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July 26, 2018

Aquatic Resources Assessment Report

# AQUATIC RESOURCES ASSESSMENT REPORT

## BHP Potash Export Facility at Fraser Surrey Docks

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## **EXECUTIVE SUMMARY**

BHP Billiton Canada Inc. (BHP) is considering a portion of the Fraser Surrey Docks (FSD) in Surrey, British Columbia (BC), as a potential site for the construction of a potash export facility (Project).

The Aquatic Resources Assessment Report has been prepared to assess potential effects to aquatic resources in accordance with the Vancouver Fraser Port Authority Project and Environment Review Guidelines for Habitat Assessment (VFPA 2015). This report presents the environmental assessment for aquatic resource components within the vicinity of the Project.

The Aquatic Resources Assessment includes an assessment of fish and fish habitat, benthic invertebrates, marine mammals, species of conservation concern, and commercial, recreational, and Aboriginal (CRA) fisheries within each of the respective zones of influence (ZOI). The Project overlaps with a portion of the Fraser River that provides general foraging and rearing habitat value to CRA fish, including Pacific salmon and trout, char, sturgeon, and eulachon. The Project does not overlap with fish-bearing upland fish habitat, but does intersect a culverted ditch that is municipally designated as providing downstream food and nutrient value to the Fraser River. The FSD breakwater area within the PDA likely provides holding habitat for salmonids migrating upriver. Benthic invertebrate productivity was comparably low within the PDA, suggesting relatively poor foraging habitat for CRA fish compared to other parts of the Fraser River. Marine mammals within the ZOI are limited to humpback whale, southern resident killer whale, Steller sea lion, harbour seal, and harbour porpoise. Potential habitat, including foraging and breeding habitat, has been identified for a number of fish and marine mammal species of provincial and federal conservation concern that overlap with the respective ZOIs. Fishing for CRA species, particularly salmon gill net fishing, also occurs throughout the lower Fraser River within its respective ZOI.

Existing conditions, potential Project-related effects, mitigation measures, and residual effects for each of the components are described in this assessment. Potential effects associated with Project activities for fish and fish habitat include change in habitat structure and cover; change in sediment concentration; and change in contaminant concentrations. Potential Project-related effects for benthic invertebrates include direct mortality or physical disturbance due to the re-suspension of sediment in the Fraser River and change in habitat quality, namely water and sediment quality. Potential Project-related effects for marine mammals include physical injury or behavioural disturbance from increased underwater noise; behavioural disturbance from in-air noise; mortality from vessel strikes, and acoustic masking from increased vessel traffic. Potential effects to CRA fishing include increased vessel traffic, which may interfere with fishing, particularly gill net fisheries during select openings in the lower Fraser River.

The Project's construction phase may affect the aquatic components as a result of demolition of existing infrastructure; vegetation removal; installation of temporary construction trailers and infrastructure; ground improvements; installation of marine piles; seismic upgrades; excavation; construction of the product unloading facility, storage shed, and material handling and transfer system; installation of the shiploader;

construction of the terminal rail loop; installation of utilities and stormwater management facilities; disposal of construction waste; and transportation of people and materials to and from the site. Project activities that may interact with aquatic resources during the operation phase include rail traffic and maintenance of the rail right-of-way; transfer and storage of the product at the site; vessel mooring and loading; marine vessels traffic; transport of people and materials to and from the site; disposal of operation waste; storage of fuels or petroleum products for equipment; and stormwater management.

Despite potential effects to aquatic resources during Project construction and operation, with the application of appropriate mitigation measures and adherence to best management practices, residual Project-related effects are not anticipated.

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## 1.0 INTRODUCTION

BHP Billiton Canada Inc. (BHP) is considering a portion of the Fraser Surrey Docks (FSD) in Surrey, British Columbia (BC), as a potential site for the construction of a potash export facility (Project).

Aquatic resources were selected for the Vancouver Fraser Port Authority's (VFPA's) Project and Environmental Review (PER) because of the potential interaction between the Project and ecological values such as fish and fish habitat, benthic invertebrates, marine mammals, species at risk, and commercial, recreational, and Aboriginal (CRA) fisheries. Project activities that may affect aquatic resources during construction include demolition of existing infrastructure; vegetation removal; installation of temporary construction trailers and infrastructure; ground improvements; installation of marine piles; seismic upgrades; excavation; construction of the product unloading facility, storage shed, and material handling and transfer system; installation of the shiploader; construction of the terminal rail loop; installation of utilities and stormwater management facilities; disposal of construction waste; and, transportation of people and materials to and from the site. During the operation phase, Project activities that could interact with aquatic resources include rail traffic and maintenance of the rail right-of-way; transfer and storage of the product at the site; vessel mooring and loading; marine vessel traffic; transport of people and materials to and from the site; disposal of operation waste; storage of fuels or petroleum products for equipment; and stormwater management. A full description of the Project activities, materials and equipment, and the proposed work plan and schedule is provided in **Section 2.0 Project Description Requirements** of the Application.

In recognition of the importance of minimising the potential effects of the Project on aquatic resources, VFPA's PER Application Submission Requirements requires the following studies related to aquatic resources:

- Biophysical survey
- Species at Risk assessment.

To assist applicants of projects on lands and waters managed by VFPA in the assessment of potential Project-related effects on biophysical resources including aquatic resources, VFPA has developed a guidance document entitled Project and Environmental Review Guidelines - Habitat Assessment (VFPA 2015). This chapter summarises the aquatic resources study work conducted to determine changes in aquatic resources as a result of the Project.

The aquatic resources study focused on determining the potential Project-related effects on fish and fish habitat, benthic invertebrates, marine mammals, species at risk, and CRA fisheries. Work conducted to support the aquatic resources study is presented in the following sections and comprises the following:

- A review of existing baseline information for fish, fish habitat, benthic invertebrates, marine mammals, and CRA fisheries that was available for the defined technical study area (TSA)
- Field visits consisting of visual surveys, fish sampling, water quality sampling, and benthic invertebrate sampling
- Determination of interactions between aquatic resource components and Project activities
- Assessment of potential Project-related effects and recommended mitigation measures.

Information on the Project location and rationale are provided in **Section 2.0 Project Description Requirements** of the Application.

## 2.0 SCOPE

### 2.1 SCOPE OF ASSESSMENT

The Aquatic Resources Assessment considers potential changes to aquatic resources, and focuses on those environmental components and features with the potential to be affected by the Project. Components and features were selected based on ecological importance or conservation status, and relative sensitivity of environmental components to Project activities. The following components were selected for further evaluation in this report:

- Fraser River fish and fish habitat
- Upland fish and fish habitat
- Benthic invertebrates
- Marine mammals
- Species of conservation concern
- CRA fisheries.

### 2.2 SPATIAL SCOPE

The Project is located at the Fraser Surrey Docks (FSD) site on the south bank of the South Arm of the Fraser River, adjacent to the South Fraser Perimeter Road in the City of Surrey. The Project will include: Berth #9, Yard Area 9, and the current container yard of the FSD site. All aspects of the Project will be confined to lands within the FSD site, which is leased to FSD by VFPA. A potash export facility is consistent with the current and zoned uses of the site, both by the City of Surrey and VFPA. An overview of the Project and its orientation on the FSD site is shown in the Site Overview Map (**Figure 2-1**).

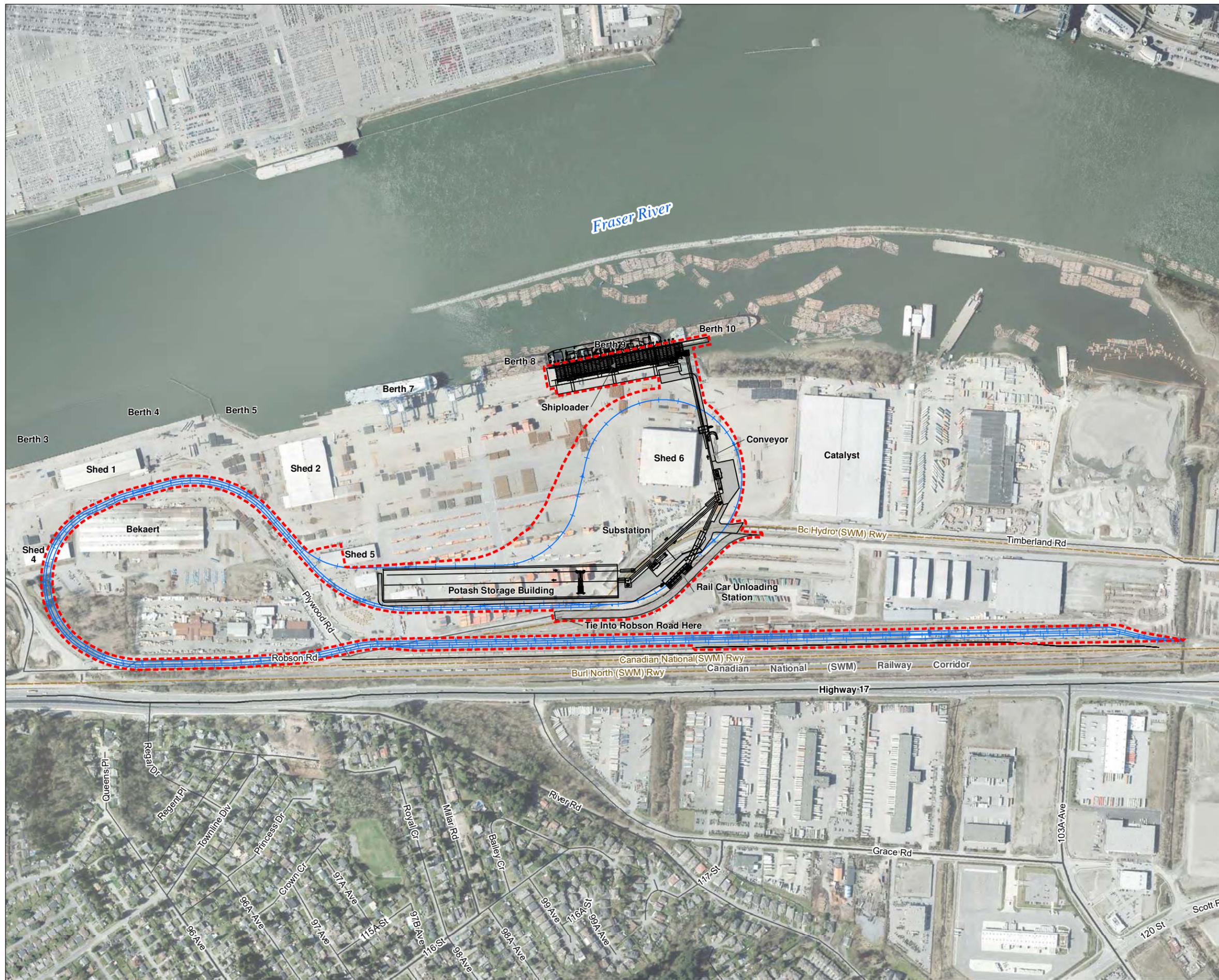
The spatial scope of the assessment was influenced by the aquatic component being evaluated. The following terms are defined as they relate to the spatial scope of this aquatic resources assessment:

- **Project development area (PDA):** The area where Project operation activities are planned, as shown on **Figure 2-1**, equivalent to 28.6 hectares (ha).
- **Zone of Influence (ZOI):** The predicted physical extent of the ZOI is meant to represent the areas where Project activities are likely to have direct influence on aquatic resources. The following ZOIs are defined for the aquatic resource components:
  - **Fraser River fish and fish habitat:** The upstream berths (Berths 5 to 10) in the Fraser River South Arm at FSD (equivalent to the ZOI for benthic invertebrates), equivalent to 22.3 ha (**Figure 2-2**).
  - **Upland fish and fish habitat:** Upland fish habitat, including instream and riparian habitat, located within the PDA (equivalent to the PDA footprint), equivalent to 28.6 ha (**Figure 2-3**).
  - **Benthic invertebrates:** The upstream berths (Berths 5 to 10) in the Fraser River South Arm at FSD (equivalent to the ZOI for Fraser River Fish and Fish Habitat), equivalent to 22.3 ha (**Figure 2-4**).

- **Marine mammals:** The navigational channel of the Fraser River South Arm from the Port Mann Bridge downstream to the western extent of VFPA's navigational jurisdiction over Roberts Bank (equivalent to the TSA for marine mammals), equivalent to 21,184.5 ha (**Figure 2-5**).
- **Species of conservation concern:** See above description for suitable species category (i.e., Fraser River fish and fish habitat or marine mammals) (**Figure 2-2** and **Figure 2-5**).
- **CRA fisheries:** The Fraser River, from the Port Mann Bridge to the river mouth at Sand Heads and relevant tributaries including Gunderson Slough (equivalent to the TSAs for CRA fisheries, and Fraser River fish and fish habitat), amounting to 3,921.6 ha (**Figure 2-6**)
- **Technical study area:** The physical extent of the assessment area where Project activities were determined as having direct or indirect influence on selected environmental components. The following TSAs are defined for the aquatic resource components:
  - **Fraser River fish and fish habitat:** The Fraser River, from the Port Mann Bridge to the river mouth at Sand Heads and relevant tributaries including Gunderson Slough (equivalent to the TSA and ZOI for CRA fisheries), equivalent to 3,921.6 ha (**Figure 2-2**)
  - **Upland fish and fish habitat:** Includes upland fish habitat within 10 metres (m) of the PDA bounded by Gunderson Slough to the south, BNSF Railway to the east, Manson Canal to the north, and the Fraser River to the west, equivalent to 37.7 ha (**Figure 2-3**)
  - **Benthic invertebrates:** Annieville Channel reach of the Fraser River South Arm (i.e., kilometre (km) 30 to 35), adjacent to FSD, equivalent to 444.8 ha (**Figure 2-4**)
  - **Marine mammals:** The navigational channel of the Fraser River South Arm from the Port Mann Bridge downstream to the western extent of VFPA navigational jurisdiction over Roberts Bank (equivalent to the ZOI for marine mammals), equivalent to 21,184.5 ha (**Figure 2-5**)
  - **Species of conservation concern:** See above descriptions for applicable species category (i.e., Fraser River fish and fish habitat or marine mammals) (**Figure 2-2** and **Figure 2-5**)
  - **Commercial, recreational, and Aboriginal fisheries:** The Fraser River, from the Port Mann Bridge to the river mouth at Sand Heads and relevant tributaries including Gunderson Slough (equivalent to the TSA for Fraser River fish and fish habitat and ZOI for CRA fisheries), equivalent to 3,921.6 ha (**Figure 2-6**).

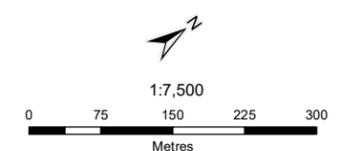
Site Overview Map

- Legend**
-  Project Development Area
  -  Project Access Corridor
  -  Project Infrastructure
  -  Proposed Project Rails
  -  Highway
  -  Road (Collector)
  -  Road (Local)
  -  Road (Gravel)



- Notes**
1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.
  2. This extent should be considered approximate only.

