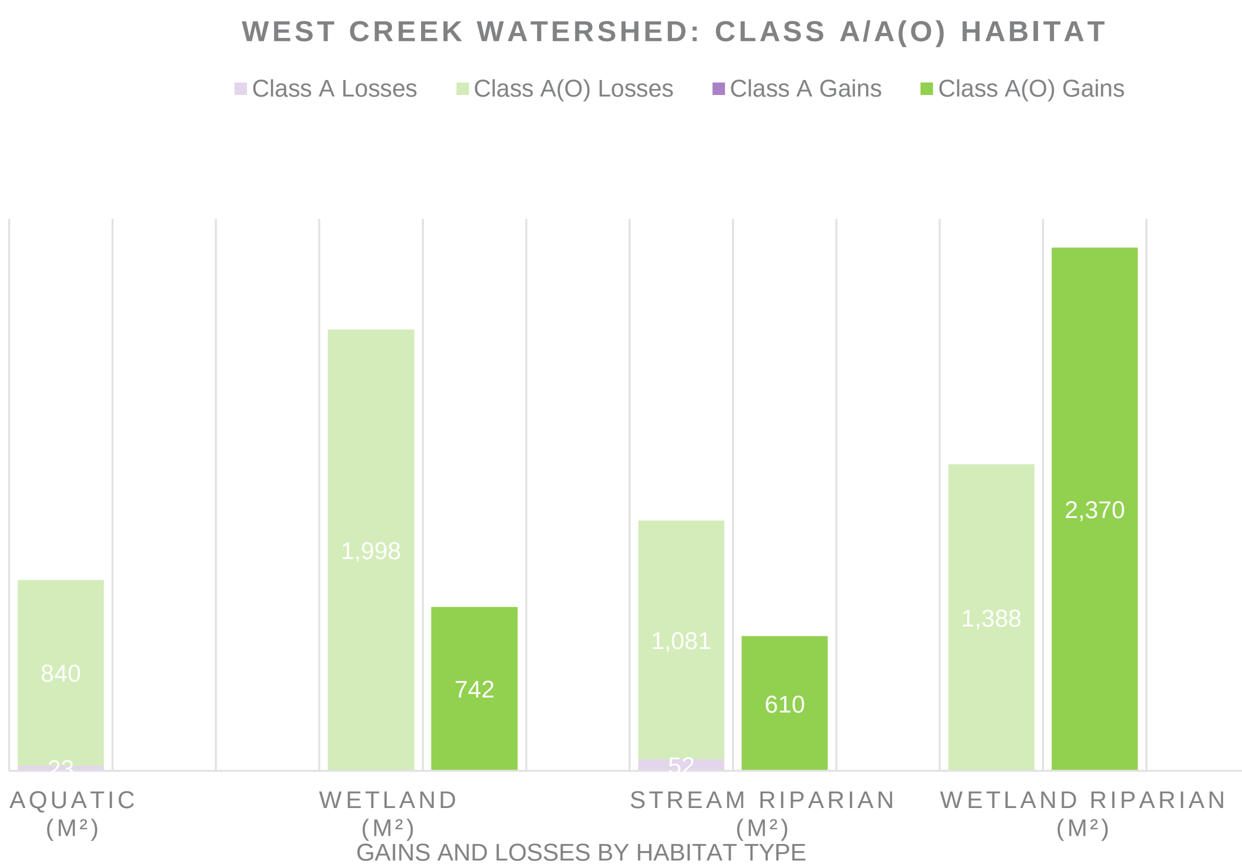


Figure 26. Impacts and offsets to instream, riparian, and wetland habitats for Class A and A(O) watercourses and wetlands within the West Creek watershed.

Total net values for impacts and proposed offsetting measures will result in a loss of -1,478 m^2 of aquatic habitat and -2,113 m^2 of riparian habitat in Class B waterbodies and Wetlands in the West Creek watershed (***Figure 27***).

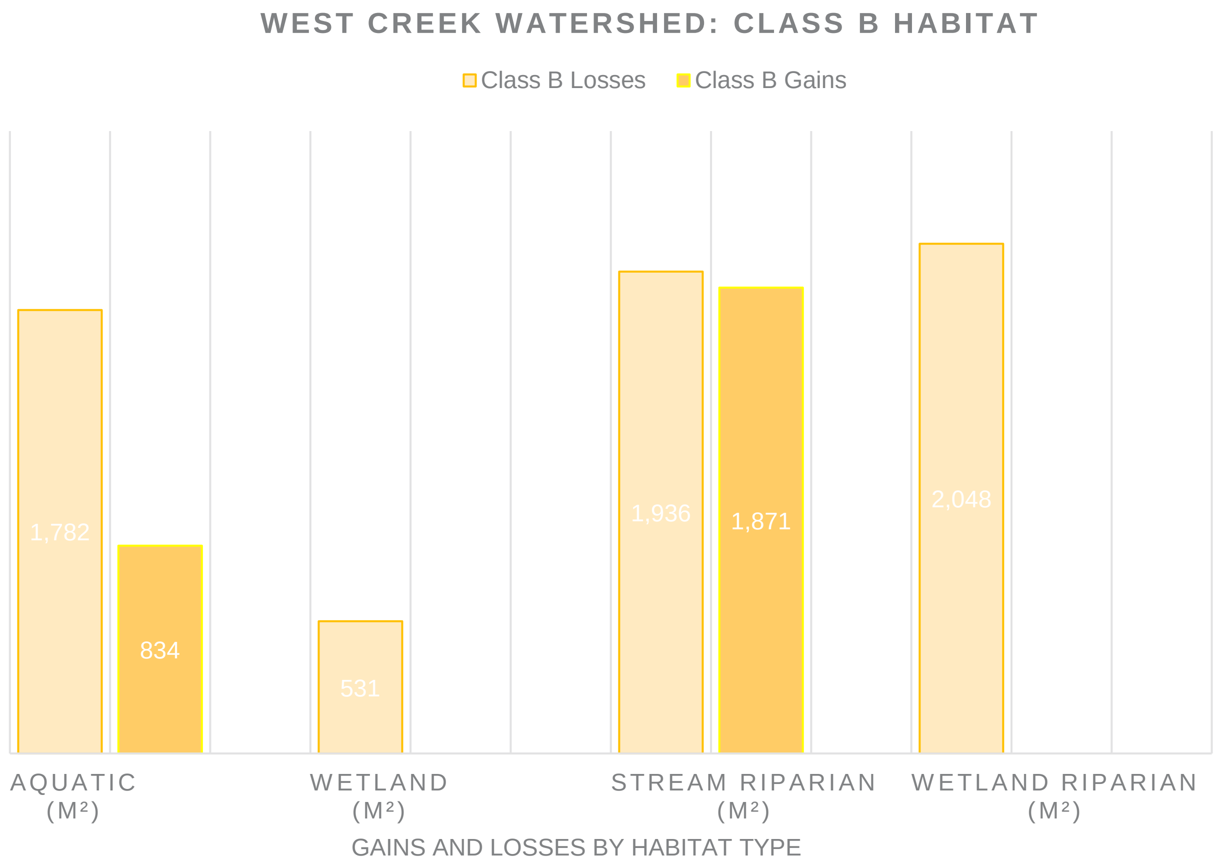


Figure 27. Impacts and offsets to instream, riparian and wetland habitats for Class B watercourses and wetlands within the West Creek watershed.

VI.6.3 Nathan Creek Watershed

In summary of Nathan Creek watershed impacts, a net loss of -167 m^2 of aquatic habitat and -629 m^2 of riparian habitat in Class A wetlands is anticipated. In Class A(O) waterbodies and wetlands, offsetting will result in a net gain of 5,683 m^2 of aquatic habitat and 6,453 m^2 of riparian habitat.

Total net values for impacts and proposed offsetting measures will result in a net gain of 5,516 m^2 of aquatic habitat and 5,824 m^2 of riparian habitat in Class A and A(O) waterbodies and wetlands within the Nathan Creek watershed (***Figure 28***; ***Table 47***).