**Sources**  
- Basemap: Ortho Imagery from City of Surrey.

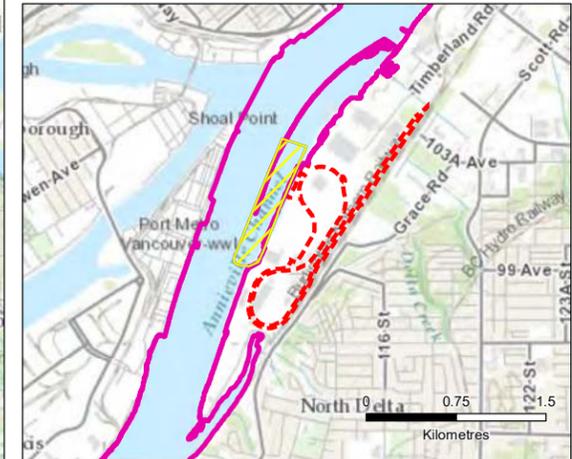
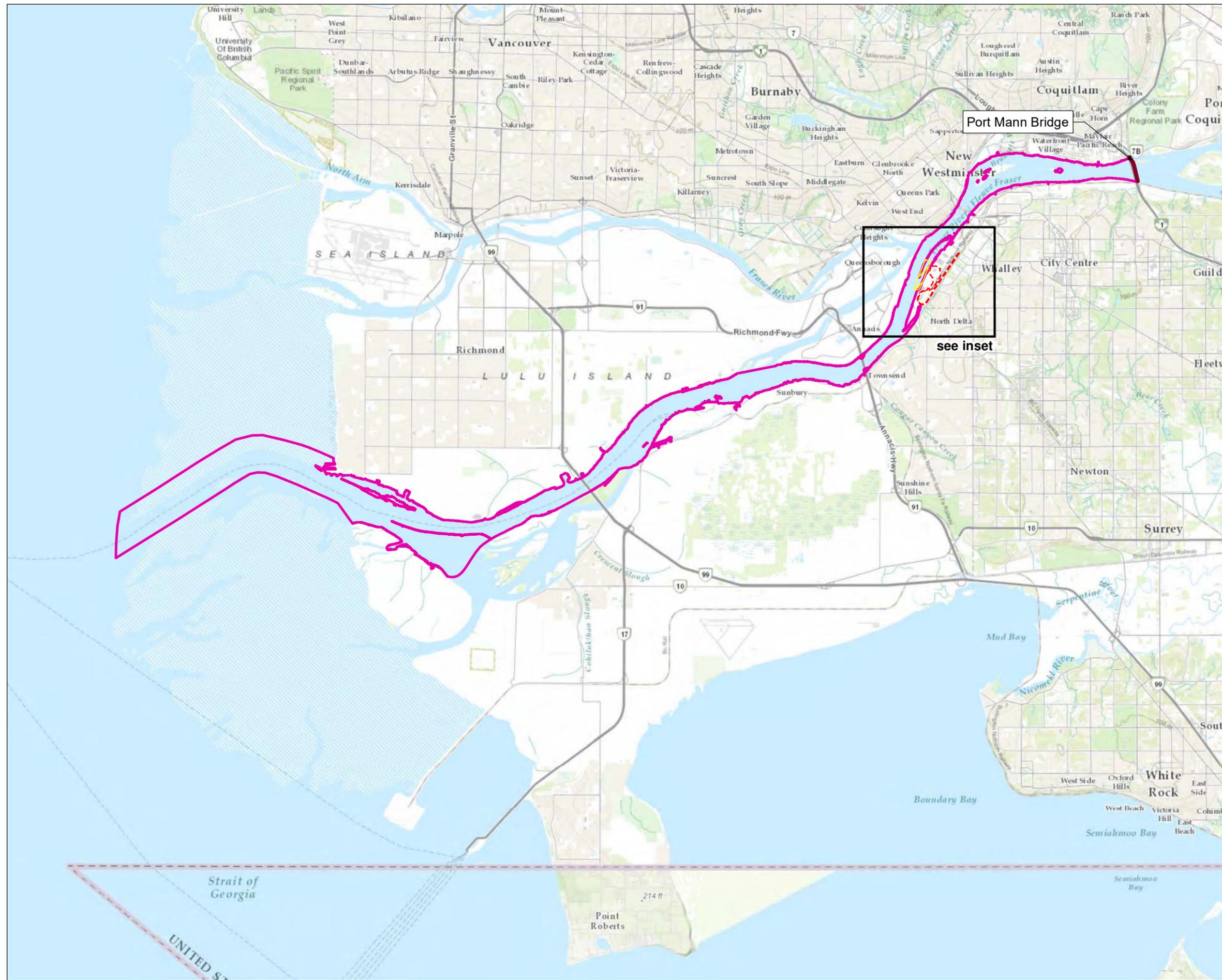


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**TECHNICAL STUDY AREA AND  
ZONE OF INFLUENCE FOR  
FRASER RIVER FISH AND FISH HABITAT**



**Legend**

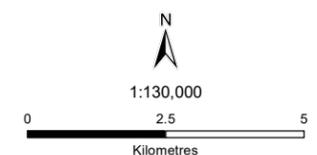
- Zone of Influence (Berths 5 to 10 at Fraser Surrey Docks)
- Technical Study Area (Fraser River, from the Port Mann Bridge to the river mouth at Sand Heads and relevant tributaries including Gunderson Slough)
- Project Development Area

**Notes**

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**Sources**

- PDA obtained from BHP Billiton Ref: 101051-03-G-SK-20 REV B.dwg
- Basemap: ESRI World Topo Map



NAD 1983 UTM Zone 10N  
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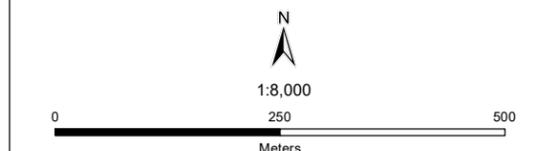
**Technical Study Area and  
Zone of Influence for  
Upland Fish and Fish Habitat**



- Legend**
- Zone of Influence (Project Development Area)
  - Technical Study Area ((10 m buffer around the Project Development Area)
  - Flow Direction
- Watercourse (Fish Classification)**
- Class A
  - Class A(O)
  - Class B
  - Class C
  - Unknown
  - Culvert
  - Drainage Lateral
  - Drainage Main (In Service/For Construction)

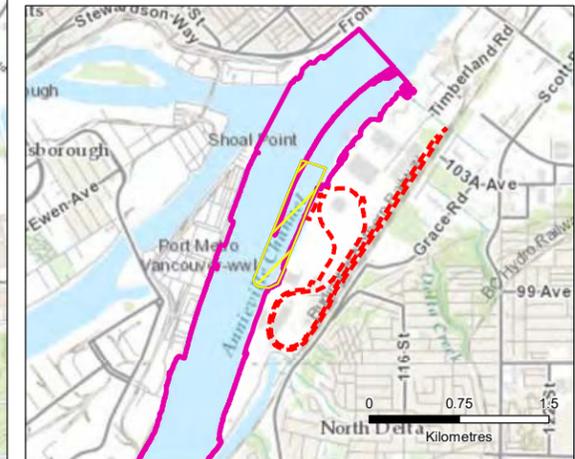
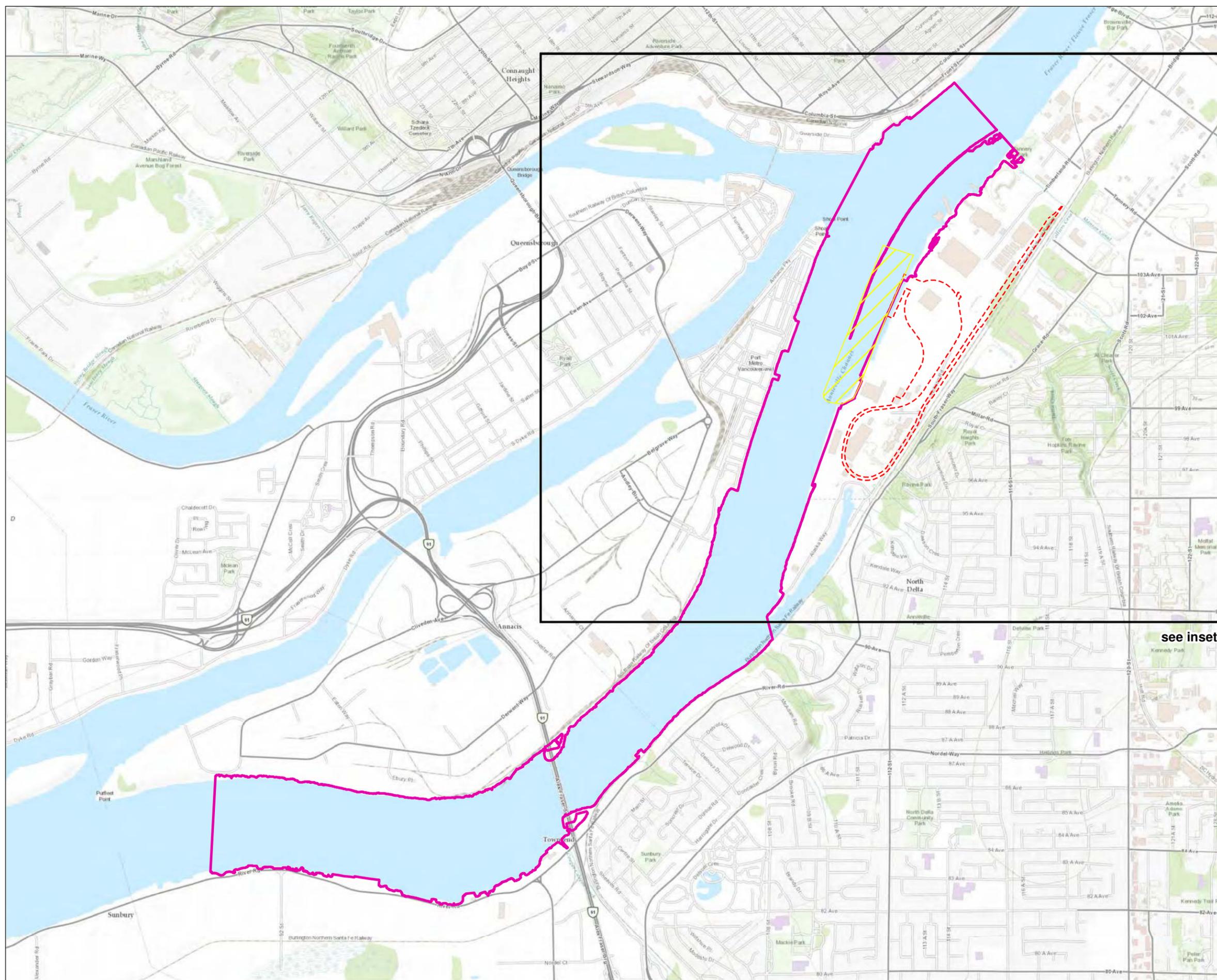
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  - Basemap: ESRI World Topo Map



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**TECHNICAL STUDY AREA AND  
ZONE OF INFLUENCE FOR  
BENTHIC INVERTEBRATES**



**Legend**

- Zone of Influence (Berths 5 to 10 at Fraser Surrey Docks)
- Technical Study Area (Annieville Channel)
- Project Development Area

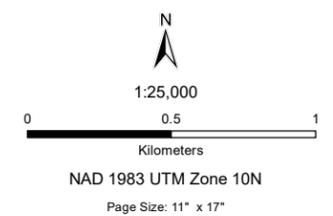
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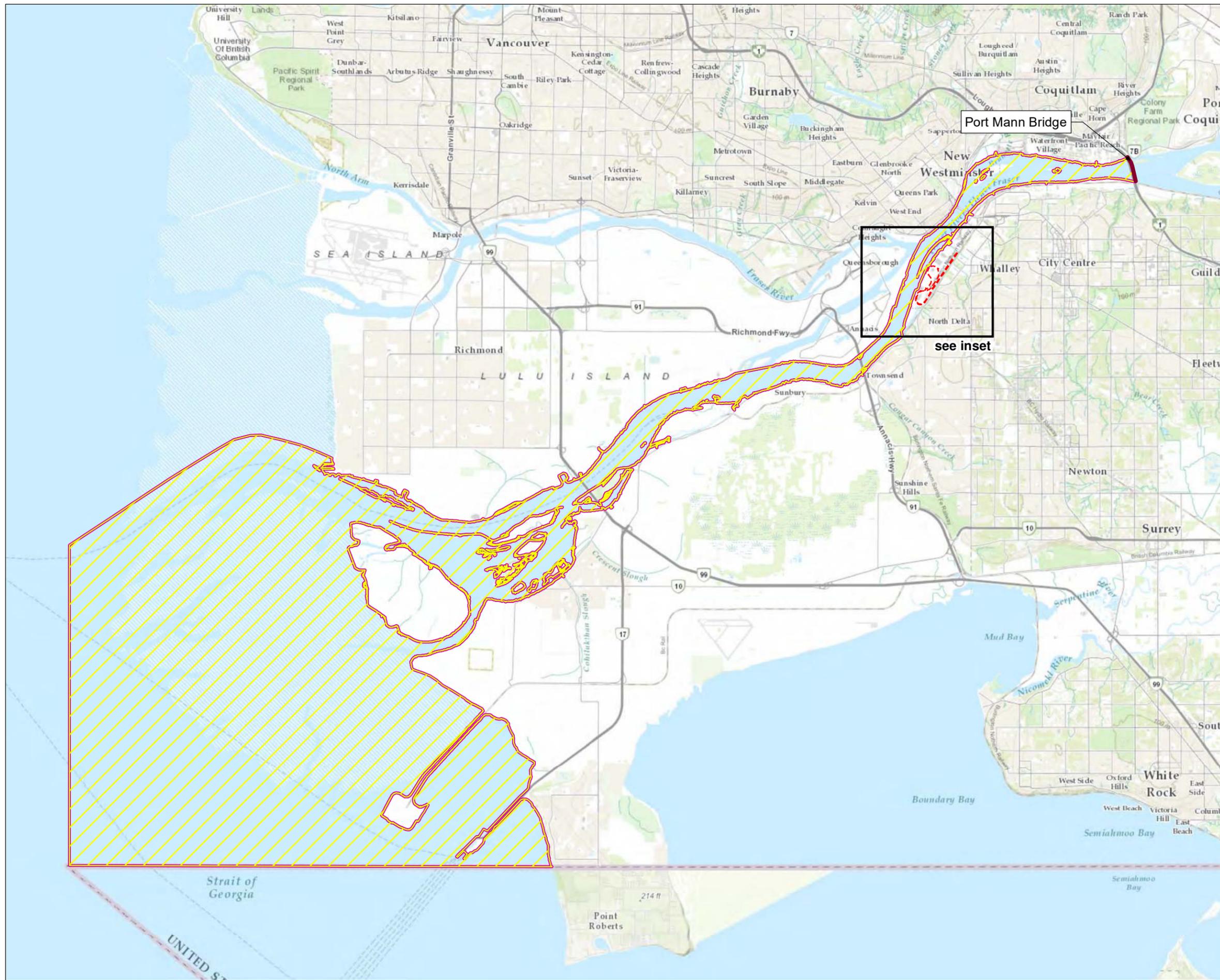
**Sources**

- PDA obtained from BHP Billiton Ref: 101051-03-G-SK-20 REV B.dwg
- Basemap: ESRI World Topo Map

see inset



**TECHNICAL STUDY AREA AND  
ZONE OF INFLUENCE FOR  
MARINE MAMMALS**



**Legend**

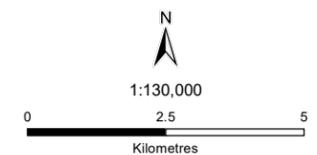
-  Zone of Influence (Fraser River, from the Port Mann Bridge to the western extent of Vancouver Fraser Port Authority navigational jurisdiction over Roberts Bank)
-  Technical Study Area (Fraser River, from the Port Mann Bridge to the western extent of Vancouver Fraser Port Authority navigational jurisdiction over Roberts Bank)
-  Project Development Area

**Notes**

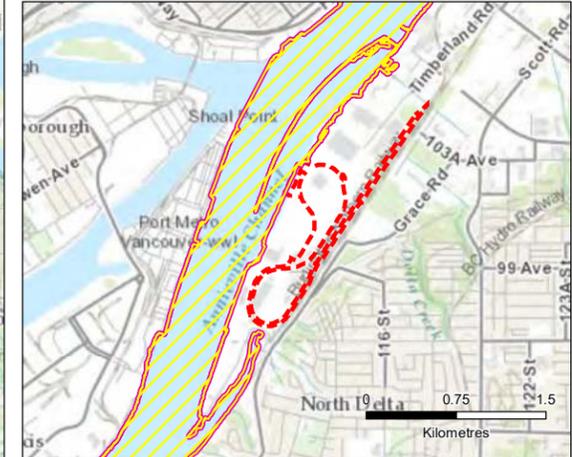
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- Basemap: ESRI World Topo Map



**TECHNICAL STUDY AREA AND ZONE OF  
INFLUENCE FOR COMMERCIAL,  
RECREATIONAL & ABORIGINAL FISHERIES**



**Legend**

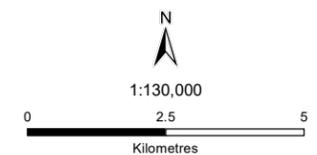
-  Zone of Influence (Fraser River, from the Port Mann Bridge to the river mouth at Sand Heads and relevant tributaries including Gunderson Slough)
-  Technical Study Area (Fraser River, from the Port Mann Bridge to the river mouth at Sand Heads and relevant tributaries including Gunderson Slough)
-  Project Development Area

**Notes**

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- Basemap: ESRI World Topo Map



### **2.3 TEMPORAL SCOPE**

Project construction and operation are considered in this review. Construction will take approximately three to four years to complete and timing is subject to approval of the Board of BHP, and receipt of construction permits. This would not occur before Q1 2019. Proposed construction works may overlap with environmentally sensitive periods. For example, environmental work windows apply to certain Project activities for the protection of fish and fish habitat, including:

- Least-risk window for the Fraser River Estuary (from the George Massey Tunnel to Mission Bridge): June 16 to February 28 (DFO 2014a)
- Least-risk instream (i.e., upland) work window for watercourses in the Lower Mainland containing Pacific salmon and trout: August 1 to September 15 (MOE 2006).

### 3.0 REGULATORY STANDARDS AND GUIDELINES

The Project is located entirely on federal lands within the jurisdiction of VFPA. Under the *Canada Marine Act*, SC 1998, c. 10, VFPA is responsible for the administration, management, and control of land and water within its authority. The PER process applies to all physical works and activities on federal lands and waters that are located partially or wholly within VFPA's authority.

In addition to the PER process, federal legislation and regulations exist to manage activities that can affect aquatic resources. In addition to federal legislation, at the request of VFPA an overview of the provincial *Wildlife Act*, RSBC 1996, c. 488, is provided as it relates to species of conservation concern.

An overview of regulatory standards and guidelines that may apply is provided below.

#### 3.1 FEDERAL LEGISLATION

##### 3.1.1 *Fisheries Act*

The *Fisheries Act* (RSC 1985, c. F-14) prohibits serious harm to fish that are part of a CRA fishery, or to fish and fish habitat that support such a fishery (Section 35(2)). Serious harm is defined as "any mortality to fish and/or alteration of habitat sufficient to result in a localised impact to the population in the study area" (DFO 2013a). It is also prohibited to deposit deleterious substances in water frequented by fish (Section 34(1)). Information gathered for the **Aquatics Technical Data Report (Attachment 4.2-A)** was used to determine whether the Project is likely to cause serious harm or residual harmful effects to fish. The *Marine Mammals Regulations* (SOR/ 93-56) under the *Fisheries Act* includes the protection of marine mammals. Section 7 of the Marine Mammal Regulations prohibits the disturbance of marine mammals, unless fishing for marine mammals under the authority of the regulations. The *Fisheries Act* provides for the protection of marine mammal habitat from physical alteration and introduction of deleterious substances.

##### 3.1.2 *Species at Risk Act*

The *Species at Risk Act*, SC 2002, c. 29, (SARA) aims to prevent species of conservation concern from becoming extirpated or extinct, and ensures the appropriate management of species of special concern to prevent them from becoming threatened or endangered. Status codes under SARA are defined as follows:

- Special concern - a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events
- Threatened - a species that is likely to become endangered if limiting factors are not reversed
- Endangered - a species facing imminent extirpation or extinction
- Extirpated - a species that no longer exists in the wild in Canada, but occurring elsewhere
- Extinct - a species that no longer exists.

Listing under an endangered, threatened, or extirpated status in Schedule 1 of SARA protects individuals and their residences on federal lands.

## **3.2 PROVINCIAL LEGISLATION**

### **3.2.1 *Wildlife Act***

The BC *Wildlife Act* protects most vertebrates, including fish, from direct harm or harassment, as well as certain species of conservation concern. The BC Ministry of Environment (MOE) maintains the British Columbia Conservation Data Centre, which, based on scientific data, identifies conservation status ranks and assigns at-risk species to either Red or Blue lists. Red-listed status applies to species or ecosystem that are at risk of being lost (i.e., extirpated, endangered, or threatened). Extirpated taxa no longer exist in the wild in BC, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Blue-listed status applies to species or ecosystem that are of special concern. Taxa of special concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. Red- or Blue-listed species or ecological communities do not automatically have protection.

The lists developed for the Project identify potentially sensitive species or ecological communities that provincial regulators may identify as requiring permits, approvals, or further consideration.

## **3.3 GUIDELINES**

In addition to the federal and provincial statutes described above, additional guidance documents have also been referenced and may be relevant to this aquatic resources assessment, including:

- An Applicant's Guide to Submitting an Application for Authorization under Paragraph 35(2)(b) of the *Fisheries Act* (DFO 2013a)
- Fisheries Protection Policy Statement (DFO 2013b)
- Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting (DFO 2013c)
- Pathways of Effects (DFO 2014b)
- Measures to avoid causing harm to fish and fish habitat including aquatic species at risk (DFO 2016a)
- British Columbia Water Quality Guidelines (Criteria): January 2017 Edition (MOE 2017)
- Standards and Best Practices for Instream Works (MWLAP 2004).

## 4.0 BASELINE STUDY METHODS

Existing aquatic conditions were characterised based on a review of publicly available literature and field studies conducted for the Project. To address data gaps identified during the desktop review and to further characterise baseline conditions, a field reconnaissance was undertaken that included fish and benthic invertebrate sampling programs, as detailed in the **Aquatics Technical Data Report (Attachment 4.2-A)**. A summary of the assessments conducted for the aquatic resource components is provided in **Table 4-1**.

**Table 4-1 Assessments Conducted for Components of Aquatic Resources**

Component	Assessment Methods and Techniques
Fraser River fish and fish habitat	<p>Existing conditions in the Fraser River fish and fish habitat TSA (encompassing the freshwater navigational route of Project-related vessels through the South Arm of the Fraser River) were initially assessed through a desktop review of existing literature and geospatial databases. The TSA was used to determine potential fish presence (based on biophysical conditions and range information) for use in assessment of potential Project-related effects to fish within the ZOI.</p> <p>A focused background review was subsequently undertaken within the Fraser River fish and fish habitat ZOI (i.e., the sheltered waters of Berths 5 to 10 at FSD where vessel traffic from transiting Project-related vessels will likely concentrate) to assess potential Project-specific effects.</p> <p>Alteration of habitat (i.e., areal effects resulting from installation or replacement of infrastructure such as piles and dolphins) was assessed for the PDA.</p>
Upland fish and fish habitat	<p>Existing conditions for upland fish and fish habitat were initially assessed through a desktop review of existing literature and geospatial databases (e.g., City of Surrey's online mapping system) to determine fish habitat presence and value within the TSA (i.e., upland habitat overlapping with and located within 10 m of the PDA).</p> <p>Data gaps identified during the desktop review were supplemented by field studies aimed at collecting information regarding fish presence, distribution, and relative abundance, including fish sampling using Gee-type minnow traps in accordance with provincial standards and procedures including: <i>Fish Collection Methods and Standards</i> (RISC 1997), and <i>Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures</i> (RISC 2001).</p> <p>Effects resulting from alteration of habitat within the PDA were quantified for the assessment.</p>
Benthic invertebrates	<p>Existing conditions for benthic invertebrates were initially assessed through a desktop review of existing literature and geospatial databases for the TSA.</p> <p>Field sampling was conducted within the ZOI (i.e., in finer-sediment habitat within Berths 5 to 10 at FSD) and within the mainstem portion of Annieville Channel adjacent to FSD within the broader TSA. Sampling was conducted in accordance with federal and provincial standards including the BC Ministry of Water, Land and Air Protection (MWLAP) <i>British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples</i> (2003) and Environment Canada's <i>CABIN: Canadian Aquatic Biomonitoring Network Laboratory Methods, Processing, Taxonomy, and Quality Control of Benthic Macroinvertebrate Sampling</i> (2014).</p> <p>Direct effects to benthic invertebrates were assessed for in-water benthic activities overlapping with the PDA.</p>

Component	Assessment Methods and Techniques
Marine mammals	<p>The presence and distribution of marine mammals that may occur in the TSA (considered to be the same as the ZOI) and PDA were assessed through a desktop review of existing literature and geospatial databases.</p> <p>Specific field surveys were not conducted for marine mammals as these species have been evaluated for previous assessments, including the FSD Direct Transfer Coal Facility, Fraser Grain Export Facility at FSD, South Fraser Perimeter Road, and George Massey Tunnel Replacement.</p>
Species of conservation concern	<p>The presence and distribution of species of conservation concern that may occur within the respective TSAs and ZOIs were assessed through a desktop review of existing literature and geospatial databases (e.g., BC Species and Ecosystem Explorer).</p> <p>Available information on habitat preferences and range information was compiled to assess potential presence of species of conservation concern within the respective TSAs and ZOIs.</p> <p>Field surveys of upland fish and fish habitat were undertaken to confirm habitat availability within the PDA.</p>
Commercial, Recreational, and Aboriginal fisheries	<p>The presence and distribution of CRA fisheries that may occur in the lower Fraser River TSA, ZOI and PDA was assessed through a desktop review of existing literature and geospatial databases. Specifically, information was compiled from Fisheries and Oceans Canada (DFO) and from VFPA data sources in addition to environmental assessment documents issued for previous projects.</p>

In addition to the Aquatics Technical Data Report, this assessment has been informed by the relevant technical reports, including:

- Commercial, Recreational, and Aboriginal Fisheries Overview Technical Data Report (**Attachment 4.2-C**)
- Wildlife Technical Data Report (**Attachment 4.2-M**)
- Plant Communities and At-risk Plants Technical Data Report (**Attachment 4.2-L**)
- Water and Sediment Quality Technical Data Report (**Attachment 4.2-J**)
- River Hydraulics and Morphology Technical Data Report (**Attachment 4.2-I**)
- Land and Water Use Technical Data Report (**Attachment 4.2-F**)
- Traditional Land Use Technical Data Report (**Attachment 4.2-K**).

A summary of the existing conditions, as discussed in the **Aquatics Technical Data Report (Attachment 4.2-A)**, and the above referenced reports, is presented in **Section 5.0** below.

## 5.0 EXISTING CONDITIONS

FSD is an established, active marine terminal with existing berthing and rail and road infrastructure in place. The TSA at FSD overlaps with Annieville Channel, a main area of port activity in the lower Fraser River, designated for deep-sea shipping. A study of ship movements undertaken on behalf of VFPA found approximately 7,706 vessel movements between the mouth of the Fraser River and FSD between July 2010 and June 2011 (DNV 2012). The study however did not account for all traffic in the river, however, given that not all vessels (e.g., small vessels) are required to transmit automatic identification system data. To accommodate marine vessels with large drafts, FSD's berths undergo annual maintenance dredging to maintain an adequate draft of 11.5 m, removing volumes of sediment in the range of approximately 300,000 cubic metres per year (Broś 2007).

The Project site, including the aquatic habitat within and surrounding it, has been highly modified from its pre-development setting (circa 1930) by industrial and transportation activities (such as filling and paving), as well as urbanisation. Drainage within the upland section of the site is generally channelised or culverted and isolated from fish-bearing habitat (e.g., in the Fraser River and Gunderson Slough). The Fraser River, Gunderson Slough (to the south of the PDA) and Manson Canal (to the northeast of the PDA) provide direct habitat value for fish, including CRA species. Several of the upland drainages connecting to these watercourses also have the potential to provide food and nutrient values for fish. Existing conditions as they relate to the identified components are described below and in the **Aquatics Technical Data Report (Attachment 4.2-A)**.

### 5.1 FRASER RIVER FISH AND FISH HABITAT

Within the TSA, the lower Fraser River provides year-round habitat for resident fish, along with migration, rearing, and overwintering habitat for species of CRA value including: Pacific salmon and trout, char, sturgeon, and eulachon (*Thaleichthys pacificus*). The likelihood of these CRA fish to be present within the TSA, ZOI, and PDA is described in **Table 5-1**.

**Table 5-1 Likelihood of Presence of Fish Species of Commercial, Recreational, and Aboriginal Value within the Technical Study Area, Zone of Influence, and Project Development Area**

CRA Species	Likelihood of Presence Within the TSA	Likelihood of Presence within the ZOI and PDA
<b>Salmon</b> ( <i>Oncorhynchus</i> spp.)		
Sockeye salmon ( <i>O. nerka</i> )	Juveniles: High Adults: High (spawners)	Juveniles: Low to Moderate Adults: Low
Chinook salmon ( <i>O. tshawytscha</i> )	Juveniles: High Adults: High (spawners)	Juveniles: High Adults: High (spawners)
Chum salmon ( <i>O. keta</i> )	Juveniles: High Adults: High (spawners)	Juveniles: High Adults: Low
Coho salmon ( <i>O. kisutch</i> )	Juveniles: High Adults: High (spawners)	Juveniles: High Adults: Low
Pink salmon ( <i>O. gorbuscha</i> )	Juveniles: High Adults: High (spawners)	Juveniles: Low Adults: Low
<b>Trout</b> ( <i>Oncorhynchus</i> spp.)		
Rainbow/steelhead trout ( <i>O. mykiss</i> )	Juveniles: High Adults: High	Juveniles: High Adults: High
Coastal cutthroat trout ( <i>O. clarkii clarkii</i> )	Juveniles: High Adults: High	Juveniles: High Adults: Moderate
<b>Char</b> ( <i>Salvelinus</i> spp.)		
Bull trout ( <i>S. confluentus</i> )	Juveniles: High Adults: High	Juveniles: Moderate Adults: Moderate
Dolly Varden ( <i>S. malma</i> )	Juveniles: High Adults: High	Juveniles: Moderate Adults: Moderate
<b>Sturgeon</b> ( <i>Acipenser</i> spp.)		
White sturgeon ( <i>A. transmontanus</i> )	Juveniles: High Adults: High	Juveniles: High Adults: Moderate
Green sturgeon ( <i>A. medirostris</i> )	Juveniles: Low Adults: Low to Moderate	Juveniles: Low to Nil Adults: Low to Nil
<b>Eulachon</b> ( <i>Thaleichthys pacificus</i> )	Juveniles: High Adults: High (spawners)	Juveniles: High Adults: Moderate

Within the PDA, the Fraser River shoreline is coded as low productivity (i.e., green-coded) habitat (**Attachment 4.2-A**; Figure 3-1). Filling, bank armoring, and wharf construction have extensively modified the original shoreline between Berths 9 and 10 (**Attachment 4.2-A**; Photos 1 to 3). Fish habitat within the PDA generally consists of riprap slopes shaded by dock structures and sheet pile walls, with the exception of Berth 10, which comprises monopole dolphins and a pile-supported deck (**Attachment 4.2-A**; Photo 4). The riprap slope adjacent to Berth 10 is backed by a narrow (less than 1 m wide) band of shrubs near the top of bank. Some high-productivity (i.e., red-coded) shoreline exists east of Berth 10, and consists of a narrow band of intertidal marsh and mudflat bordered by an upland riparian fringe. This productive habitat

extends northwest to Timberland Basin (approximately 1 km) upstream of the PDA). Although fish habitat values have been substantially reduced along the sheet pile walls and riprap slopes, the waters adjacent to the FSD berth areas are used by fish including out-migrating juvenile salmonids, as well as adult salmonids and eulachon migrating upriver. The FSD breakwater area within the PDA provides holding habitat for salmonids migrating upriver.

The riverbed sediments near Berth 9 predominantly consist of fine-textured clayey silt sediments. Benthic invertebrate sampling undertaken in support of the Project found that benthic invertebrate productivity within sheltered FSD berths near the PDA was lower than (i.e., less than half that of) an adjacent sampling site in the mainstem of the Fraser River in Annieville Channel (**Attachment 4.2-A**). While the spatial and temporal scale of the sampling data was limited, the preliminary data suggest that overall productivity at berth sites within the ZOI may be lower than those reported in the literature for reference sites within the mainstem Fraser River, which may result in comparatively lower foraging value within the ZOI and PDA for certain CRA fish species.