Table 47. Habitat balance for Class A, A(O), and B habitats in the Nathan Creek watershed.

Stream	Stream – Instream			Stream – Riparian			Wetland – Instream			Wetland – Riparian			AQUATIC Net (m²)	RIPARIAN Net (m²)
	Loss (m²)	Gain (m²)	Net (m²)	Loss (m²)	Gain (m²)	Net (m²)	Loss (m²)	Gain (m²)	Net (m²)	Loss (m²)	Gain (m²)	Net (m²)		
Nathan Creek														
Class A	**0**	**0**	**0**	**0**	**0**	**0**	**167**	**0**	**-167**	**629**	**0**	**-629**	***-167***	***-629***
Class AO	**2059**	**7742**	**5683**	**10205**	**16658**	**6453**	**0**	**0**	**0**	**0**	**0**	**0**	***5683***	***6453***
Class B	**3203**	**2746**	**-457**	**5470**	**10649**	**5180**	**143**	**851**	**708**	**993**	**3474**	**2481**	***251***	***7661***

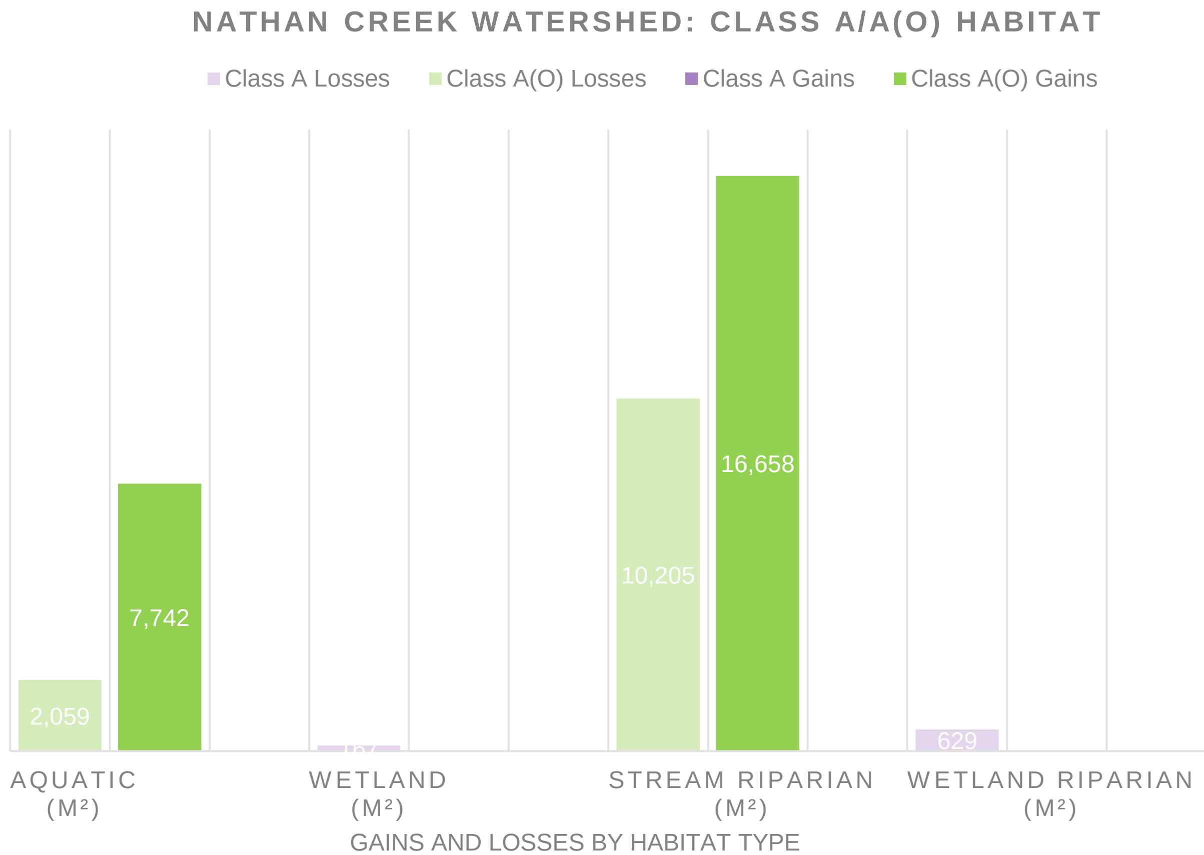


Figure 28. Impacts and offsets to instream, riparian and wetland habitats for Class A and A(O) watercourses and wetlands within the Nathan Creek watershed.

Proposed offsetting measures undertaken in Class B watercourse and wetland habitat will result in total gains of 2,746 m^2 of aquatic habitat and 10,649 m^2 of riparian area in the Nathan Creek watershed. Class B wetland habitat will be developed, accounting for gains of 851 m^2 of aquatic habitat and 3,474 m^2 of riparian habitat (***Figure 29***).

Total net impacts to Class B waterbodies within the Nathan Creek watershed include net gain of 251 m^2 of aquatic habitat and 7,661 m^2 of riparian habitat.

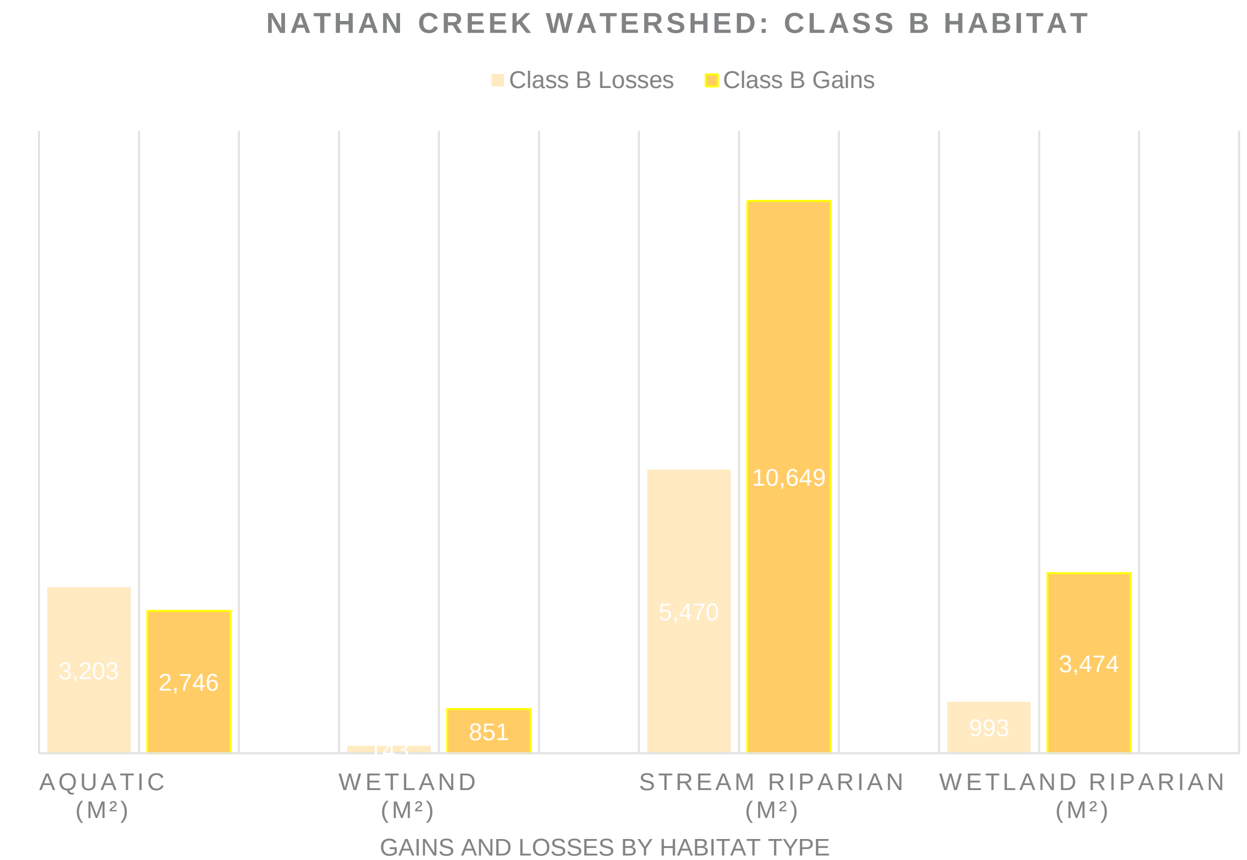


Figure 29. Impacts and offsets to instream, riparian and wetland habitats for Class B watercourses and wetlands within the Nathan Creek Watershed.