## 5.2 UPLAND FISH AND FISH HABITAT

Upland streams within the vicinity of FSD have been highly modified from their natural condition as drainage patterns and water quality have been affected from urbanisation in the immediate surrounding area. The existing surface flows for these watercourses are mainly conveyed to the Fraser River through channelised drainages and culverts. The PDA overlaps with daylighted sections of two channelised upland watercourses (Bekaert South Ditch and Robson Ditch), and culverted sections of three other upland drainages (Berth 9 Ditch, Berth 10 Drainage and Bekaert North Ditch) (**Figure 2-3**). Current fish classifications provided by the City of Surrey are defined below:

- Class A: A watercourse inhabited by fish year-round, or potentially inhabited year-round.
- Class A(O): A watercourse inhabited by fish primarily during the overwintering period, or potentially inhabited during the overwintering period with access enhancement.
- Class B: A watercourse that has or currently contributes significant food or nutrient input to downstream fish populations. No fish present.

Class C: A watercourse that does not contribute significant food or nutrient value to downstream fish populations. No fish present.

**Table 5-2** outlines the current fish classifications from the City of Surrey. A summary of the biophysical descriptions of these watercourses from the Aquatics Technical Data Report (Attachment 4.2-A), is provided in the subsections below.

**Table 5-2 Fish Classifications for Assessed Watercourses in the Project Development Area**

Watercourse	Fish Classification (Surrey)
<b>Fraser River Tributaries</b>	
Berth 9 Ditch	Class B
Berth 10 Drainage	Class C
<b>Gunderson Slough and Tributaries</b>	
Bekaert South Ditch	Class C
Bekaert North Ditch	Class C
Robson Ditch	Class C

## 5.2.1 Fraser River Tributaries

### 5.2.1.1 Berth 9 Ditch

The Berth 9 Ditch appears to receive most of its flow from runoff adjacent to the Canadian National Railway and VFPA rail yard. The ditch is approximately 1,200 m long and daylighted for approximately 5 m within the rail yard before it is culverted under FSD's container yards for approximately 525 m (i.e., where it functions as a storm sewer). It discharges under FSD into the Fraser River through a 1,050-millimetre (mm) diameter, flap-gated concrete culvert. Within an upstream daylighted section, the ditch has an average channel width of 2.0 m, depth of 1.5 m, and gradient of 1 percent (%). Here, some instream vegetation is present but there is little overhead cover. Based on the sampling results, access constraints, and water quality conditions observed (primarily low dissolved oxygen levels), the Berth 9 Ditch is not likely to be fish-bearing and would likely not provide habitat for salmonids, though due to its flow and direct connectivity to the Fraser River, the ditch should provide some food and nutrients to downstream fish populations. The Berth 9 Ditch is classified as Class B non-fish-bearing fish habitat by the City of Surrey.

### 5.2.1.2 Berth 10 Drainage

The Berth 10 Drainage was previously an open ditch prior to infilling and culverting in 2004 (Delcan 2004, Google Earth 2017). Currently, the drainage appears to be entirely sourced by stormwater collected from upland areas at FSD, and only daylighted at its outfall at the Fraser River adjacent to Berth 10. The drainage flows into a marsh on the edge of the Fraser River to the north of the site, and a riprapped shoreline to the south. This enclosed drainage does not appear to contribute food or nutrients to downstream fish habitat, nor provide habitat for salmonids or coarse resident fish species. It is classified as a Class C non-fish habitat drainage by the City of Surrey.

## **5.2.2 Gunderson Slough and Tributaries**

### **5.2.2.1 Bekaert South Ditch**

The Bekaert South Ditch is situated parallel to the north side of Elevator Road and receives flow from Bekaert North Ditch and Robson Ditch through culverts located at its east end. The ditch flows west and appears to be hydraulically connected on its downstream end to Gunderson Slough via a 45-m-long, 600-mm-diameter, top-hinged, flap-gated, culvert located at the west end of the ditch. The ditch is approximately 175 m long with an average channel width of 2.5 m, depth of 2.0 m, and gradient of less than 1%. The channel supports abundant instream vegetation, with approximately 25% overhead cover by riparian vegetation. Based on sampling, observed water quality (primarily very low dissolved oxygen levels), and fish access constraints, the Bekaert South Ditch is unlikely to be fish-bearing or provide habitat for salmonids. Although fish habitat values are generally low, due to its instream vegetation, higher flows (combined with Bekaert North Ditch and Robson Ditch), and apparent direct connectivity to Gunderson Slough, this ditch is anticipated to provide some input of food and nutrients to downstream fish populations (i.e., the ditch may be better designated as Class B fish habitat). As currently designated per the municipal classification system, however, the ditch is not considered to provide fish habitat value.

### **5.2.2.2 Bekaert North Ditch**

The Bekaert North Ditch is fed by surface drainage water originating from the southern portions of FSD, and appears to be only wetted during and immediately following rain events. Based on available mapping data, the ditch connects through a 900-mm-diameter, 65-m-long culvert to the east side of the Bekaert South Ditch. The ditch is approximately 2.0 m wide, 2.5 m deep, and 150 m long, with a gradient of approximately 1%. Overhead coverage of the channel by riparian vegetation is approximately 65%. Based on sampling and the hydrological conditions observed during field assessments, the Bekaert North Ditch is unlikely to be fish bearing. The ditch would be better classified as a stormwater channel that, due to factors such as limited flows and its small daylight area, does not provide significant food or nutrients to downstream fish populations.

### **5.2.2.3 Robson Ditch**

The Robson Ditch is approximately 350 m long with an average channel width of 2.0 m, depth of 1.5 m, and a gradient of close to 0%. The ditch parallels the south side of Robson Road. Based on available mapping data, the Robson Ditch flows into the Bekaert South Ditch through a 300-mm, 35-m-long culvert beneath Robson Road. The channel supports abundant instream vegetation although overhead cover of the channel is low (approximately 10%). While the ditch does provide amphibian habitat based on sampling, observed water quality, and potential fish access constraints, the Robson Ditch is unlikely to be fish bearing or provide habitat for salmonids or coarse resident fish species. Due to its low flows, the ditch is not anticipated to provide significant food or nutrients to downstream fish populations.

## 5.3 BENTHIC INVERTEBRATES

### 5.3.1 Sediment Texture

Within the Fraser River South Arm, sediments are dominated by sand with grain sizes ranging in diameter from 0.25 mm to 0.5 mm (Swain and Walton 1991, McLaren and Tuominen 1999, Phippen 2001). Finer-textured clayey and silty sediments tend to accumulate in sloughs, side-channel areas, or nearshore eddies of the Fraser River South Arm, while the higher current areas are characterised by sandy sediments with very limited fines.

A benthic macroinvertebrate sampling program was completed as part of an Aquatics Environmental Assessment program for the Project. The purpose of this program was to collect baseline data with respect to benthic macroinvertebrates and sediment composition at three sampling locations (**Attachment 4.2-A**; Figure 2-2): two locations (BI-SI and BI-U/S) located within the ZOI for benthic invertebrates and one location downstream of the Project site (BI-D/S) in the TSA for benthic invertebrates, which is used as a reference location. Sediment collected from the reference site within Annieville Channel was predominantly sand (97%) with minimal silt (2.5%). Sediments collected at the BI-U/S and BI-SI locations<sup>1</sup> were similar by observation, with sediment at the BI-U/S location comprising a silty loam (64% silt, 23% sand, and 13% clay).

In general, the sediment data indicates that the FSD site is higher in finer sediments than the mainstem of the Fraser River sampled at the reference location. Additional details around sediment composition within the TSA are provided in the **Aquatics Technical Data Report (Attachment 4.2-A)**.

### 5.3.2 Benthic Community

Samples collected from the reference site in Annieville Channel contained the highest total wet weight abundance of invertebrate individuals and number of taxa (i.e., species richness). The benthic community at this site predominantly consisted of infaunal and epifaunal invertebrates (i.e., those that reside within or on bottom substrates, respectively). Specifically, invertebrates comprised 64% molluscs, 33% annelids, and 3% arthropods, and contained 20 and 23 different taxa within the two samples collected. The location was relatively diverse and not dominated by any one taxa.

Invertebrate samples were also collected from two locations near the PFD, BI-SI and BI-U/S. Invertebrate species composition of BI-SI was more similar to the reference location than the BI-U/S location with 71% molluscs, 20% annelids, and 9% arthropods by wet weight versus 30% molluscs, 50% annelids, and 20% arthropods by wet weight at BI-U/S. Species diversity and evenness were similar between the BI-U/S site

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<sup>1</sup> BI-U/S and BI-SI sample locations are outside the PDA, but are considered representative of the sediments within the PDA, inside of the Timberland Training Dyke.

and the BI-D/S reference location with both having lower diversity and evenness than the BI-SI location; however, total abundance and number of taxa at BI-SI and BI-U/S were less than half of that observed at the BI-D/S site.

Overall, invertebrate productivity at the two sampling sites within the benthic invertebrate ZOI (i.e., sample sites BI-SI and BI-U/S) was less than half that of the site sampled in the mainstem of Annieville Channel (i.e., sample site BI-D/S). Additional details on the benthic community composition are documented in the **Aquatics Technical Data Report (Attachment 4.2-A)**.

#### **5.4 MARINE MAMMALS**

A total of 31 species of marine mammals can be found in BC waters (Ford and Nichol 2014), many of which have been observed in the Strait of Georgia and Juan de Fuca Strait. The most commonly observed cetaceans within the Strait of Georgia and Juan de Fuca Strait include:

- Southern resident killer whale (*Orcinus orca* pop. 5; SRKW)
- Harbour porpoise (*Phocoena phocoena*)
- Dall's porpoise (*Phocoenoides dalli*)
- Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) and
- Humpback whale (*Megaptera novaeangliae*).

Lesser common species observed in the area include: minke whale (*Balaenoptera acutorostrata*), grey whale (*Eschrichtius robustus*), and fin whale (*Balaenoptera physalus*). Cetaceans rarely occur within the Fraser River, though sightings are not unheard of (Dunphy 2015, COSEWIC 2016), and are unlikely to occur within or near the PDA.

##### **5.4.1 Humpback Whale**

Humpback whale is common in the Strait of Georgia and Juan de Fuca Strait, particularly during summer months when foraging in BC waters, and while traveling to and from more northern foraging grounds in Alaska. Occasionally, humpback whale occurs near the western extent of the ZOI, near Point Roberts. Critical habitat has been designated under SARA along the southwest part of Vancouver Island for a potentially distinct subpopulation of humpback whale (DFO 2013d). No humpback whale sightings have been reported within the ZOI.

Humpback whale is listed as a species of special concern both by SARA and the provincial *Wildlife Act* (i.e., Blue-listed). Recent studies estimate that between 200 and 400 humpback individuals feed in the waters around northern Washington and southern Vancouver Island (DFO 2013d, Ford et al. 2009, Calambokidis et al. 2008).

#### **5.4.2 Southern Resident Killer Whale**

The SRKW occurs within the western extent of the ZOI, over Roberts Bank. Due to the small population size of this species (approximately 78 individuals as of December 2016; CWR 2016), low reproductive rate, and potential anthropogenic threats (DFO 2011), this subpopulation has been classified as endangered under SARA and provincially threatened and endangered (i.e., Red-listed).

The SRKW Recovery Strategy was released by Fisheries and Oceans Canada (DFO) in 2008 and amended in 2011 (DFO 2011). An Action Plan for SRKW was released in early 2016 (DFO 2016b). Critical SRKW habitat was outlined in the Recovery Strategy and includes the southern portion of the Strait of Georgia, Puget Sound, and the Juan de Fuca Strait. Potential threats to SRKW include acoustic disturbance and physical disturbance (i.e., presence, vessel strike) (DFO 2011).

#### **5.4.3 Harbour Porpoise**

Harbour porpoise generally occupies coastal shelf waters less than 150 m deep, with temperatures ranging between 6 degrees Celsius (° C) to 17° C. Deep-water habitats (waters exceeding 200 m) have been identified in BC, including the Strait of Georgia, off the southwest coast of Haida Gwaii, and southeast of Cape St. James. Little information is presently known about population size or trends of harbour porpoise in BC. Anthropogenic threats to harbour porpoise include habitat degradation due to acoustic disturbance, entanglement in fishing gear, fisheries, shipping traffic, pollution, pathogens, predation, and habitat loss due to coastal developments (COSEWIC 2016).

Harbour porpoise is a likely year-round resident in the Strait of Georgia, and uses this area for foraging and calving. The species commonly occurs over Roberts Bank, but typically does not travel up the Fraser River or occur within the PDA. They are listed as Special Concern both under SARA and the provincial *Wildlife Act*, although a recovery strategy has not been developed for this species.

#### **5.4.4 Pinnipeds**

The most common pinniped species within the ZOI are harbour seal (*Phoca vitulina richardsi*) and Steller sea lion (*Eumetopias jubatus*). California sea lion (*Zalophus californianus*) may also be present, to a lesser extent, within the Juan de Fuca Strait and Strait of Georgia, but is unlikely to occur within or near the PDA.

##### **5.4.4.1 Harbour Seal**

The harbour seal is the most abundant marine mammal species in BC, and is the most commonly occurring marine mammal species in the marine mammal ZOI. Population estimates for harbour seal in BC are at about 105,000 individuals, as of 2008, and may be approaching historic highs (Olesiuk 1999, DFO 2010a). The highest harbour seal densities in BC are found in the Strait of Georgia (13.1 seals per km of shoreline), representing 37% (39,000 individuals) of the provincial population (DFO 2010a). According to a 2000 DFO

assessment, as many as 1,600 harbour seal individuals are present in the Fraser River (Pablo 2008, DFO 2010a).

Harbour seal occur in the Fraser River seasonally, with peak abundance typically coinciding with seasonal physical and biological factors such as availability of prey (e.g., eulachon, salmon). Typically, harbour seal is seen in small groups, resting on exposed rocks and sandbars (Baird 2001), and individuals have been observed as far upstream as 50 km up the Fraser River (DFO 2010a). Several harbour seal haul-out sites have been documented on Roberts Bank and Sturgeon Bank (EAO and VFPA 2012). Due to the species' high abundance throughout BC, harbour seal is not designated as a species of provincial or federal conservation concern.

#### **5.4.4.2 Steller Sea Lion**

Stellar sea lion occasionally ventures into freshwater, as far as 35 km upriver (Olesiuk, unpublished data as cited in DFO 2010b), and may occur near the Project PDA. Individuals also congregate in estuaries during autumn to feed on pre-spawning salmon and at the mouth of the Fraser River in spring when eulachon are running (Bigg 1985, Bigg et al. 1990, Olesiuk, unpublished data as cited in DFO 2010b); however, feeding can occur within about 60 km off shore during summer, and can range over 200 km from shore in winter (Kenyon and Rice 1961; Merrick and Loughlin 1997). A tagging study showed that Steller sea lion captured in BC rarely ventured more than 50 km from shore (DFO 2010b, Olesiuk and Jeffries, unpublished data). Stellar sea lion breeding occurs from May to August (LGL Limited et al. 2009) at four main breeding areas in BC, including the northern tip of Vancouver Island, southern tip of Haida Gwaii, as well as central and northern mainland coasts (DFO 2008, BCMCA Project Team 2011).

The Stellar sea lion hauls out on rocky outcrops, log booms, floats, and docks when not foraging to avoid predators, thermoregulate, engage in social activity, rest, and reproduce. Although the closest documented haul-out site to the Project is near Sand Heads (along the Steveston Jetty) at the mouth of the Fraser River (Jeffries et al. 2000, DFO 2010b), this species is not likely present in large numbers in the Fraser River, and is more common at the mouth of the Fraser River. Steller sea lion is listed as a species of special concern both by SARA and the provincial *Wildlife Act* (i.e., Blue-listed).

### **5.5 SPECIES OF CONSERVATION CONCERN**

Aquatic species of conservation concern associated with the Project that have potential to occur within the defined ZOIs are outlined below. These species are federally listed under SARA or provincially listed as at risk.

There is a low likelihood of encountering any SARA-listed aquatic species, within the ZOI or PDA; however, there is a low to moderate likelihood of encountering these species within the broader TSA. The PDA does not contain critical habitat for any aquatic listed SARA species.

There is potential for encountering provincially at-risk aquatic species within the PDA; however, the habitat productivity values along the shoreline of the PDA are relatively low in comparison to higher productivity habitat immediately adjacent (upstream) of the PDA (**Aquatics Technical Data Report Attachment 4.2-A**; Figure 3-1). **Table 5-3** presents a summary of wildlife species of conservation concern that are likely to occur in the ZOIs for the Project.

**Table 5-3 Summary of Wildlife Species of Conservation Concern Likely to Occur in the Project Zones of Influence**

Species Common Name	Scientific Name	SARA Schedule 1 <sup>1</sup>	BC List <sup>2</sup>	Potential Occurrence <sup>3</sup>	Foraging / Breeding Habitat	Comments <sup>4</sup>
<b>Fish</b>						
Green Sturgeon	<i>Acipenser medirostris</i>	Special Concern	Red	Low to Nil	Yes / No	<ul style="list-style-type: none"> <li>Habitat use by green sturgeon in the Fraser River is not well known, but it may be similar to white sturgeon (see below).</li> </ul>
Brassy Minnow – Pacific Group	<i>Hybognathus hankinsoni</i>	No status	Blue	Low	Yes / No	<ul style="list-style-type: none"> <li>Brassy minnow is generally not found within mainstem habitats of the Fraser River, but its distribution overlaps with sections of the lower Fraser River.</li> <li>Within the TSA, the likelihood of encountering juvenile and adult brassy minnow is moderate. Within the ZOI and PDA, there is low likelihood of encountering juveniles and adults.</li> </ul>
Bull Trout – South Coast BC populations	<i>Salvelinus confluentus</i>	No status	Blue	Moderate	Yes / No	<ul style="list-style-type: none"> <li>Both anadromous and non-anadromous forms of bull trout may be present at or near the site (e.g., during outmigration or seasonally to prey upon juvenile Pacific salmon).</li> </ul>
Coastal Cutthroat Trout – <i>clarkii</i> subspecies	<i>Oncorhynchus clarkii clarkii</i>	No status	Blue	High to Moderate	Yes / No	<ul style="list-style-type: none"> <li>Cutthroat trout present at and near the site are most likely anadromous (during rapid outmigration or up-migration), although river-run cutthroat may also use this portion of the river for foraging. Adults may also use shoreline habitats on a seasonal basis to prey upon seasonally abundant juvenile Pacific salmon.</li> </ul>
Eulachon – Fraser River population	<i>Thaleichthys pacificus</i>	No status	Blue	High to Moderate	Yes / No	<ul style="list-style-type: none"> <li>Suitable spawning habitats for eulachon are not considered to be located within the berths in the ZOI, but may be present within the mainstem channel in association with suitable depths, velocities, and substrates. Tidal habitats within Timberland Basin would provide high-value rearing habitat for fry, with the shoreline along the FSD having general value for outmigration.</li> </ul>
White Sturgeon – Lower Fraser River population	<i>Acipenser transmontanus</i>	No Status (Schedule 3)	Red	High to Moderate	Yes / No	<ul style="list-style-type: none"> <li>The site is in general proximity to preferred habitat for adult white sturgeon (i.e., in and around Annacis Island). Juveniles may seasonally use locations near FSD (lower Timberland Basin and the FSD site) as they prefer shallower depths and are often found in side channels and pools.</li> </ul>

Species Common Name	Scientific Name	SARA Schedule 1 <sup>1</sup>	BC List <sup>2</sup>	Potential Occurrence <sup>3</sup>	Foraging / Breeding Habitat	Comments <sup>4</sup>
<b>Marine Mammals</b>						
Steller sea lion	<i>Eumetopias jubatus</i>	Special Concern	Blue	Moderate	Yes / No	<ul style="list-style-type: none"> <li>Up-river habitat use by Steller sea lion is associated with the timing of eulachon runs, although their closest haul-out site is located near Sand Heads.</li> <li>The potential for Steller sea lion to occur in the ZOI is moderate, with low likelihood of it occurring in the PDA.</li> </ul>
Killer whale	<i>Orcinus orca</i> pop. 5	Endangered	Red	High	Yes / No	<ul style="list-style-type: none"> <li>Critical SRKW habitat includes the southern portion of the Strait of Georgia, Puget Sound, and the Juan de Fuca Strait (DFO 2011), and overlaps with the western extent of the ZOI.</li> <li>There is a high likelihood of use of the western extent of the ZOI by SRKW for foraging and social behaviours; They are unlikely to use any part of the Fraser River.</li> </ul>
Humpback whale	<i>Megaptera novaeangliae</i>	Special Concern	Blue	Moderate	Yes / No	<ul style="list-style-type: none"> <li>Humpback whale is observed frequently foraging south of Vancouver Island and in the Juan de Fuca Strait (DFO 2013d).</li> <li>The potential for Humpback whale to occur within the ZOI is moderate. Humpback whale is unlikely to use any part of the Fraser River with low likelihood of occurring in the PDA.</li> </ul>
Harbour porpoise	<i>Phocoena phocoena</i>	Special Concern	Blue	High	Yes / Yes	<ul style="list-style-type: none"> <li>Harbour porpoise is commonly observed throughout the Strait of Georgia and Juan de Fuca Strait.</li> <li>The potential for Harbour porpoise to occur within the ZOI is high; however, individuals typically do not travel up the Fraser River or occur within the PDA.</li> </ul>

**Notes:**

<sup>1</sup> **Endangered:** a species facing imminent extirpation or extinction.

**Threatened:** a species that is likely to become endangered if limiting factors are not reversed.

**Special Concern:** a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

<sup>2</sup> **Red:** any species that is at risk of being lost (i.e., extirpated, endangered, or threatened). Extirpated taxa no longer exist in the wild in BC, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed.

**Blue:** any species of that is of special concern. Taxa of special concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events.

**Yellow:** any species that is at the least risk of being lost. Yellow-listed species may have red- or blue-listed subspecies.

<sup>3</sup> **High:** current understanding of the species' range and habitat associations suggests that the species is expected to occur in the site regularly and in densities indicative of a preferred habitat.

**Moderate:** species is expected to occur in the site on a temporary or regular (i.e., predictable) seasonal basis and in densities that facilitate persistence of a functional population within the site.

**Low:** current understanding of the species' range and habitat associations suggests that the species is unlikely to occur within the site with regularity or in adequate density to provide a functional population.

<sup>4</sup> More information regarding the likelihood of occurrence of listed species of CRA value (i.e., green sturgeon, bull trout, cutthroat trout, eulachon and white sturgeon) is provided in **Table 5-1** above

## 5.6 COMMERCIAL, RECREATIONAL, AND ABORIGINAL FISHERIES

Existing conditions for CRA fisheries in the vicinity of the Project site are described in the **Commercial, Recreational, and Aboriginal Fisheries Overview Technical Data Report (Attachment 4.2-C)**. Currently, no field studies or focused engagement with respect to fishing has occurred with any CRA fishing groups.

The lower Fraser River supports CRA fisheries primarily targeted at Pacific salmon (see **Table 5-1**). Historically, CRA fisheries in the lower Fraser River also targeted eulachon and sturgeon, but these fisheries are suspended due to conservation concerns for the status of the stocks. Salmon fishing in the lower Fraser River occurs primarily with gill nets, and fisheries openings are relatively short, depending on run strength. Gill net fisheries generally target sockeye and chum salmon runs, but pink and chinook salmon retention is also permitted. A mandatory non-retention and non-possession of coho salmon, steelhead trout, and sturgeon is currently in effect.

Aboriginal groups that may be involved in the lower Fraser River salmon fishery below the Port Mann Bridge include Musqueam Indian Band, Tsawwassen First Nation, Tsleil-Waututh Nation and Qayqayt First Nation, and fish with drift nets downstream of the Port Mann Bridge and into the Strait of Georgia (DFO 2016c). Salmon fishery catch monitoring in this area is conducted by Aboriginal Fishery Officers and fishery observers. Due to the limited nature of the Aboriginal eulachon fishery, fishing times are restricted to one day per year for each communal licence.

Commercial Fraser River salmon fisheries are subject to seasonal openings, which are governed by species abundance and run timings. Aboriginal Pacific salmon fisheries openings for chinook salmon may occur from mid-March through late November, while fishing for chum salmon may occur from October to mid-December. Sockeye salmon openings may occur between late June and late September, while the pink salmon fishery may begin in late August and last through early October (DFO 2015).

Recreational fishing also occurs within the lower Fraser River. Fishing techniques include trolling, mooching, and casting from boats, piers, or the shore. Access to fishing along the lower Fraser River shoreline is possible from recreational parks, piers, boat launches, and private and public marinas.

While navigation on the South Arm is generally unencumbered, during certain periods (e.g., gill net fishery openings), fishing nets may be set within the active channel (VFPA 2016). Many vessels using gill nets operate both by day and night in the Fraser River, with the period of operation typically extending from July 1 to November 1, and sporadically throughout the rest of the year (DFO 2017a). The gill nets used in these fisheries can range up to 375 m in length and may be difficult to see (VFPA 2016, DFO 2017a). Although gill net fishing takes place within the lower Fraser River in vicinity of FSD, the Project site is located at FSD, which is an active marine terminal where no fishing is known to occur; however, CRA fishing occurs within the broader local area of the Fraser River South Arm where there may be interactions with potential shipping activity associated with the Project.

## 6.0 AQUATIC RESOURCES ASSESSMENT

### 6.1 PROJECT INTERACTIONS

Physical works, including activities required for construction and operation of the Project, may interact with environmental components (**Section 2.1**). The following criteria have been used to indicate the degree of the effect from the interaction between the environmental component and each activity (prior to the implementation of mitigation measures):

- 0 indicates no or negligible<sup>2</sup> interaction is likely.
- 1 indicates minor interaction, i.e., an adverse effect may result from an interaction; however, the potential for interaction is considered minor due to spatial or temporal separation between the proposed activity and the component.
- 2 indicates significant interactions that may result in an adverse effect.

A complete interactions matrix is provided in **Table 6-1** below. An assessment of potential effects for identified interactions (i.e., interactions classified as 1 or 2) and measures to mitigate potential adverse effects are provided in the subsections below. Project activities with no or negligible interaction are not discussed further.

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<sup>2</sup> Negligible potential interactions result in effects before mitigation that are so small they are not detectable or measurable, and will not likely influence the short-term or long-term viability of the component.

**Table 6-1 Potential Project Interactions Table for Components within the Project’s Zone of Influence**

Project Activity	Component					
	Fraser River Fish and Fish Habitat	Upland Fish and Fish Habitat	Benthic Invertebrates	Marine Mammals	Species of Conservation Concern	Commercial, Recreational, and Aboriginal Fisheries
<b>Construction</b>						
Demolition of existing infrastructure (including hazardous materials management)	1	1	0	1	1	1
Vegetation removal	0	1	0	0	0	0
Installation of temporary construction trailers and infrastructure (including lighting, petroleum product storage, and materials laydown)	1	1	0	0	1	0
Ground improvements (pre-loading and upland stone columns/piles)	0	0	0	1	1	0
Installation of marine piles	2	0	2	2	2	0
Seismic upgrades for the shiploader (i.e., densification and upland piling)	0	0	0	1	1	0
Excavation	1	1	0	1	1	0
Construction of product unloading facility, storage shed, material handling, and transfer system	1	1	0	1	1	0
Installation of the shiploader	1	0	0	0	0	0
Construction of terminal rail loop	0	1	0	0	0	0
Installation of utilities and stormwater management facilities	1	2	0	0	1	0
Disposal of construction waste (i.e., materials and water)	1	1	0	0	1	0
Transport of people and materials to and from the site	0	0	0	1	1	1

Project Activity	Component					
	Fraser River Fish and Fish Habitat	Upland Fish and Fish Habitat	Benthic Invertebrates	Marine Mammals	Species of Conservation Concern	Commercial, Recreational, and Aboriginal Fisheries
<b>Operation</b>						
Rail traffic	0	1	0	0	0	0
Maintenance of rail right-of-way	0	1	0	0	0	0
Transfer and storage of product at the site	0	1	0	0	0	0
Vessel mooring and loading	1	0	0	0	1	0
Marine vessels traffic	1	0	0	2	2	2
Transport of people and materials to and from the site	0	0	0	0	0	1
Disposal of operation-phase waste	1	1	0	0	1	0
Site lighting	0	0	0	0	0	0
Storage of fuels or petroleum products for equipment	1	1	0	0	1	0
Stormwater management	1	1	1	1	1	0

## 6.1.1 Fraser River Fish and Fish Habitat

### 6.1.1.1 *Potential Project-related Effects*

Project activities for shore-side infrastructure and inwater work in the Fraser River consist of berth improvements and inwater installation of a pile-supported transfer tower located between Berth 10 and the shoreline. Pile driving and structural upgrades are required along the full length of Berth 9. Approximately 186 steel piles will be driven using a shore-side crane. The transfer tower closest to the shiploader will be located in the river, and will consist of approximately 13 steel piles, which will result in shading over approximately 188 square metres (m<sup>2</sup>) of inwater area. Piles are anticipated to be approximately 1,219 mm in diameter, 32 mm in thickness, and 55 m in length. Installation of the transfer tower will include removal of existing riprap on the shoreline slope at the location of the new piles, storing the riprap onsite for later re-use, and preparing an area slightly larger than the pile diameter. The piles will be driven to the depth required (i.e., to refusal). Piling will be either by vibration, impact hammering, or a combination of the two methods, depending on geotechnical requirements. The installation of piles will affect inwater habitat in the Fraser River.

In addition to removal and replacement of existing riprap along the berth, new riprap will be placed around the piles to provide scour protection. Placement of riprap can provide fish habitat complexity, including additional protected rearing habitat (cover) for juvenile fish as well as promoting invertebrate settling (Quigley and Harper 2004). Estimates indicate approximately 25 m<sup>3</sup> of new rip-rap will be required. Any remaining riprap may be used for repairs or improvements at the site as required.

In addition to piling-related effects, during operation, an average of three to four vessels will berth at the site per week (approximately 185 per year), although potash shipments will be dynamic through Project operation. Peak periods of daily activity at the site will be associated with vessel and train arrivals, which could occur at any time of the day and the average loading time for a vessel will be 26 hours.

Potential for lighting effects during operation on fish have been reviewed. However, research is limited with respect to two key factors: dosage (amount of light) and duration (how long lighting is on for) as it relates to impacts on a given species. Effects of lighting on fish are much more difficult to assess than effects on humans, therefore the impact on the majority of species are not well known with respect to dosage and duration. That said, based on the additional lighting proposed for the site, the dosage on the shoreline and Fraser River would be very low and therefore is considered insignificant.

Based on these Project activities, the following land-based and inwater activities (as described in DFO's Pathways of Effects (DFO 2014b), and outlined in **Table 6-2**) have the potential to affect Fraser River fish and fish habitat.

**Table 6-2 Pathways of Effects for Land-based and Instream Construction Activities Potentially Affecting Fraser River Fish and Fish Habitat**

Pathway of Effect	Project Activity
Use of industrial equipment	Industrial equipment will be used throughout Project construction and operation. Project activities that were specifically identified as potentially affecting Fraser River fish and fish habitat pertaining to use of industrial equipment include: <ul style="list-style-type: none"> <li>• Demolition of existing infrastructure (including hazardous materials management)</li> <li>• Installation of temporary construction trailers and infrastructure (including lighting, petroleum product storage, and material laydown)</li> <li>• Installation of marine piles</li> <li>• Excavation</li> <li>• Construction of the product unloading facility, storage shed, material handling, and transfer system</li> <li>• Installation of the shiploader</li> <li>• Installation of utilities and stormwater management facilities</li> <li>• Vessel mooring and loading.</li> </ul>
Excavation	Excavation will occur in the upland area adjacent to the Fraser River during demolition activities and when building foundations for the storage building, conveyor, and transfer tower structures.
Placement of material or structures in water	Placement of structures in water will occur during installation of marine piles.
Contact water management	Contact water will be generated during Project construction and operation: <ul style="list-style-type: none"> <li>• Demolition of existing infrastructure (including hazardous materials management)</li> <li>• Excavation</li> <li>• Disposal of construction waste (i.e., materials and water)</li> <li>• Disposal of operation-phase waste</li> <li>• Stormwater management.</li> </ul>

**6.1.1.2 Mitigation Measures**

A preliminary list of mitigation measures to be implemented to protect Fraser River fish and fish habitat during Project construction and operation is provided in **Table 6-3**, based on the assessed potential for components to interact with Project activities as outlined in **Table 6-1**.