VI.6.4 Fishtrap Creek Watershed

In summary of Fishtrap Creek watershed impacts, a net gain of 674 m^2 of aquatic habitat and 1,536 m2 of riparian habitat between Class A and A(O) watercourses and wetlands is anticipated.

Overall, the Fishtrap Creek watershed will yield new open channel habitat when the existing culverts currently conveying flows across the highway will be replaced with clear-span bridges. This enhancement will daylight approximately 1,104 m^2 of open channel that will be directly tied-in to mapped critical habitat for the Salish sucker.

During construction, there will be a small temporary “change” to aquatic conditions where channel daylighting overlaps with mapped Salish sucker critical habitat as a result of the new Fishtrap Creek Bridge and channel tie-in on the north connection to Fishtrap Creek. This will be 20 m^2 of instream and 171 m^2 of riparian habitat. These temporary losses will be reinstated with the construction of the new bridge and open channel cross section. Distribution habitat, identified as having historic presence of Salish sucker, will also be impacted within and adjacent to the Project footprint. Permanent impacts to year-round distribution habitat (Class A) consist of 430 m^2 instream and 800 m^2 of riparian, and temporary impacts to Class A distribution habitat include 315 m^2 of instream and 1396 m^2 of riparian impact. Permanent impacts to seasonal Class A(O) distribution habitat include 166 m² instream and 120 m² of riparian, and temporary impacts to Class A(O) distribution habitat include 161 m² of instream and 245 m² of riparian impact.

Total net values for permanent impacts and proposed offsetting measures will result in gains of 1,104 m² of aquatic habitat and 1,971 m² of riparian habitat for Class A(O) watercourses and wetlands within the Fishtrap Creek Watershed (***Figure 30; Table 48***).

Table 48. Habitat balance for Class A, A(O) and B habitats in the Fishtrap Creek watershed.

Stream	Stream – Instream			Stream – Riparian			Wetland – Instream			Wetland – Riparian			AQUATIC Net (m²)	RIPARIAN Net (m²)
	Loss (m²)	Gain (m²)	Net (m²)	Loss (m²)	Gain (m²)	Net (m²)	Loss (m²)	Gain (m²)	Net (m²)	Loss (m²)	Gain (m²)	Net (m²)		
Fishtrap Creek														
Class A	430	1104	674	435	1971	1536	0	0	0	0	0	0	*674*	*1536*
Class AO	161	0	-161	123	0	-123	0	0	0	0	0	0	*-161*	*-123*
Class B	676	4813	4137	2032	10100	8069	2123	0	-2123	5905	0	-5905	*2014*	*2164*

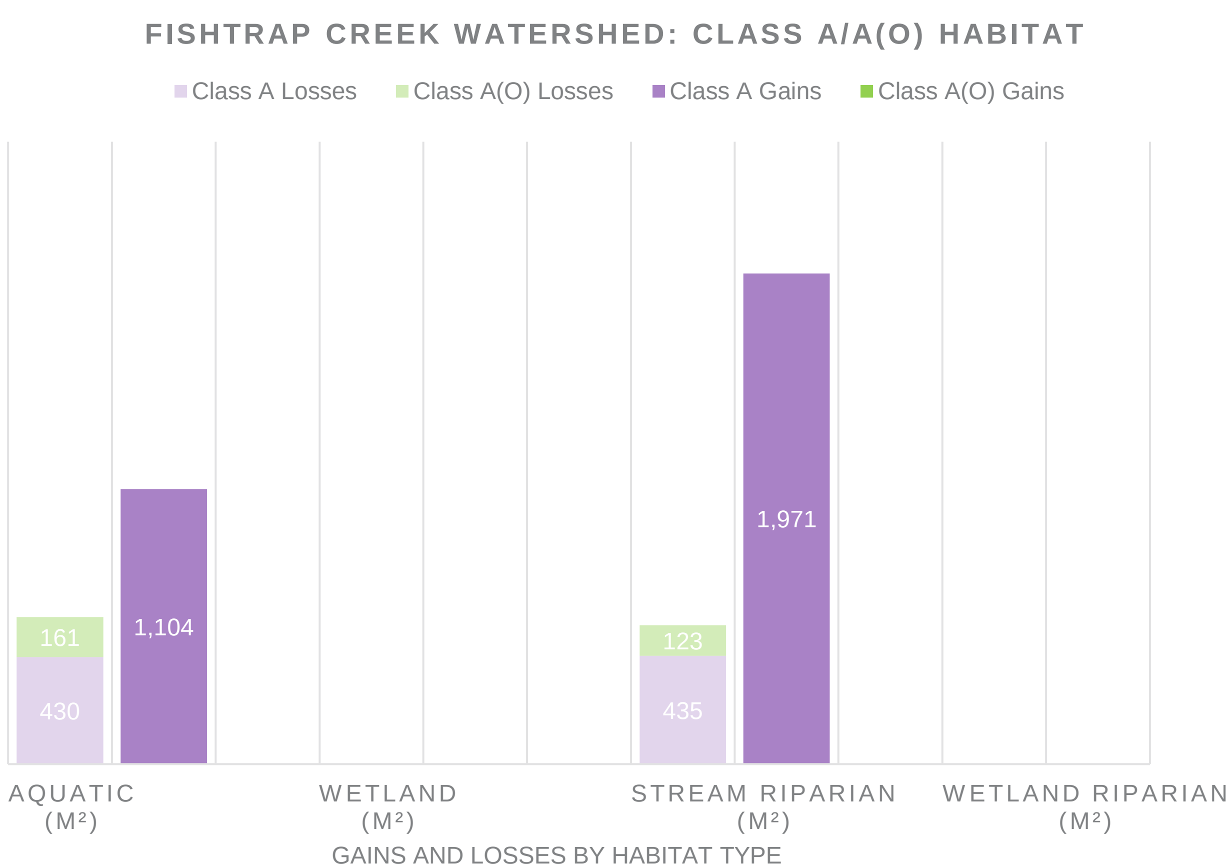


Figure 30. Impacts and offsets to instream, riparian and wetland habitats for Class A and A(O) watercourses and wetlands within the Fishtrap Creek watershed.

Total net impacts to Class B watercourses in the Fishtrap Creek watershed include the net gain of 2,014 m^2 of aquatic habitat and 2,164 m^2 of riparian habitat.

Proposed offsetting measures undertaken in Class B watercourse and wetland habitat will result in total gains of 4,813 m^2 of aquatic habitat and 10,100 m^2 of riparian area in the Fishtrap Creek Watershed through the creation of new open channels in the median (***Figure 31***).

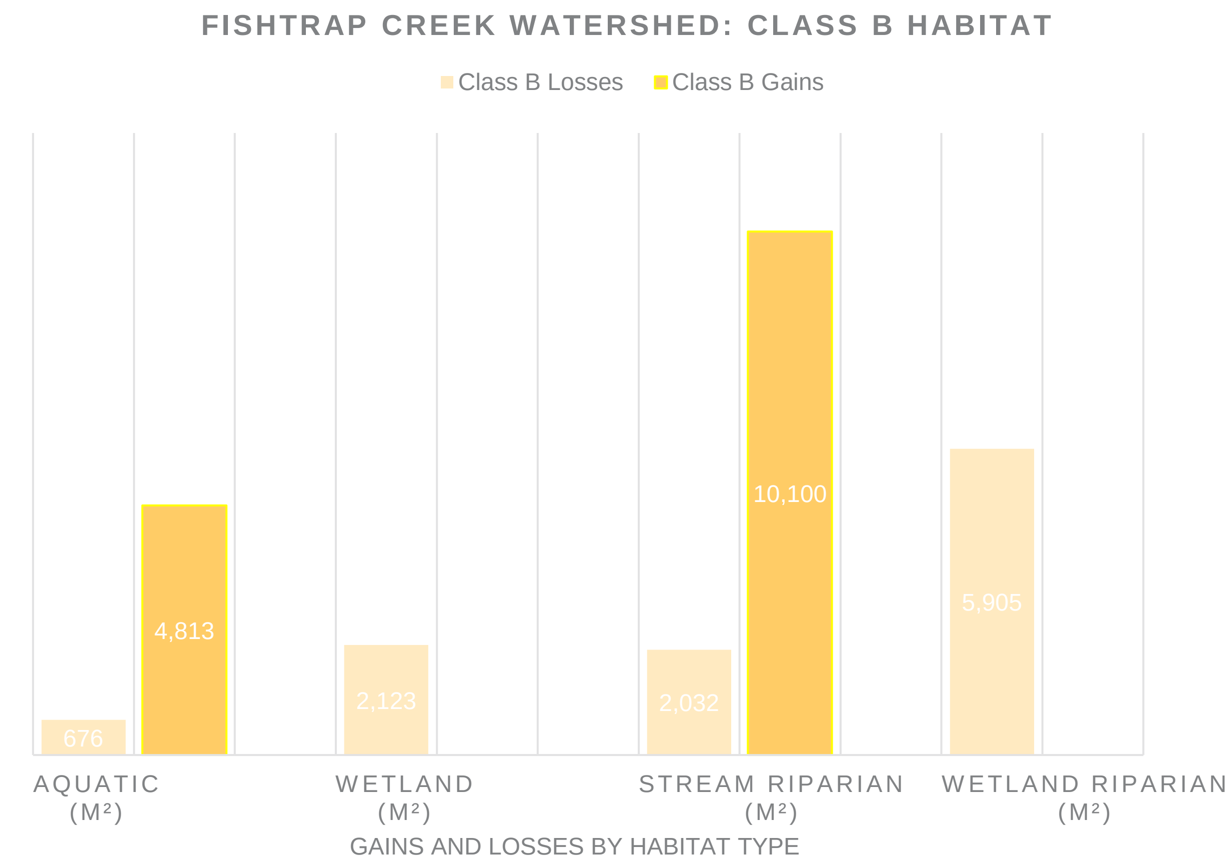


Figure 31. Impacts and offsets to instream, riparian and wetland habitats for Class B watercourses and wetlands within the Fishtrap Creek watershed.

VI.6.5 Wildlife

The primary effects on wildlife from this Project are associated with habitat loss and disturbance during construction. Adverse effects resulting from construction, including sensory disturbance and mortality, can be mitigated through the implementation of mitigation measures described in ***Part VI.3.8***, including adherence to reduced risk timing windows, pre-construction surveys, and salvages. Residual effects on wildlife associated with construction are not anticipated.

The Project comprises the expansion of an existing highway, and wildlife using habitat along this corridor are habituated to a high level of disturbance. Habitat lost as a result of the Project is an incremental loss in a highly developed corridor and is therefore unlikely to have population-level effects on wildlife in the LAA.

Culvert replacement has the potential to result in a residual effect on wildlife if passage is impeded. For instance, design for the highway widening involves the replacement of two shorter culverts (that previously connected the outside of the highway to the centre) with one long culvert. Habitat in the median will be lost, and the long culvert may deter wildlife passage; however, wildlife usage of the existing culverts has not been assessed to confirm the level of potential impact. Additionally, some of the existing culverts are undersized and are therefore subject to high flows, these are likely submerged at some times of the year. The new culverts have been designed for fish passage and will be embedded with baffles, which may facilitate aquatic wildlife passage at certain life stages. Further, upsizing of the culverts will result in more openness in the crossing, potentially increasing the willingness of wildlife to use them.

VI.6.6 Vegetation

The Project is anticipated to result in the permanent loss of approximately 110,414 m^2 of young forest habitat throughout the Project alignment, predominantly where it occurs as small stands less than 5 ha in size. This stand type likely represents a disturbed ecosystem and clearing is primarily associated with road widening, resulting in an incremental loss of this habitat type where it occurs. Overall, this loss of vegetation is not expected to result in a residual effect within the RAA. The loss of sensitive riparian vegetation is anticipated to be mitigated through onsite and offsite compensation and offsetting.

However, the clearing of approximately 27,300 m^2 of intact young mixed forest habitat, which is mapped as a sensitive ecosystem, for the Bradner Road Rest Area Expansion will likely result in a localized residual effect. The expanded rest area footprint has been designed to avoid sensitive habitats to the extent possible, including watercourses, wetlands and riparian areas, and drainage improvements (e.g., perimeter swale and bioswale) will be revegetated with native species, however, the loss of this contiguous forest habitat, within a highly disturbed corridor, cannot be fully mitigated onsite.

Cleared areas are vulnerable to rapid colonization by invasive plant species. Several priority invasive species are known to occur along the highway corridor, and there is a potential to spread these species of regional concern. The potential can be reduced by following best management practices for invasive species, as described in ***Part VI.3.7***.

VI.7 OFFSITE RESTORATION AND OFFSETTING

Where onsite restoration was not feasible due to limitations within the watershed, offset offsetting was proposed to compensate for residual impacts that resulted in a habitat deficit. The following locations have been selected for offsite offsetting:

- Salmon River Watershed: Salmon River North of Highway 1, Salmon River West of MacMillan Lake
- Nathan Creek Watershed: Nathan Creek Watercourse and Wetland Enhancements, Bradner Rest Area North, Nathan Creek East of Bradner Rest Area

Detailed descriptions of offsite offsets by watershed and watercourse classification are provided below. Design drawings are provided in ***Appendix I***.

VI.7.1 Salmon River Watershed

VI.7.1.1 Salmon River North of Highway 1

Offsetting measures in the form of additional Class A watercourse and wetland habitat will result in total gains of 6,068 m^2 of aquatic habitat and 5,668 m^2 of riparian area.

The proposed backwater channel and off-channel pools are located east of Glover Road, north of Trinity Western University and north of Highway 1. These off-channel pools will be constructed on Provincial crown lands adjacent to the Salmon River, with a backwater channel providing connectivity between the off-channel pools and the Salmon River.

On the eastern side of the Salmon River is a parcel with vegetation dominated by young, forested stand. Topography at this site is conducive to off-channel pools due to the flat nature of the ground adjacent to the river. The off-channel pools will provide quality rearing and overwintering habitat. The backwater channel will tie into the Salmon River, invert to invert. Therefore, the water levels within the Salmon River will control the water levels within the off-channel pools. The backwater channel is designed to slope towards the Salmon River, acting as a low flow channel within the pools. The bottoms of the proposed off-channel pools are sloped towards the backwater channel.

The Provincial Crown parcel on the western side of the Salmon River has an area of flat topography adjacent the river that is conducive to off-channel pools. The backwater channel ties into the Salmon River, invert to invert. The backwater channel will be sloped towards the Salmon River acting as a low flow channel within the pool. The bottom of the off-channel pool will be sloped towards the backwater channel. The off-channel pool replaces an isolated wetland that was located within the parcel.

These pools will provide substantively better habitat, in terms of quality, relative to the existing habitat being impacted within the Highway 1 median. The off-channel pools will be fully complexed with emergent vegetation, rock clusters, and varying sizes of woody debris.

VI.7.1.2 Salmon River West of McMillan Lake

Offsetting measures in Class A watercourse and wetland habitat will result in total gains of 748 m^2 of aquatic habitat and 826 m^2 of riparian area in the Salmon River watershed.

A backwater channel and off-channel pool are proposed within the Trinity Western University owned parcel, on the east side of the Salmon River and the west side of Glover Road. The topography is flat, conducive to backwater channeling and off-channel pools. The backwater channel will tie into the Salmon River, invert to invert. Therefore, the water levels within the Salmon River will control the water levels within the off-channel pools. A drainage channel from Glover Road will tie into the backwater channel. The bottom of the off-channel pool will be designed to slope towards the backwater channel at 0.5%. The length of the backwater channel is to be approximately 12 m. The area of the off-channel pools will be approximately 865 m^2. Armouring with vegetation will be used to prevent erosion of the Salmon River into the backwater pool during higher flow events.