In addition to the measures listed in **Table 6-3**, the following BMPs and guidelines will be applied to protect Fraser River fish and fish habitat:

- Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2016a)
- Fisheries Productivity Investment Policy: A Proponent’s Guide to Offsetting (DFO 2013c)
- Land Development Guidelines for the Protection of Aquatic Habitat (Chilibeck et al. 1993)
- Environmental Management Strategy for Dredging in the Fraser River estuary (FREMP 2006)
- Develop with Care 2012: Environmental Guidelines for Urban and Rural Land Development in British Columbia (MOE 2012)
- Standards and Best Practices for Instream Works (MWLAP 2004).

More detailed measures will be outlined in the Project's **Construction Environmental Management Plan (Attachment 4.3-B)**.

**Table 6-3 Mitigation Measures to Protect Fraser River Fish and Fish Habitat**

Project Activity	Mitigation Measures
<b>Construction</b>	
Demolition of existing infrastructure (including hazardous materials management)	<ul style="list-style-type: none"> <li>• Demolition will likely require deep excavations extending into the groundwater table, which will likely require dewatering and associated testing and treatment prior to discharge to confirm it meets water quality requirements.</li> <li>• A <b>Soil and Groundwater Management Plan (Attachment 4.3-B, Appendix C)</b> is being developed to address soil management, soil sampling, stockpile management, contaminated soil disposal, and groundwater management if these issues are encountered during the construction/decommissioning of site facilities.</li> <li>• A qualified environmental monitor (EM) will be available for activities within environmentally sensitive areas during construction and intrusive soil work onsite including soil excavation/movement.</li> </ul>
Installation of temporary construction trailers and infrastructure (including lighting, petroleum product storage, and materials laydown)	<ul style="list-style-type: none"> <li>• There is increased potential for spills to result when using industrial equipment and storing petroleum products onsite during construction. To minimise the likelihood of adverse effects, fuel and maintenance activities shall be conducted and stored a sufficient distance from the water to prevent any deleterious substances from entering the water.</li> <li>• Emergency spill equipment will be available whenever working near or on the water.</li> <li>• Refer to the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E)</b>.</li> </ul>
Installation of marine piles	<ul style="list-style-type: none"> <li>• To mitigate potential effects, pile installation will be consistent with the <i>Best Management Practices for Pile Driving and Related Operations</i> (MPDCA and DFO 2003).</li> <li>• For pile driving, a vibratory hammer will be used wherever feasible, as this method produces lower sound levels than the conventional impact driver. Where this method cannot be used due to engineering constraints, an impact hammer may be used. A common method employed to reduce sound levels associated with impact hammers is the use of a bubble curtain, which attenuate the sounds produced during impacts by approximately 10 decibels (dB) to 15 dB (Stantec 2011). During pile driving, bubble curtains may also be used (i.e., to dampen overpressure waves and to reduce sound levels emitted within the Fraser River).</li> <li>• Noise from pile driving should meet interim criteria for fish (i.e., peak sound pressure level should not exceed 206 dB per single strike) (Reinhall et al. 2016). Acoustic monitoring can be conducted at Project startup, and on a selected basis thereafter (depending on conditions and observations).</li> <li>• Slow commencement of inwater activities is recommended to encourage mobile fish species to leave the construction area.</li> <li>• Inwater works in the Fraser River should adhere to the Timing Window for the Protection of Fish and Fish Habitat (DFO 2017b) of June 16 – February 28, unless authorized to occur outside of those times.</li> </ul>

Project Activity	Mitigation Measures
Excavation	<ul style="list-style-type: none"> <li>• Since the major effects of excavation on Fraser River fish and fish habitat relate to water quality, the work generally will be conducted in adherence with water quality guidance as provided in British Columbia Water Quality Guidelines (Criteria): January 2017 Edition (MOE 2017).</li> <li>• Erosion and sediment control (ESC) measures will be implemented and maintained throughout construction.</li> <li>• A <b>Soil and Groundwater Management Plan (Attachment 4.3-B, Appendix C)</b> is being developed to address soil management, soil sampling, stockpile management, contaminated soil disposal, and groundwater management if these issues are encountered during the construction/decommissioning of site facilities.</li> <li>• A qualified EM will be available for activities within environmentally sensitive areas during construction and intrusive soil work onsite including soil excavation/movement.</li> </ul>
Construction of product unloading facility, storage shed, material handling, and transfer system	<ul style="list-style-type: none"> <li>• An increased potential for spills may result when using industrial equipment and storing petroleum products onsite during construction. To minimise the likelihood of adverse effects, fuel and maintenance activities shall be conducted and stored a sufficient distance from the water to prevent any deleterious substances from entering the water.</li> <li>• Emergency spill equipment will be available whenever working near or on the water.</li> <li>• Refer to the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E)</b>.</li> </ul>
Installation of the shiploader	<ul style="list-style-type: none"> <li>• The shiploader will be constructed along the edge of the Fraser River which increases the potential for spills or other construction-related materials to enter the water. To minimise the likelihood of adverse effects, fuel and maintenance activities shall be conducted and stored a sufficient distance from the water to prevent any deleterious substances from entering the water.</li> <li>• Emergency spill equipment will be available whenever working near or on the water.</li> <li>• Refer to the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E)</b>.</li> </ul>
Installation of utilities and stormwater management facilities	<ul style="list-style-type: none"> <li>• During installation of utilities and stormwater management facilities there is an increased potential for spills and generation of sediment. To minimise the likelihood of adverse effects, fuel and maintenance activities shall be conducted and stored a sufficient distance from the water to prevent any deleterious substances from entering the water.</li> <li>• Emergency spill equipment will be available whenever working near or on the water.</li> <li>• Refer to the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E)</b>.</li> <li>• Erosion and sediment control measures will be implemented and maintained throughout construction.</li> </ul>
Disposal of construction waste (i.e., materials and water)	<ul style="list-style-type: none"> <li>• Construction waste will be disposed of at approved facilities, and any contact water will be tested to confirm that it meets water quality guidelines (e.g., in adherence with the British Columbia Water Quality Guidelines (Criteria): January 2017 Edition (MOE 2017)) prior to being discharged back into the environment.</li> <li>• A <b>Soil and Groundwater Management Plan (Attachment 4.3-B, Appendix C)</b> is being developed to address soil management, soil sampling, stockpile management, contaminated soil disposal and groundwater management if these issues are encountered during the construction/decommissioning of site facilities.</li> </ul>

Project Activity	Mitigation Measures
<b>Operation</b>	
Vessel mooring and loading	<ul style="list-style-type: none"> <li>• The potential for potash spills will be reduced as transfer equipment is enclosed.</li> <li>• Spill prevention will be addressed throughout the operation phase, through routine inspections and maintenance of tracks, receiving pits, and conveyers.</li> </ul>
Marine vessels traffic	<ul style="list-style-type: none"> <li>• See assessment of residual effects below.</li> </ul>
Disposal of operation-phase waste	<ul style="list-style-type: none"> <li>• Waste will be appropriately disposed of at approved facilities.</li> </ul>
Storage of fuels or petroleum products for equipment	<ul style="list-style-type: none"> <li>• Spill prevention will be addressed throughout the operation phase, through routine inspections and maintenance of the track, receiving pits, and conveyers.</li> <li>• Follow the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E)</b>.</li> </ul>
Storage of potash	<ul style="list-style-type: none"> <li>• Appropriate flood protection measures will be implemented for the potash storage building to protect against major potash-affected water releases to fish-bearing water.</li> </ul>
Stormwater management	<ul style="list-style-type: none"> <li>• A <b>Stormwater Pollution Prevention Plan (Attachment 4.3-A)</b> is being developed, which identifies best management practices (BMPs) to improve the quality of stormwater discharged from the facility. These include reducing the amount of stormwater discharged to the environment, preventing or reducing the pollutant loading of stormwater, and treating or otherwise managing stormwater if pollutant loading cannot be prevented. The management strategy includes good housekeeping, preventive maintenance, containment/reduction, spill prevention and response, and treatment.</li> </ul>

### 6.1.1.3 Residual Effects

Identified effects were evaluated according to criteria as outlined in **Table 6-4**. A summary of the assessment of serious harm for each of the potential residual effects is provided in **Table 6-5**; however, the assessment does not consider the effects of increased marine traffic on fish behaviour. Few published studies have examined the behavioural responses of fish to underwater sounds produced by large ocean-going vessels (Stantec 2011). The studies that do exist have found some evidence of localised avoidance and changes in school structure and swim depth; however, the geographic extent over which these effects are realised, and how individual or population-level fitness is affected have not been quantified. Fish within the ZOI may exhibit a localised behavioural response to the sounds produced by transiting vessels; however, there is no qualitative or quantitative evidence that vessel traffic interferes with the foraging or migratory behaviour of Fraser River fish. For example, the Fraser River is one of the busiest shipping regions on the west coast of North America, and underwater sounds produced by large vessels is pervasive in this environment; however, the Fraser River still supports some of the largest runs of salmon in Canada (Stantec 2011). Thus, these sensory disturbances are not expected to compromise the fitness or survival of any fish.

Overall, the risk of serious harm associated with the potential effects was assessed as low, provided that the recommended mitigation measures are implemented during construction. All potential adverse effects are considered insignificant or avoidable with mitigation. Permanent residual adverse effects to Fraser River fish and fish habitat are not likely during Project operation.

**Table 6-4 Criteria Used to Evaluate Effects on Fisheries Resources**

Characteristic and Description		Rank and Description of Associated Effect	
Likelihood	Likelihood and risk of the residual effect occurring	Likely	Residual effect likely to occur
		Unlikely	Residual effect unlikely to occur
Duration	Length of time over which the residual effect is expected to persist. For example, is the duration short enough that the effect does not diminish the ability of fish to carry out one or more of its life processes?	Short Term	Days to weeks
		Moderate Term	Months to year
		Long Term	Multiple years to permanent
Magnitude	Intensity of the effect relative to natural or baseline conditions	Negligible or Nil	No measurable change in fish populations, fish habitat quality or quantity, parameter
		Low	A measurable change within the range of natural variability, but not affecting fish population viability
		Moderate	A measurable change outside the range of natural variability, but not posing a risk to fish population viability
		High	A measurable change outside the range of natural variability and may affect long-term fish population viability
Geographic Scale	Geographic extent / distribution of the residual effect. For example, is the scale small enough that the disturbance will not displace fish that would otherwise be occupying the habitat?	Site	Site/segment, localised effect or temporary displacement
		Reach	Waterbody significantly affected or permanent displacement (channel reach or lake region)
		Waterbody	Majority of waterbody affected or permanent displacement (watershed or lake)
Reversibility	Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased)	Reversible	Baseline conditions will be naturally restored after disturbance has ceased
		Irreversible	Baseline conditions will not be naturally restored after disturbance has ceased
Ecological Context	The availability and condition of the habitat to be altered, relative to nearby fish habitat. For example, is the habitat that is being altered or destroyed the only habitat of its type and quality in the Project area?	Prevalent	Altered habitat is prevalent and widely distributed in the TSA or waterbody is still suitable
		Limited	Altered habitat is confined to small areas or has limited distribution in the TSA or waterbody and is significantly reduced in quality
		Rare	Altered habitat is rare or limiting (e.g., critical habitat for species at risk) and is no longer suitable

**Table 6-5 Assessment of Serious Harm and Potential for Residual Effects for Fraser River Fish and Fish Habitat**

Potential Effect	Associated Pathway of Effects	Potential Risk of Residual Serious Harm	Criteria						Rationale
			Likelihood	Duration	Magnitude	Geographic Scale	Reversibility	Ecological Context	
Potential mortality of fish/eggs/ova	<ul style="list-style-type: none"> <li>Placement of materials or structures in water</li> </ul>	Low	Unlikely	Short Term	Negligible	Site	Reversible	Prevalent	<p>The Project will involve installation of marine piles. Inwater sounds produced during the construction phase (e.g., pile driving) may elicit localised behavioural responses in Fraser River fish, which may result in temporary avoidance of the area. In extreme cases, acoustic effects could result in injury or fatality of affected animals; however, based on existing conditions (including the silty loam sediment type) and implementation of mitigation measures as required (e.g., bubble curtains, acoustic monitoring,), sound levels will not likely be of sufficient intensity to cause physical harm to fish. Any adverse responses to fish behaviour will likely return to normal when sound production ceases. Activities will not likely result in harm or residual effects to fish as these organisms are mobile and will likely avoid directly affected habitats.</p> <p>Sounds produced by pile driving are anticipated to be below the threshold levels capable of inducing injury or mortality to fish. By implementing appropriate mitigation measures (see <b>Table 6-3</b>), the potential risk of residual effects is low.</p>
Change in habitat structure and cover	<ul style="list-style-type: none"> <li>Placement of materials or structures in water</li> </ul>	Low	Likely	Long Term	Low	Site	Reversible	Prevalent	<p>Some alteration of in-river habitat (e.g., increased shading and installation of piles) is anticipated from construction of an inwater transfer tower and berth improvements; however, the shoreline adjacent to the PDA is designated as relatively low-productivity habitat, which likely does not provide any spawning habitat, but may provide areas for rearing fish and act as a migratory corridor. Given the low-risk nature of the works (i.e., installation of piles) potential risk of residual effects is low; however, as a precautionary measure, this aspect of the Project will be submitted for a project review by DFO.</p>
Change in sediment concentration	<ul style="list-style-type: none"> <li>Use of industrial equipment</li> <li>Excavation</li> <li>Placement of material or structures in water</li> <li>Contact water management</li> </ul>	Low	Likely	Short Term	Low	Site	Reversible	N/A	<p>Use of industrial equipment for ground-disturbing upland activities (e.g., excavation works) in addition to inwater pile driving (i.e., placement of material or structures in water) and contact water management may all change sediment concentrations in the receiving environment. Sediment and suspended solids can be detrimental to fish with effects such as reduced light penetration, increased water temperature, smothering of habitats, reduced oxygen, and injury to fish. Increased turbidity can cause behavioural responses in fish including stress, reduced feeding, impacts to growth rates, and potentially even death; however, by implementing appropriate mitigation measures (e.g., erosion and sediment control (ESC) measures and stormwater management) the potential risk of residual effects is low.</p>
Change in contaminant concentrations	<ul style="list-style-type: none"> <li>Use of industrial equipment</li> <li>Excavation</li> <li>Contact water management</li> </ul>	Low	Unlikely	Short Term	Low	Site/Reach	Reversible	N/A	<p>Use of industrial equipment in the upland and inwater environment, and contact water management may change contaminant concentrations in the receiving environment. Degradation of water quality (with potential effects to downstream fish and fish habitat) may result due to the introduction of hazardous materials such as gasoline, diesel fuel, hydraulic fluids, and/or lubricants used during construction. Other examples of hazardous materials that are likely to be associated with the Project include dry concrete products and concrete contact water, solvents, and waste oils. Activities with the potential to expose stormwater runoff to contaminants include waste disposal, fueling of vehicles, routine servicing of equipment, and repair and maintenance activities. Project-related hazardous materials that may interact with stormwater are petroleum fuels (diesel and gasoline), concrete (contact water), solid waste/garbage, hydraulic and lubricating oils, coolants, and antifreeze.</p> <p>Additionally, excavation activities have the potential to change contaminant concentrations. A Phase I and II Environmental Site Assessment was undertaken for the Project, which concluded that there is potential for previous onsite operations to have caused constituents of concern to be present in the soil, groundwater, and potentially soil vapour at levels of concern. However, by implementing appropriate mitigation measures (e.g., in the <b>Stormwater Pollution Prevention Plan (Attachment 4.3-A)</b> and <b>Soil and Groundwater Management Plan (Attachment 4.3-B, Appendix C)</b>, the potential risk of residual effects is low.</p> <p>Operations that may result in potash spillage include receiving (unloading of railcars and around the railcar unloading station), transfer of stored potash (although risk of spillage is low as all equipment will be enclosed with a dust collector), reclaim from storage (although risk of spillage is low as all equipment is enclosed), and ship loading (potential spillage, but generally restricted to the vessel deck). There is some potential for potash to be accidentally released into the aquatic environment (e.g., due to equipment malfunction). If an accumulation occurs there could be temporary, localised adverse effects to aquatic organisms; however, potash dissolves rapidly in water and is non-toxic (UNEP 2001); effects will likely be minimal, resulting only in potential localised increases in salinity. Waters surrounding FSD exhibit dynamic fluctuations in salinity (as a result of freshet and tidal inputs from the Strait of Georgia). Species living in environments with dynamic salinity fluctuations have adapted to those conditions and are generally tolerant of changes. As such, the potential risk of residual effects is low.</p>

## **6.1.2 Upland Fish and Fish Habitat**

### **6.1.2.1 Potential Project-related Effects**

Upland works most likely to affect fish and fish habitat are activities associated with construction of the rail loop. The new rail loop will include three tracks for both inbound and outbound trains (i.e., it will be able to accommodate a total of three trains to allow for one train to be unloaded while a second train is waiting to be unloaded and a third train is leaving the site empty). The rail right-of-way will be excavated to rough grade, backfilled with sub-base and base, then compacted with crushed stone to form the track ballast. Wooden or pre-cast concrete railway ties will then be installed on the prepared surfaced, followed by laying of steel rails. Crushed stone will be laid between the railway ties, and the ballast will be compacted by a tamping machine.