VI.7.1.3 Coghlan Creek Drainage (West of Mobility Hub 264th Interchange)

The proposed Class B wetland will connect with a Coghlan Creek tributary to the northwest and the interchange stormwater system. Principle ecological services will include baseflow recharge for Coghlan Creek tributary, enhanced food and nutrient sources, treatment of road runoff and improved wildlife habitat. This will primarily be a standing water wetland comprised of emergent vegetation for treatment and upland planted riparian habitat comprising various tree species and understory shrubs. The wetland will be approximately 1,184 m^2 in area with a surrounding riparian area of 2,805 m^2.

VI.7.2 Nathan Creek Watershed

VI.7.2.1 Nathan Creek (Watercourse and Wetland Enhancements)

Offsetting measures in the Class A(O) watercourse and wetland habitat would have total gains of 4,865 m^2 of aquatic habitat and 7,558 m^2 of riparian area in the Nathan Creek watershed.

The crown-owned parcel immediately east of the Bradner Rest Area offers opportunity for offsetting. Proposed offsetting includes a side channel, an ephemeral wetland, mainstream pool habitat, and large woody debris complexing.

The side channel is intended to provide overwintering refuge habitat for juvenile salmonids. The side channel is to be situated on Nathan Creek's right bank terrace. The confluence with Nathan Creek is located approximately 10 m upstream a box culvert beneath a ROW located at the north end of the parcel. The side channel will be backwatered by a rock riffle situated within the main channel. The rock riffle is to contain a concrete weir to provide a stable slot within the backwatering rock riffle such that the riffle provides the desired backwatering and fish passage while draining out at very low waters. At the head of the channel will be the terminus of a grass-lined ditch that conveys overtopping flow from the constructed wetland. In general, the channel geometry and bank treatments will be consistent for both side channels.

A constructed ephemeral wetland is proposed in the south-eastern quadrant of the parcel, approximately 50 m west of Bradner Rd and 25 m north of Nathan Creek. The intent is to provide habitat for amphibians and invertebrates and water into the head of Side Channel No.1. The input of water introduces nutrients, food, increases dissolved oxygen and flushes the side channel.

The wetland will be designed to receive water from precipitation, overland runoff from uphill drainage, and the west Bradner Rd ditch. Water will be diverted from the Bradner Rd ditch into the wetland via cobble-lined channel. A round rock-lined channel will provide an overflow path when wetland depths exceed 0.3 m. The rock-lined channel is to transition into a grass-lined channel that terminates at the head of the side channel.

Two pools are to be formed along the mainstem of Nathan Creek. One of the pools will be located at the confluence of the side channels, while the second pool is to be located 50 m upstream of the confluence. The pools will provide variability in the channel habitat present, increasing the areas of refuge and rearing, and backwater the side channels increasing the water depth. A weir will create the pools. The weir will have low flow notch to allow draining to prevent fish stranding during drought periods with no creek flow. The notch invert will be set to the thalweg elevation. Riprap will be placed along the banks and downstream of the weir to mitigate erosion. Further habitat enhancement is provided with the installation of LWD complexing.

VI.7.2.2 Bradner Rest Area North

On-site restoration measures in the Class A(O) watercourse and wetland habitat will result in total gains of 2,041 m^2 of aquatic habitat and 5,672 m^2 of riparian area in the Nathan Creek watershed.

The Bradner Rest Area North enhancement will consist of a long side channel, with the upstream extent tying into the Bradner Rest Area surface runoff bioswale associated with the proposed expanded Bradner Rest Area. The side channel is to be situated on Nathan Creek's left bank with the confluence 150 m north of the rest area.

A berm will run parallel to the side channel and Nathan Creek mainstem to mitigate an avulsion potential from overtopping bank flows. A spawning pad is to be located upstream of the confluence as an additional habitat enhancement feature.

VI.7.2.3 Nathan Creek (Bradner East Offset)

Crown-owned parcel immediately east of the Bradner Rest Area offers opportunity for offsetting. Proposed design drawings for Class B habitat includes creation of one side channel and one ephemeral wetland. The proposed enhancements at Nathan Creek include 851 m^2 of aquatic habitat and 3,021 m^2 of riparian habitat of Class B wetland area.

PART VII CONCLUSIONS

This Change Approval package has been prepared for the MoF to meet the requirements of the WSA relating to "Changes in and about a Stream". MoTI's Project, the Fraser Valley Highway 1 Corridor Improvement Program, is designed to support the movement of people, goods, and services in BC. The Project proposes expansion of Highway 1 to 4 general purpose lanes, 2 HOV lanes, truck climbing lanes and 2 BOS lanes from 264 Street to Townline Road, within the City of Abbotsford and the Township of Langley. This upgrade will increase the current capacity and reduce frequent congestion affecting safety and reliability of Highway 1. A multidisciplinary team has worked together from McElhanney, AE and ISL, to produce the required engineer drawings and information for this WSA Change Approval, and further design iterations will be completed. Following final design, the Project will continue through construction, operation, and maintenance phases. Works to date have included a thorough inventory of the corridor including environmental values, and stream and wetland habitat classification.

Four watersheds are involved in the Project area including the Salmon River, Fishtrap Creek, Nathan Creek and West Creek with stream and wetland classifications of A, A(O), and B and wetland classifications of Class C for isolated features. West Creek and Nathan Creek are provincially designated "Sensitive Streams". We've provided specific mitigation measures to be implemented when working in and around these streams as per provincial regulations. Project works will take place across 19 sites distinguished by sub-catchment, proposed works and location of offsite offsets. A summary of construction works by site is provided as ***Appendix B: Appendix B***.

Two fish species at risk, including Salish sucker and Nooksack dace, are present in the Project area. Critical habitat for both species occurs in the area surrounding the Project alignment and proposed works at the new Fishtrap Creek Bridge overlap with critical habitat for Salish sucker.

Aquatic and riparian associated wildlife species at risk in the Project area include Oregon forestsnail and red-legged frog. Critical habitat for painted turtle and barn owl has also been mapped within or adjacent to all the watershed sub-catchments in the LAA. Many of the watercourses in the LAA provide moderately or highly suitable habitat for pacific water shrew.

Overall net effects for aquatic habitat are gains of 1,593 m^2 for Class A and 1,193 m^2 for Class B. Class A(O) aquatic areas will result in a loss of 191 m^2. Riparian habitat impacts will result in a net zero balance for Class A, 3,390 m^2 gains for Class A(O), and 11,505 m^2 gains for Class B.

There will be a small temporary construction-related effect to 20 m^2 of instream habitat and 171 m^2 of riparian habitat to critical habitat at the East Fishtrap Creek crossing of Highway 1. Impacts to critical habitat will be related to and inherently offset by the daylighting of the two highway-spanning culverts, resulting in the creation of 1,140 m^2 of open channel instream habitat and 1,971 m2 of riparian habitat underneath the new bridge and in the median/ROW. This new habitat will be in-line and immediately downgradient of mapped critical habitat.

Environmentally substantial construction activities include the installation of Fishtrap Creek bridge which will daylight habitat for aquatic species at risk, and culvert installations. Eight fish-passable culverts and additional minor culverts are proposed for the Project. Culverts in fish-bearing waterbodies have been designed to be passable for all life stages of resident fish at a wide range of flows. Various features are utilized to ensure fish passability including culvert embedment, backwatering, outlet pools and downstream riffles, self draining riffles, and baffles. Other proposed infrastructure includes storm sewers, catch basins and spillways, ditches, ponds and sound walls. Construction works are proposed to begin in the fall of 2023. Proposed permanent and temporary infrastructure has been defined and drawings are provided.