The stormwater system (affecting some culverted drainages) within the PDA will also require some minor re-alignments and slight re-positioning of one outfall (the Berth 9 Ditch). The new bypass storm sewer will be constructed around the north end of the proposed storage building, and the existing storm sewer will be removed. The storm sewer re-alignments and re-positioned outfall will not likely change the quantity and quality characteristics of the stormwater runoff. A small increase is expected in impervious surface area where the railway track area will either be paved or covered by roofed-over structures.

The construction phase will result in loss and alteration of low-quality upland instream and riparian features as a result of culverting and riparian removal associated with construction of the rail corridor. Of the watercourses with potential to be affected, none were assessed to be fish-bearing, with the majority of watercourses not classified by the City of Surrey as fish habitat. Only one watercourse (Berth 9 Ditch) is classified by the City of Surrey as providing some fish habitat value (i.e., it is a Class B ditch), but only culverted sections of the watercourses underneath FSD will likely be affected.

Potential quantitative effects of the Project on upland instream and riparian features (predominantly roadside ditches) was assessed for affected instream and riparian features based on the current design for the Project (**Table 6-6**).

**Table 6-6 Potential Project-related Effects to Upland Watercourses**

Watercourse	Potential Project-related Effects <sup>1</sup>	Estimate of Affected Area <sup>2</sup>
Bekaert South Ditch	<ul style="list-style-type: none"> <li>Removal of riparian vegetation along most of the north (right) bank of the 175-m-long ditch</li> </ul>	Riparian = 1,500 m <sup>2</sup> (Class C)
Robson Ditch	<ul style="list-style-type: none"> <li>Culverting along the 350-m-long, 2-m-wide ditch</li> <li>Installation of a diagonal culvert (southwesterly alignment) at the south end of the ditch</li> <li>Installation of a southward-aligned culvert off the south end of the diagonal culvert</li> </ul>	Instream = 700 m <sup>2</sup> (Class C) Riparian = 1,750 m <sup>2</sup> (Class C)
Bekaert North Ditch	<ul style="list-style-type: none"> <li>Crossing of a culverted section of the ditch on its east end (where it meets the Robson Ditch culvert junction)</li> </ul>	n/a <sup>3</sup>
Berth 9 Ditch	<ul style="list-style-type: none"> <li>Construction of a building overtop a culverted section of the ditch (i.e., a storm sewer) on its east end</li> <li>Lateral re-alignment of the culvert system on its east end towards the north, around the north end of the proposed storage building</li> <li>Construction of a shiploader facility overtop a culverted section of the ditch and outfall (i.e., a storm sewer) on its west end</li> <li>Lateral re-alignment of the culvert system on its west end slightly to the south (between proposed rows of piles)</li> </ul>	n/a
Berth 10 Drainage	<ul style="list-style-type: none"> <li>Construction of a conveyor tower overtop a culverted section of the ditch (i.e., a storm sewer) on its west end</li> <li>Lateral re-alignment of the culvert system near its west end towards the north, around the proposed conveyer tower</li> <li>Railway crossing of the culvert (i.e., a storm sewer) at its west end</li> </ul>	n/a

<sup>1</sup>The above effects are subject to revision during further development and refinement of the Project design.

<sup>2</sup>Rough area impact estimates were calculated with regard to existing conditions onsite (e.g., lack of riparian habitat along some channel banks) using the average channel width of the ditch, existing riparian vegetation width, and with reference to the City of Surrey's stream classification and setback areas for ditches (City of Surrey 1993). Note: For Class A(O) ditches in the City of Surrey, the minimum setback distance from top of bank is 10 m, while the minimum distance from Class B ditches is 7 m. No setback is required for Class C watercourses as they do not constitute fish habitat.

<sup>3</sup>Indicates no effect to the open channel (i.e., due to the culverted nature of the drainages).

Following a review of the anticipated Project activities, the following land-based and inwater activities, as described by DFO Pathways of Effects, and outlined in **Table 6-7**, may affect upland fish and fish habitat.

**Table 6-7 Pathways of Effects for Land-based and Instream Construction Activities Potentially Affecting Upland Fish and Fish Habitat**

Pathway of Effect	Project Activity
Use of industrial equipment	<p>Industrial equipment will be used throughout Project construction and operation. Project activities that were specifically identified as potentially affecting upland fish and fish habitat pertaining to use of industrial equipment include:</p> <ul style="list-style-type: none"> <li>• Demolition of existing infrastructure (including hazardous materials management)</li> <li>• Vegetation removal</li> <li>• Installation of temporary construction trailers and infrastructure (including lighting, petroleum product storage, and material laydown)</li> <li>• Excavation</li> <li>• Construction of the product unloading facility, storage shed, material handling, and transfer system</li> <li>• Construction of the terminal rail loop</li> <li>• Installation of utilities and stormwater management facilities</li> <li>• Maintenance of rail right-of-way.</li> </ul>
Grading	Grading will be undertaken for construction of the terminal rail loop, which is located adjacent or overtop several of the upland ditches.
Vegetation clearing	Vegetation will be removed during construction of the terminal rail loop and during maintenance of the rail right-of-way throughout operation of the Project.
Removal of aquatic vegetation	Aquatic vegetation will be removed during culverting of upland ditches.
Excavation	Excavation will occur in the upland area adjacent to several of the upland ditches and has potential to affect water quality in the ditches.
Placement of material or structures in water	Culverting of several of the upland ditches will be required to facilitate construction of the terminal rail loop. One culverted ditch (Berth 9 Ditch) will require re-alignment.
Contact water management	<p>Through Project construction and operation, contact water will be generated. Some of the Project activities that this applies to are:</p> <ul style="list-style-type: none"> <li>• Demolition of existing infrastructure (including hazardous materials management)</li> <li>• Excavation</li> <li>• Disposal of construction waste (i.e., materials and water)</li> <li>• Disposal of operation-phase waste</li> <li>• Storage of fuels or petroleum products for equipment</li> <li>• Stormwater management</li> </ul>

**6.1.2.2 Mitigation Measures**

A preliminary list of mitigation measures to be implemented to protect Upland fish and fish habitat during Project construction and operation is provided in **Table 6-8**, based on the assessed potential for components to interact with Project activities as outlined **Table 6-1**. In addition to the measures listed in **Table 6-8**, the BMPs listed in **Section 6.1.1.2** will be followed. More detailed measures will be outlined in the Project's **Construction Environmental Management Plan (Attachment 4.3-B)**.

**Table 6-8 Mitigation Measures to Protect Upland Fish and Fish Habitat**

Project Activity	Mitigation Measures
<b>Construction</b>	
Demolition of existing infrastructure (including hazardous materials management)	<ul style="list-style-type: none"> <li>• Demolition will likely require deep excavations extending into the groundwater table, which will likely require dewatering and associated testing and treatment prior to discharge to confirm it meets water quality requirements.</li> <li>• A <b>Soil and Groundwater Management Plan (Attachment 4.3-B, Appendix C)</b> is being developed to address soil management, soil sampling, stockpile management, contaminated soil disposal, and groundwater management if these issues are encountered during the construction/decommissioning of site facilities.</li> <li>• A qualified Environmental Monitor (EM) will be available for activities within environmentally sensitive areas during construction and intrusive soil work onsite including soil excavation/movement.</li> </ul>
Vegetation removal	<ul style="list-style-type: none"> <li>• Removal of riparian vegetation on not fish-bearing watercourses (Class C) is anticipated to occur in the Project area. Restoration of disturbed areas along ditches will be completed, where practical, as soon as possible after disturbance.</li> </ul>
Installation of temporary construction trailers and infrastructure (including lighting, petroleum product storage, and material laydown)	<ul style="list-style-type: none"> <li>• There is increased potential for spills to result when using industrial equipment and storing petroleum products onsite during construction. To minimise the likelihood of adverse effects, fuel and maintenance activities shall be conducted and stored a sufficient distance from the water to prevent any deleterious substances from entering the water.</li> <li>• Emergency spill equipment will be available whenever working near or on the water.</li> <li>• Refer to the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E)</b>.</li> </ul>
Excavation	<ul style="list-style-type: none"> <li>• As the major effects of excavation on upland fish and fish habitat relates to water quality, the work will generally be conducted in adherence with water quality guidance as provided in British Columbia Water Quality Guidelines (Criteria): January 2017 Edition (MOE 2017).</li> <li>• Erosion and sediment control (ESC) measures will be implemented and maintained throughout construction.</li> <li>• A <b>Soil and Groundwater Management Plan (Attachment 4.3-B, Appendix C)</b> is being developed to address soil management, soil sampling, stockpile management, contaminated soil disposal and groundwater management if these issues are encountered during the construction/decommissioning of site facilities.</li> <li>• A qualified EM will be available for activities within environmentally sensitive areas during construction and intrusive soil work onsite including soil excavation/movement.</li> </ul>
Construction of product unloading facility, storage shed, material handling, and transfer system	<ul style="list-style-type: none"> <li>• There is increased potential for spills to result when using industrial equipment and storing petroleum products onsite during construction. To minimise the likelihood of adverse effects, fuel and maintenance activities shall be conducted and stored a sufficient distance from the water to prevent any deleterious substances from entering the water.</li> <li>• Emergency spill equipment will be available whenever working near or on the water.</li> <li>• Refer to the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E)</b>.</li> </ul>

Project Activity	Mitigation Measures
<p>Construction of a terminal rail loop</p>	<ul style="list-style-type: none"> <li>• Removal of riparian vegetation on not fish-bearing watercourses (Class C) is anticipated to occur in the Project area. Restoration of disturbed areas along ditches will be completed, where possible, as soon as possible after disturbance.</li> <li>• Erosion and sediment control measures will be implemented and maintained throughout construction.</li> <li>• To meet water quality standards, ditch culverting should be scheduled when ditches are driest and water in the ditches shall be pumped to an approved area for infiltration prior to culverting.</li> <li>• Conduct a salvage of fish on any wetted channel prior to instream work. Monitor water drawdown of ditches to confirm that no fish are present. A qualified EM will be onsite to confirm no fish are present, and all native amphibians have been salvaged. Due to the anticipated conditions, salvage methods will primarily focus on traps and visual observations during dewatering. Electrofishing may be conducted in suitable areas</li> <li>• There is also increased potential for spills to result when using industrial equipment and storing petroleum products onsite during construction. To minimise the likelihood of adverse effects, fuel and maintenance activities shall be conducted and stored a sufficient distance from the water to prevent any deleterious substances from entering the water.</li> <li>• Emergency spill equipment will be available whenever working near or on the water. Refer to the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E)</b>.</li> <li>• The work will generally be conducted in adherence with water quality guidance as provided in British Columbia Water Quality Guidelines (Criteria): January 2017 Edition (MOE 2017).</li> </ul>
<p>Installation of utilities and stormwater management facilities</p>	<ul style="list-style-type: none"> <li>• During installation of utilities and stormwater management facilities there is an increased potential for spills and generation of sediment. To minimise the likelihood of adverse effects, fuel and maintenance activities shall be conducted and stored a sufficient distance from the water to prevent any deleterious substances from entering the water.</li> <li>• Emergency spill equipment will be available whenever working near or on the water. Refer to the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E)</b>.</li> <li>• Erosion and sediment control measures will be implemented and maintained throughout construction.</li> </ul>
<p>Disposal of construction waste (i.e., materials and water)</p>	<ul style="list-style-type: none"> <li>• Construction waste will be disposed of at approved facilities, and any contact water will be tested to confirm that it meets water quality guidelines (e.g., in adherence to the British Columbia Water Quality Guidelines (Criteria): January 2017 Edition (MOE 2017)) prior to being discharged back into the environment.</li> <li>• A <b>Soil and Groundwater Management Plan (Attachment 4.3-B, Appendix C)</b> is being developed to address soil management, soil sampling, stockpile management, contaminated soil disposal, and groundwater management if these issues are encountered during the construction/decommissioning of site facilities.</li> </ul>

Project Activity	Mitigation Measures
<b>Operation</b>	
Rail traffic	<ul style="list-style-type: none"> <li>• Potential for potash spills will be reduced as transfer equipment is enclosed.</li> <li>• Spill prevention will be addressed throughout the Project's operation phase, through routine inspections and maintenance of track, receiving pits, and conveyers.</li> </ul>
Maintenance of rail right-of-way	<ul style="list-style-type: none"> <li>• Ongoing maintenance of the rail right-of-way, which may include vegetation clearing with industrial machinery, will be required throughout Project operation.</li> <li>• Spill prevention will be addressed throughout the Project's operation phase.</li> <li>• <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E).</b></li> </ul>
Disposal of operation-phase waste	<ul style="list-style-type: none"> <li>• Waste will be appropriately disposed of at approved facilities.</li> </ul>
Storage of fuels or petroleum products for equipment	<ul style="list-style-type: none"> <li>• Spill prevention will be addressed throughout the operation phase, through routine inspections and maintenance of the track, receiving pits, and conveyers.</li> <li>• Refer to the <b>Spill Prevention and Emergency Response Plan (Attachment 4.3-E).</b></li> </ul>
Storage of potash	<ul style="list-style-type: none"> <li>• Appropriate flood protection measures will be implemented for the potash storage building to protect against major potash-affected water releases to fish-bearing water.</li> </ul>
Stormwater management	<ul style="list-style-type: none"> <li>• A <b>Stormwater Pollution Prevention Plan (Attachment 4.3-A)</b> is being developed, which identifies BMPs to improve the quality of stormwater discharged from the facility. These include reducing the amount of stormwater discharged to the environment, preventing or reducing the pollutant loading of stormwater, and treating or otherwise managing stormwater if pollutant loading cannot be prevented. The management strategy includes good housekeeping, preventive maintenance, containment/reduction, spill prevention and response, and treatment.</li> </ul>

### 6.1.2.3 Residual Effects

A summary of the assessment of serious harm for each of the potential residual effects is provided in **Table 6-9**. Overall, the risk of serious harm associated with the potential effects was assessed as low, provided that the recommended mitigation measures are implemented during construction. All potential adverse effects are considered insignificant or avoidable with mitigation. Permanent residual adverse effects to upland fish or fish habitat are not anticipated from Project-related construction or operation-phase activities.