Activities known to impact fish and fish habitat include excavation and grading, vegetation clearing, use of industrial equipment, placement or removal of structures in water, addition or removal of aquatic vegetation, and fish passage issues. Impacts to fish habitat values can occur during a variety of project phases, however environmental impacts have been avoided and minimized by design and mitigations. Measures to mitigate impacts are proposed; critical measures include environmental monitoring, erosion and sediment control structures, site restoration and habitat offsetting, and development of a CEMP.

Habitat loss associated with vegetation clearing and sensory disturbance from construction activities are the primary impacts to wildlife anticipated with culvert replacement and crossing installation. Impacts to wildlife and wildlife habitat is largely mitigated by design and site-specific measures including timing windows, pre-construction surveys and salvages, environmental monitoring, erosion and sediment control measures and site restoration.

Species at risk also have potential to be impacted by the project. Impacts and mitigation measures specific to the two species at risk, Salish sucker and Nooksack dace are provided for. Residual effects are anticipated to be minimal after the implementation of the mitigation measures. With respect to the Project-wide habitat balance, the habitat enhancements proposed throughout the alignment will yield net surpluses of aquatic habitat across all habitat classes. There will be losses in some areas and gains in others. Based on the net balance of habitat across the project, residual effects to fishery productivity will likely be limited to temporal lags in habitat form and function post construction. Such uncertainty may be mitigated through mindful approaches in the implementation of offsetting. These may include early construction of offsets, ahead of impacts, utilization of larger tree stock in riparian area plantings, and timing of works to benefit sensitive life history stages of fish.

VII.1 CLOSURE

This report has been prepared with information available at the time of writing. Should any questions arise, please do not hesitate to contact the undersigned (***Table 49***).

Table 49. Professional responsibility table.

Professional			Portion(s) of Technical Data Report or Environmental Assessment (and Appendices) Responsible For
Name	**Accreditation**	**Signature**	
Environmental – McElhanney			
Patty Burt	R.P. Bio.		Senior review, Appendix L
Thomas Fita	R.P. Bio., P.Ag.		Senior review; Parts VI.1, VI.4, VI.5, VI.6, VI.7; Appendix A, M
Emilia Cronin	B.Sc.		Primary contributor
Sandra Hemstock	R.P. Bio.		Table 35
Courtney Lahue	B.I.T.		Document steward; primary contributor/editor
Gina Le Bel	R.P. Bio.		Primary contributor/editor
Emily MacInnis	B.Sc.		Parts VI.3.3.1, VI.3.14, editor; Tables 5, 19, 21, 24, 27

Professional			Portion(s) of Technical Data Report or Environmental Assessment (and Appendices) Responsible For
Name	**Accreditation**	**Signature**	
Karina Ernst	A.Ag., BC-CESCL		Charts in Part VI.6
Environmental - AE			
Jennifer Prive	R.P. Bio.	COLLEGE OF APPLIED BIOLOGY Jennifer Prive R.P. Bio 2401 CAB	Parts I.2, I.3, I.6, II.3.2, IV.1.1.4; Appendix E, J, N
Thomas Smith	M.Sc.		Parts IV.1.1, IV.2, IV.3.3, IV.3.4, IV.3.5, IV.3.6
Naomi Sands	R.P.Bio.		Parts IV.4.1, IV.4.2, IV.5, V.2, V.3, VI.3.7, VI.3.8, VI.6.5, VI.6.6
Dave Muhlert	R.B.Tech.		Parts IV.4.1, IV.4.2, IV.4.3, IV.4.4, IV.4.6, IV.5.1, IV.5.2
Engineering - McElhanney			
Steve Hobbs	BCLS, P.Eng., PTOE		Table 3; Parts II.1, II.2, II.3; Appendix B; senior review
Kevin Leggett	P.Eng.		Senior review
Jack McKee	P.Eng.		Appendix I
Landscape Architecture - McElhanney			
Stan Siemens	B.L.A., C.S.L.A, B.C.S.L.A., SAFE A.P.		Planting Plans
Christopher Thiede	B.ENV D. Associate AALA		Planting Plans

PART VIII REFERENCES

BC Marine and Pile Driving Contractors Association (MPDCA). 2003. Best Management Practices for Pile Driving and Related Operations. Published: March, 2003. Accessed at: Microsoft Word - Pile Driving BMP2.doc (buyandsell.gc.ca)

Conservation Data Centre (CDC). 2011. Species Summary: *Sorex bendirii*. B.C. Ministry of Environment. Victoria, B.C. Accessed from: https://a100.gov.bc.ca/pub/eswp/

Conservation Data Centre (CDC). 2022a. BC Species and Ecosystems Explorer. B.C. Ministry of Environment. Victoria, B.C. Accessed from: https://a100.gov.bc.ca/pub/eswp/

Conservation Data Centre (CDC). 2022b. Conservation Data Centre iMap. B.C. Ministry of Environment. Victoria, B.C. Accessed from: http://maps.gov.bc.ca/ess/hm/cdc/

Conservation Data Centre (CDC). 2008. Species Summary *Rana aurora*. B.C. Ministry of Environment. Victoria, B.C. Accessed from: https://a100.gov.bc.ca/pub/eswp/speciesSummary.do?id=19586

City of Abbotsford (CoA). 2022. WebMap: City of Abbotsford's interactive mapping tool. Accessed from: https://maps.abbotsford.ca/Html5Viewer/

City of Abbotsford (CoA). 2020. Sensitive Ecosystems. Accessed from: https://opendata-abbotsford.hub.arcgis.com/datasets/Abbotsford::sensitive-ecosystems/about.

Clark, J. and D. Meidinger. 2020. Update of the Metro Vancouver Sensitive Ecosystem Inventory (2009 – 2014). Prepared for Metro Vancouver.

Community Mapping Network (CMN). 20221. Fraser Valley Watershed Atlas. Accessed from: https://cmnmaps.ca/FVRD/map.php?agree=0

Cornell Lab of Ornithology (Cornell). 2022. eBird (Citizen Science Birding Data). Accessed from: https://ebird.org/home

Committee on the Status of Endangered Wildlife (COSEWIC). 2011. COSEWIC assessment and status report on the Oregon Spotted Frog *Rana pretiosa* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xi + 47 pp.

Committee on the Status of Endangered Wildlife (COSEWIC). 2003. COSEWIC assessment and update status report on Townsend's mole *Scapanus townsendi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa.

Craig, V.J., R.G. Vennesland, and K.E. Welstead (Craig et al.) 2010. Best Management Practices for pacific watershrew in urban and Rural Areas. Version May 2010. Prepared for the Pacific Water Shrew recovery Team.

Environment and Climate Change Canada (ECCC). 2013. Oregon Forestsnail (*Allogona townsendiana*) Species Summary. Ottawa, ON. Accessed from: https://species-registry.canada.ca/index-en.html#/species/745-304

Environment and Climate Change Canada (ECCC). 2016. Recovery Strategy for the Tall Bugbane (Actaea elata) in Canada [Proposed]. Species at Risk Act Recovery Strategy Series. Environment and Climate Change Canada, Ottawa, ON.

Environment and Climate Change Canada (ECCC). 2021. Recovery Strategy for the Barn Owl (*Tyto alba*), Western Population, in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment and Climate Change Canada. Ottawa, ON.

Environment and Climate Change Canada (ECCC). 2022. Species at Risk Public Registry. Ottawa, ON. Accessed from: https://www.sararegistry.gc.ca

Fisheries and Oceans Canada (DFO). 1995. Freshwater Intake End-of-Pipe Fish Screen Guideline. Ottawa, ON.

Fisheries and Oceans Canada (DFO). 1999. Lower Fraser Valley Streams Strategic Review, Vol. 1. Fraser River Action Plan. Department of Fisheries and Oceans – Habitat and Enhancement Branch. Vancouver, BC.

Fisheries and Oceans Canada (DFO). 2013. Projects Near Water - British Columbia Marine/Estuarine Timing Windows for the Protection of Fish and Fish Habitat - South Coast and Lower Fraser Area (dfo-mpo.gc.ca)- . Ottawa, ON. Accessed from: Projects Near Water - British Columbia Marine/Estuarine Timing Windows for the Protection of Fish and Fish Habitat - South Coast and Lower Fraser Area (dfo-mpo.gc.ca)

Fisheries and Oceans Canada (DFO). 2022. Aquatic species at risk map. Ottawa, ON. Accessed from: http://www.dfo-mpo.gc.ca/species-especes/sara-lep/map-carte/index-eng.html

Fraser Valley Invasive Species Society (FVISS). 2022. Annual Invasive Species Inventory Methodology for Highway 1. Pers. Comm. Kathy Ma Green.

Government of British Columbia (GoBC). 2019. Guidance Document for Applications or Notifications for Changes in and about a Stream in the South Coast Region. BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, South Coast Region. Accessed from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/south_coast_cias_guidance.pdf

Government of British Columbia (GoBC). 2022a. Requirements and Best Management Practices for Making Changes in and About a Stream in British Columbia. Version 2022.01. Accessed from: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/wsa-cias-requirements-bmps.pdf

Government of British Columbia (GoBC). 2022b. A User's Guide for Changes In and About a Stream in British Columbia. Version 2022.01. Accessed from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/wsa-cias-users_guide.pdf

Government of Canada (Canada). 2002. *Species at Risk Act*. Ottawa, ON. Accessed from: http://laws-lois.justice.gc.ca/PDF/S-15.3.pdf

Government of Canada (Canada). 1994. *Migratory Birds Convention Act*: http://laws-lois.justice.gc.ca/PDF/M-7.01.pdf

Government of Canada (Canada). 1985. *Fisheries Act*: http://laws-lois.justice.gc.ca/eng/acts/f-14/page-1.html

Green, R.N. and K. Klinka. 1994. A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region. BC Ministry of Forests. Research Branch. Victoria, BC.

Kerr Wood Leidal (KWL). 2021. Highway 1 - 264th St to Whatcom Rd Widening – Drainage Scoping Study, Final Report. Prepared for the Ministry of Transportation and Infrastructure.

Meidinger, D, J. Clark, and D. Adamoski. 2014. Sensitive Ecosystem Inventory for Metro Vancouver & Abbotsford. Prepared for Metro Vancouver.

Ministry of Environment & Climate Change Strategy (MOECCS). 1998. Inventory Methods for Pond-breeding Amphibians and Painted Turtle. Standard for Components of British Columbia's Biodiversity No. 37 Version 2.0. Prepared for the Terrestrial Ecosystems Task Force Resource Inventory Committee.

Ministry of Environment & Climate Change Strategy (MOECCS). 2014. Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia. Government of BC. Victoria, BC. Accessed from: https://www.env.gov.bc.ca/wld/documents/bmp/devwithcare/

Ministry of Environment & Climate Change Strategy (MOECCS). 2018 Available at: http://www.sccp.ca/sites/default/files/species-habitat/documents/OFS%20BMP%20April%2010%202018%20distributed.pdf. Accessed February 2022.

Ministry of Environment & Climate Change Strategy (MOECCS). 2022a. Habitat Wizard. Government of BC. Victoria, BC. Accessed from: https://maps.gov.bc.ca/ess/sv/habwiz/

Ministry of Environment & Climate Change Strategy (MOECCS). 2022b. BC Water Resources Atlas. Government of BC. Victoria, BC. Accessed from: https://maps.gov.bc.ca/ess/sv/wrbc/

Ministry of Environment & Climate Change Strategy (MOECCS). 2022c. EcoCat Ecological Reports Catalogue. B.C. Government of BC. Victoria, B.C. Accessed from: https://a100.gov.bc.ca/pub/acat/public/welcome.do

Ministry of Environment & Climate Change Strategy (MOECCS). 2022d. Fisheries Inventory Data Queries. B.C. Government of BC. Victoria, B.C. Accessed from: https://a100.gov.bc.ca/pub/fidq/viewWatershedDictionary.do

Ministry of Environment & Climate Change Strategy (MOECCS). 2022e. Invasive Alien Plant Program. Government of BC. Victoria, B.C. Accessed from: https://maps.gov.bc.ca/ess/hm/iapp/

Ministry of Environment and Climate Change Strategy (MOECCS). 2020f. Guidelines for Amphibian and Reptile Conservation during Road Building and Maintenance Activities in British Columbia. Version 1.0, March 30, 2020. Accessed from: https://a100.gov.bc.ca/pub/eirs/finishDownloadDocument.do;jsessionid=4A4F3AF98A371578798015D3EABBF616?subdocumentId=15141

Government of BC Ministry of Environment, Lands & Parks (MOELP). October 1993. Salish Sucker. ISBN 0-7726-7468-x. Accessed from: https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/species-ecosystems-at-risk/brochures/salish_sucker.pdf

Government of BC Ministry of Environment, Lands & Parks (MOELP). March 1995. Nooksack Dace. ISBN 0-7726-7544-9. Accessed from: https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/species-ecosystems-at-risk/brochures/nooksack_dace.pdf

Ministry of Forests (MoF). 1996. Fish Habitat Assessment Procedures. Watershed Restoration Technical Circular No. 8. Government of BC. Victoria, BC.

Ministry of Forests (MoF). 2016. Best Management Practices for Amphibian and Reptile Salvages in British Columbia. Version 1.0. Government of BC. Victoria, BC.

Ministry of Transportation and Infrastructure (MoTI). 2019a. Best practices for managing invasive plants on roadsides – a pocket guide for British Columbia's maintenance contractors. Government of BC. Victoria, BC.

Ministry of Transportation and Infrastructure (MoTI). 2019b. Supplement to the TAC Geometric Design Guide: Hydraulics Chapter. Government of BC. Victoria, BC.

Ministry of Transportation and Infrastructure (MoTI). 2022. Highway 1 264-Whatcom Invasive Plant Best Practices for Geotech Drilling. Internal document prepared by Krista Englund, MoƟTI Environmental Coordinator. Government of BC. Victoria, BC.

Ministry of Transportation and Infrastructure (MoTI). 2012. Standard Specifications for Highway Construction Volume 1 or 2. Government of BC. Victoria, BC.

Ministry of Environment (MOECCS). 2006. Guidelines for Reduced Risk Instream Work Windows, Ministry of Environment, Lower Mainland Region (March 2006). Government of British Columbia. Accessed from: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/work_windows_low_main.pdf

Ministry of Transportation and Infrastructure (MoTI). 2020. 2020 Standard Specifications for Highway Construction. Volume 1. Construction and Maintenance Branch. Government of British Columbia. Accessed from: https://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/engineering-standards-and-guidelines/highway-specifications/volume_1_ss2020.pdf

Ministry of Transportation and Infrastructure (MoTI). 2021. Wildlife Accident Reporting System. Government of BC. Victoria, BC. Accessed from: https://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/environmental-management/wildlife-management/wildlife-accident-reporting-system?keyword=stan&keyword=holiday&keyword=pay

Ministry of Water, Land and Air Protection (WLAP). 2004. Environmental Best Management Practices for Urban and Rural Development. Section Six. Special Wildlife & Species at Risk. Government of BC. Victoria, BC.

Master Municipal Construction Document Association (MMCDA). 2019. Master Municipal Construction Guidelines. Accessed from: https://www.mmcd.net

Office of the Chief Information Officer (OCIO). 2021a. BC Government Data Catalogue. Government of BC. Victoria, B.C. Accessed from: https://catalogue.data.gov.bc.ca/

Office of the Chief Information Officer (OCIO). 2021b. BC Government Data Datalogue- Sensitive Ecosystems Inventory (SEI) Detailed Polygons with Short Attribute Table Spatial View. Knowledge Management. Government of BC. Victoria, BC. Accessed from: https://catalogue.data.gov.bc.ca/dataset/sensitive-ecosystems-inventory-sei-detailed-polygons-with-short-attribute-table-spatial-view.

Office of the Chief Information Officer (OCIO). 2021c. iMapBC. Government of BC. Victoria, B.C. Accessed from: https://maps.gov.bc.ca/ess/hm/imap4m/

Pearson Ecological. 2015a. Guidelines for the Capture, Handling Scientific Study, and Salvage of the Nooksack Dace. Available at: https://portal.nrs.gov.bc.ca/documents/10184/0/NooksackDaceCollectionGuidelines2015.pdf/339d65e0-23b5-10bb-b33f-a7dbf74d5d39

Pearson Ecological. 2015b. Guidelines for the Capture, Handling Scientific Study, and Salvage of the Salish Sucker (Catostomus sp.). Available at: https://portal.nrs.gov.bc.ca/documents/10184/0/SalishSuckerCollectionGuidelines2015.pdf/5893755c-1c3f-b85b-419c-a4ce50ffac71

Province of BC (BC). 1996a. *Wildlife Act*, RSBC 1996 Chapter 488. Section 34. Government of BC. Victoria, BC. Accessed from: http://www.bclaws.ca/Recon/document/ID/freeside/00_96488_01

Province of BC (BC). 1996b. *Weed Control Act*, RSBC 1996 Chapter 487. Government of BC. Victoria, BC. Accessed from: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/96487_01

Province of BC (BC). 2002. *Agricultural Land Commission Act*, SBC 2002. Government of BC. Victoria, BC. Accessed from: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/02036_01

Province of BC (BC). 2014a. *Wildlife Act* Designation and Exemption Regulation. B.C. Reg. 32/2014. Government of BC. Victoria, BC. Accessed from: http://www.bclaws.ca/Recon/document/ID/freeside/13_168_90#ScheduleB

Province of BC (BC). 2014b. *Water Sustainability Act,* SBC 2014 (Chapter 15). Government of BC. Victoria, BC. Accessed from: http://www.bclaws.ca/civix/document/id/complete/statreg/14015

Province of BC (BC). 2016. *Riparian Areas Regulation* (amendments to Reg 41/2016). Government of BC. Victoria, BC. Accessed from: http://www.bclaws.ca/civix/document/id/complete/statreg/376_2004

Province of BC (BC). 2018. Change Approval for Works in and about a Stream – Activity Guide. Government of BC. Victoria, B.C. Last updated: February 15, 2018. Accessed from: https://portal.nrs.gov.bc.ca/web/client/-/stream-change-major

Resources Inventory Committee (RIC). 1998. Inventory Methods for Pond-breeding Amphibians and Painted Turtle. Government of BC. Victoria, BC.

Resources Inventory Committee (RIC). 2001. Inventory Methods for Moles and Pocket Gophers. Standards for Components of British Columbia's Biodiversity. No. 26. Version 2.0. Government of BC. Victoria, BC.

Resource Inventory Standards Committee (RISC). 2001. Fish and Fish Habitat Inventory Standards and Procedures. Version 2.0. Government of BC. Victoria, BC.

Salmon River Enhancement Society (SRES). 2021. What makes Salmon River Unique? Accessed from: http://salmonriver.org/?page_id=586#:~:text=The%20Salmon%20River%20is%20the,in%20B.C.%20for%20wild%20coho.&text=The%20river%20is%20home%20to,and%20lower%20reaches%20(floodplain)

Sheehan, S.T., and C. Galindo-Leal. 1997. Identifying Coast Moles, *Scapanus orarius*, and Townsend's moles, *Scapanus townsendii*, from tunnel and mound size. Can. Field Naturalist Notes: 463-65

South Coast Conservation Program (SCCP). 2018. Oregon Forestsnail Best Management Practices Guidebook. April 2018 Version. South Coast. BC.

Stantec. 2021. Archaeological Overview Assessment: Highway 1 Improvement Program from the 264th Street Interchange to the Whatcom Road Interchange. Prepared for Ministry of Transportation and Infrastructure.

Township of Langley (ToL). 1979. Official Community Plan (No. 1842). Accessed from: https://www.tol.ca/your-township/about-the-township/community-plans/

Township of Langley (ToL). 2021. Geosource – The Township of Langley's Web-Based Mapping System. Accessed from: https://mapsvr.tol.ca/geosource3/

Triton Environmental Consultants (Triton). 2021. Fraser Valley Highway 1 Corridor Improvement Program 264th Street-Whatcom Road Preliminary Environmental Assessment Report and Constraint Mapping. Prepared for Ministry of Transportation and Infrastructure.

Triton Environmental Consultants (Triton). 2021b. 264th – Whatcom Road, Highway 1 Expansion – eDNA results. Prepared for Ministry of Transportation and Infrastructure.

Tunnicliffe, J., Church, M., Clague, J.J. and Feathers, J.K., 2012. Postglacial sediment budget of Chilliwack Valley, British Columbia. Earth Surface Processes and Landforms. DOI:10.1002/esp.3229

University of British Columbia (UBC). 2021a. CWH species composition. Vancouver, BC. Accessed from: https://cfcg.forestry.ubc.ca/resources/cataloguing-in-situ-genetic-resources/cwh-zone/cw-species-composition/

University of British Columbia (UBC). 2021b. E-Fauna BC: Electronic Atlas of the Fauna of British Columbia. Vancouver, BC. Accessed from: https://linnet.geog.ubc.ca/biodiversity/efauna/

University of British Columbia (UBC). 2021c. E-Flora BC: Electronic Atlas of the Flora of British Columbia. Vancouver, BC. Accessed from: https://linnet.geog.ubc.ca/biodiversity/eflora/index.html

US Department of Transportation, Federal Highway Administration (USDOT). October 2010. Culvert Design for Aquatic Organism Passage, Hydraulic Engineering Circular No. 26, First Edition. Publication No. FHWA-HIF-11-008. https://www.fhwa.dot.gov/engineering/hydraulics/pubs/11008/hif11008.pdf

Utah State University (Utah). 2012. Determining Wildlife Use of Wildlife Crossing Structures Under Different Scenarios. Report No. UT-12.07. Prepared for Utah Department of Transportation Research Division.

Weather Dashboard for Abbotsford. https://cw8841.weatherstats.ca/

Western Painted Turtle Recovery Team (WPTRT). 2016. Recovery plan for the Painted Turtle – Pacific Coast Population (*Chrysemys picta* pop. 1), in British Columbia. B.C. Ministry of Environment, Victoria, BC. 89 pp. Repr. of 1st ed., The Western Painted Turtle Recovery Team, Victoria, BC. 89 p. (Orig. pub. 2016). Accessed from: https://linnet.geog.ubc.ca/biodiversity/efauna/

Wetland Stewardship Partnership (WSP). March 2009. Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in British Columbia. https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/best-management-practices/wetland_ways_ch_1_introduction.pdf

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Statement of Limitations

This report was prepared by McElhanney and AE for the exclusive use of the MoTI and may not be reproduced in whole or in part without the prior written consent of McElhanney / AE or used or relied upon in whole or in part by a party other MoTI. Any unauthorized use of this report, or any part hereof, by a third party or any reliance on or decisions to be made based on it are at the sole risk of such third parties. McElhanney and AE accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report, in whole or in part.

This report is intended to provide a preliminary assessment of potential environmental concerns at the subject property. This report is not meant to represent a legal opinion regarding compliance with applicable laws nor to judge the acceptability of risk. Note that environmental statutes, regulations and guidelines, and the interpretation of such environmental statutes, regulations and guidelines, are subject to change over time and such changes, when put into effect, could alter the conclusions and recommendations noted in this report.

The investigation program followed the standard of care expected of professionals undertaking similar work in BC under similar conditions. No warranties, either express or implied, are made as to the professional services provided and included in this report.

This report is based on data and information collected during the investigation conducted by McElhanney / AE / Triton personnel and is based solely on the conditions of the subject property at the time of the Site work completed, as described in this report.

Achieving the objectives stated in this report has required us to arrive at conclusions based upon the best information presently known to us. No investigative method can completely eliminate the possibility of obtaining partially imprecise or incomplete information; it can only reduce the possibility to an acceptable level. Professional judgment was exercised in gathering and analyzing the information obtained and in the formulation of the conclusions. Like all professional persons rendering advice, we do not act as absolute insurers of the conclusions we reach, but we commit ourselves to care and competence in reaching those conclusions.

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