**Table 6-9 Assessment of Serious Harm and Potential for Residual Effects on Upland Fish and Fish Habitat**

Potential Effect	Associated POEs	Potential Risk of Residual Serious Harm	Criteria						Rationale
			Likelihood	Duration	Magnitude	Geographic Scale	Reversibility	Ecological Context	
Change in habitat structure and cover	<ul style="list-style-type: none"> <li>Placement of material or structure in water</li> <li>Vegetation clearing</li> <li>Removal of aquatic vegetation</li> </ul>	Low	Unlikely	Long Term	Low	Site	Irreversible	Prevalent	The construction phase will result in habitat loss and alteration of low-quality upland instream and riparian habitat features as a result of culverting and riparian removal associated with construction of the rail corridor. Removal of the channel and vegetation (instream and riparian) can result in adverse effects on downstream fish habitat. These areas can provide food and nutrients (e.g., plant litter and insect drop) for downstream fish (e.g., Gunderson Slough). Riparian vegetation also helps to protect water quality by filtering stormwater runoff (e.g., removing sediments, heavy metals, and other pollutants), reducing stormwater runoff volume, increasing soil and groundwater infiltration, stabilising banks, and preventing excessive erosion. However, as the affected ditches are not classified as fish habitat by the City of Surrey, there is a low likelihood of the Project altering upland fish habitat.
Potential mortality of fish/eggs/ova	<ul style="list-style-type: none"> <li>Placement of material of structure in water</li> </ul>	Low	Unlikely	Long Term	Negligible	Site	Irreversible	N/A	The Project will involve culverting a non-fish-bearing ditch (i.e., Robson Ditch). Precautionary measures will be undertaken during culverting (e.g., fish and amphibian salvages) to reduce the potential of direct mortality to aquatic organisms. As such, the potential mortality of fish/eggs/ova resulting from direct placement of material in water is unlikely to occur.
Change in sediment concentration	<ul style="list-style-type: none"> <li>Use of industrial equipment</li> <li>Grading</li> <li>Excavation</li> <li>Placement of material or structures in water</li> <li>Vegetation clearing</li> <li>Removal of aquatic vegetation</li> <li>Contact water management</li> </ul>	Low	Unlikely	Short Term	Low	Site	Reversible	N/A	Use of industrial equipment for ground-disturbing upland activities (e.g., grading and excavation works) in addition to culverting and removal of instream and riparian features (i.e., placement of material of structures in water, removal of aquatic vegetation and vegetation clearing) and contact water management all have the potential to change sediment concentrations in the receiving environment. Sediment and suspended solids can be detrimental to fish with effects such as reduced light penetration, increased water temperature, smothering of habitat, reduced oxygen, and injury to fish. Increased turbidity can also elicit behavioural responses in fish including stress, reduced feeding, impacts to growth rates, and potentially even death; however, by implementing appropriate mitigation measures (e.g., erosion and sediment control and stormwater management) the potential risk of residual effects to fish is low.
Change in contaminant concentrations	<ul style="list-style-type: none"> <li>Use of industrial equipment</li> <li>Grading</li> <li>Vegetation clearing</li> <li>Removal of aquatic vegetation</li> <li>Contact water management</li> </ul>	Low	Unlikely	Short Term	Low	Site/Reach	Reversible	N/A	<p>Use of industrial equipment in the upland, grading on a historically disturbed site, and contact water management may change contaminant concentrations in the receiving environment. Degradation of water quality (with potential effects to downstream fish and fish habitat) may result due to the introduction of hazardous materials such as gasoline and diesel fuel, hydraulic fluids, and/or lubricants used during construction. Other examples of hazardous materials that are likely to be associated with the Project include dry concrete products and concrete contact water, solvents, and waste oils. Activities that may expose stormwater runoff to contaminants include waste disposal, fueling of vehicles, routine servicing of equipment, and repair and maintenance activities. Project-related materials that may interact with stormwater are petroleum fuels (diesel and gasoline), concrete (contact water), solid waste/garbage, hydraulic and lubricating oils, coolants, and antifreeze. By implementing appropriate mitigation measures (e.g., stormwater management and emergency spill response), the potential risk of residual effects to fish is low.</p> <p>Additionally, excavation activities may change contaminant concentrations. A Phase I and II Environmental Site Assessment was undertaken for the Project, which concluded that there is potential for previous onsite operations to have caused constituents of concern to be present in the soil, groundwater, and potential soil vapour at levels of concern. By implementing appropriate mitigation measures (e.g., as will be provided in the <b>Stormwater Pollution Prevention Plan (Attachment 4.3-A)</b> and <b>Soil and Groundwater Management Plan (Attachment 4.3-B, Appendix C)</b>, the potential risk of residual effects to fish is low.</p> <p>Additionally, removal of vegetation and aquatic vegetation from roadside ditches may reduce the biofiltration capacity of the ditches (e.g., cattails, which can help to filter contaminants prior to downstream discharge). In addition, it is recommended that drainage ditches be replaced to provide stormwater attenuation and treatment functions.</p> <p>Operations with the potential to result in potash spillage include receiving (unloading of railcars and around the railcar unloading station), transfer of storage (although risk of spillage is low as all equipment will be enclosed with a dust collector) and reclaim from storage (although risk of spillage is low as all equipment will be enclosed). There is some potential for potash to be accidentally released into the aquatic environment (e.g., due to equipment malfunction). If an accumulation occurs there could be temporary, localised adverse effects to aquatic organisms; however, potash dissolves rapidly in water and is non-toxic, and effects will likely be minimal, resulting only in potential localised increases in salinity. As such, the potential risk of residual effects is low.</p>

Potential Effect	Associated POEs	Potential Risk of Residual Serious Harm	Criteria					Ecological Context	Rationale
			Likelihood	Duration	Magnitude	Geographic Scale	Reversibility		
Change in food supply	<ul style="list-style-type: none"> <li>Vegetation clearing</li> <li>Removal of aquatic vegetation</li> <li>Placement of material or structures in water</li> </ul>	Low	Unlikely	Long Term	Low	Site	Reversible	N/A	Culverting (of the Robson Ditch) and removal of both riparian (for the Robson Ditch and Bekaert South Ditch) and aquatic vegetation (for the Robson Ditch) will have some effect on food supply (e.g., plant litter and insect drop) for downstream fish populations (e.g., in Gunderson Slough); however, the affected ditches are not classified as fish habitat by the City of Surrey (i.e., the affected ditches were assessed as providing insignificant sources of food and nutrients to downstream fish populations). As such, the potential risk of residual effects to fish is low, and there is a low likelihood of the Project changing upland fish habitat. Still, it is recommended that replacement of the drainage ditches occur to provide stormwater attenuation and treatment functions.
Change in nutrient concentrations	<ul style="list-style-type: none"> <li>Vegetation clearing</li> <li>Removal of aquatic vegetation</li> <li>Placement of material or structures in water</li> </ul>	Low	Unlikely	Long Term	Low	Site	Reversible	N/A	Culverting (for the Robson Ditch) and removal of both riparian (for the Robson Ditch and Bekaert South Ditch) and aquatic vegetation (for the Robson Ditch) will have some effect on nutrient concentrations (e.g., produced by aquatic vegetation) for downstream fish populations (e.g., in Gunderson Slough); however, the affected ditches are not classified as fish habitat by the City of Surrey (i.e., the affected ditches were assessed as providing insignificant sources of food and nutrients to downstream fish populations). As such, the potential risk of residual effects to fish is low, and there is a low likelihood of the Project changing upland fish habitat. It is recommended that replacement of the drainage ditches occur to provide stormwater attenuation and treatment functions.
Change in water temperature	<ul style="list-style-type: none"> <li>Vegetation clearing</li> <li>Removal of aquatic vegetation</li> <li>Placement of material or structures in water</li> </ul>	Low	Likely	Long Term	Low	Site	Reversible	N/A	Culverting (for the Robson Ditch) and removal of both riparian (for the Robson Ditch and Bekaert South Ditch) and aquatic vegetation (for the Robson Ditch) may result in local changes in water temperature. Culverting of storm water may reduce water temperature, although removal of aquatic and riparian vegetation may increase temperatures; however, given the very localised effect and the City of Surrey's classifications of the affected ditches as non-fish habitat, the potential risk of residual effects to fish is low.
Change in dissolved oxygen	<ul style="list-style-type: none"> <li>Removal of aquatic vegetation</li> </ul>	Low	Unlikely	Long Term	Low	Site	Reversible	N/A	Removal of aquatic vegetation during culverting of the Robson Ditch may have a localised effect on dissolved oxygen levels; however, given the very limited spatial effect and the City of Surrey's classifications of the affected ditch as non-fish habitat, the potential risk of residual effects to fish is low.
Change in base flow	<ul style="list-style-type: none"> <li>Vegetation clearing</li> <li>Placement of material or structures in water</li> </ul>	Low	Unlikely	Long Term	Low	Site	Reversible	N/A	Culverting of ditches in addition to removal of riparian vegetation may have an effect on base flows as storm water would likely be conveyed faster through the system, which may result in increased peak flows during storm events and lower residual flows. Given the very localised effect and the City of Surrey's classifications of the affected ditches as non-fish habitat, however, the potential risk of residual effects to fish is low.

### **6.1.3 Benthic Invertebrates**

#### **6.1.3.1 Potential Project-related Effects**

##### **Direct Mortality or Physical Disturbance**

Direct mortality or physical disturbance to benthic organisms may result from Project construction activities such as pile driving, which may cause sediment re-suspension and the potential entrainment, burial, or physical disturbance of these organisms. Entrainment or burial by re-suspended sediments can result in physical abrasion of the body surface and physiological stress in response to respiratory obstruction and anoxic conditions (Johnston 1981, Essink 1999).

While this effect can affect all invertebrate life stages, egg and larval stages are particularly vulnerable due to their reduced ability to avoid or move away from inwater working areas. Inwater works associated with the Project will be limited to the installation of piles, however, and will result in limited interaction with benthic invertebrates due to the temporary and localised nature of this work.

Sediment re-suspension associated with the Project will be undetectable when compared to existing annual maintenance dredging operations conducted within sections of the Fraser River's navigational channel or within FSD's berths. The potential for Project activities to result in direct mortality of benthic invertebrates will likely be negligible.

##### *Change in Habitat Quality*

In-water construction activities such as pile driving may also increase total suspended solids (TSS) within the PDA. Elevated TSS may influence the productivity of marine invertebrates, as suspended particles can damage and clog filtering organs (e.g., gills and siphons) (Johnston 1981, Martens and Servizi 1993, Wilber and Clarke 2001), which prevents passage of water and oxygen. This can lead to extensive tissue damage, hypersecretion of mucous, decreased gas exchange, respiratory distress, and mortality (Appleby and Scarratt 1989, Lake and Hinch 1999).

Long-term effects of elevated TSS levels include physiological stress leading to reduced growth, immune system suppression, osmotic dysfunction, and increased susceptibility to disease-causing parasites (Everhart and Duckrow 1970, O'Connor et al. 1977, Redding and Schreck 1983, Redding et al. 1987). Sessile or early life history stages of marine invertebrates are generally more sensitive to high TSS levels (Appleby and Scarratt 1989), though turbidity and TSS levels within the Fraser River are naturally high due to influence by wave action, silt-laden riverine flows, and sediment movement (Mackas and Harrison 1997, Bolam and Rees 2003).

Surface TSS levels within the PDA range between approximately 5 milligrams per litre (mg/L) and 8 mg/L in March, and between 6 mg/L and 37 mg/L in July. At the riverbed, TSS concentrations range from approximately 6 mg/L to 8 mg/L in March and from 15 mg/L to 48 mg/L in July (see the **Water and Sediment**

**Quality Technical Data Report (Attachment 4.2-J)** for more details on water quality with in the PDA). Provincial water quality guidelines provide criteria for turbidity to allow for changes in background turbidity levels from background of 5 nephelometric turbidity units (NTU) at any time when the background is 8 NTU to 50 NTU during high flows or in turbid waters. Inwater construction activities associated with the Project are expected to drive changes to water quality through increased TSS and turbidity; however, these changes will likely be temporary and limited to the duration of pile driving activities. Further, increases in TSS will likely be within the acceptable range for limits for a high-flow, turbid water body such as the Fraser River. Except for localised areas of activity, TSS concentrations will not likely exceed the high-flow guideline.

#### **6.1.3.2 Mitigation Measures**

Measures to reduce or avoid any potential effects of in-water works on benthic invertebrates will be followed as per the BMPs listed in **Section 6.1.1.2**.

Sediment control measures may be used to control the dispersion of re-suspended sediments in the PDA caused by in-water pile driving. These measures will be described in the **Construction Environmental Management Plan (Attachment 4.3-B)**.

#### **6.1.3.3 Residual Effects**

Residual Project-related effects on benthic invertebrates are not anticipated. Effects will be minor and limited to the installation of piles, and will be undetectable following implementation of the mitigation measures identified in this report.

### **6.1.4 Marine Mammals**

#### **6.1.4.1 Potential Project-related Effects**

Project construction activities such as pile driving will result in sediment re-suspension and changes in sediment dispersion and deposition within the Fraser River. Sediment-bound contaminants may also be re-suspended, increasing the potential for their ingestion by marine mammals, either directly or indirectly through prey species. This potential effect will likely be minor and temporary, and will not likely result in measurable increases of resuspended contaminants, given how little inwater works are required for this Project. As such, the effect of changes to sediment and water quality on marine mammals is not considered further in this assessment. Further details on Project-related changes to sediment and water quality are provided in the **Water and Sediment Quality Technical Data Report (Attachment 4.2-J)**.

Increased vessel activity associated with the Project may result in an increased risk of vessel or equipment collision with pinnipeds within the Project ZOI, which may result in pinniped injury or mortality. Reports of pinniped vessel strikes in BC are rare; only one strike has been reported in BC (2009), involving a whale-watching vessel and a sea lion at Race Rocks Marine Reserve (DFO Marine Mammal Incident Database 1973 to October 2012). Further, the DFO Management Plan for Stellar sea lion (DFO 2010b) did not identify

vessel strikes as a potential threat to sea lion populations. Given their small size, agility, and ability to avoid moving vessels, the potential for a Project-related vessel striking a seal or sea lion during Project construction or operation is negligible, and will not be carried forward in this assessment.

Cetaceans strikes are not likely to increase due to increased vessel traffic associated with the Project's construction phase, as cetaceans typically do not occur as far upstream as the PDA, and increases in vessel traffic during this phase will likely be concentrated within the PDA. As such, vessel strikes on cetaceans during the Project's construction phase will not be assessed further.

During operations, BHP and their shipping partners will be committed to adhering to applicable shipping mitigation measures (including reduced vessel speed in Vancouver Fraser Port Authority regulated waters) related to sound and protection of marine mammals. BHP commits to meeting applicable standards for sound reduction and marine mammal protection.

## **Potential Effects of Underwater Noise**

### *Underwater Noise Background*

Sound can be classified as either pulsed or non-pulsed (i.e., continuous). Pulsed sound is brief (less than a few seconds) and intermittent, with rapid changes of sound pressure (e.g., impact pile driving). Non-pulsed sound is characterised by gradual changes in sound pressure over time (e.g., marine vessels transiting and a vibratory pile driver in operation).

Canada does not currently regulate underwater noise with respect to marine mammals. Criteria for underwater noise injury and disturbance to marine mammals have been provided and are commonly used despite this lack of government regulation (see **Table 6-10**):

- Regulatory criteria applied by the United States (NOAA 2016)
- Criteria recommended by Southall et al. (2007).

The National Oceanic and Atmospheric Administration (NOAA) criteria specify injury criteria for both cetaceans and pinnipeds, which are based on the maximum root mean square sound pressure level (SPL)<sup>3</sup> to which a marine mammal may be safely exposed before injury occurs. Injury criteria for exposure to continuous sounds has not been established, and the NOAA behavioural disturbance criteria, which are based on a limited set of behavioural data, are widely applied. The NOAA auditory injury and disturbance criteria are provided in **Table 6-10**.

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<sup>3</sup> Root mean square (rms) sound pressure levels: the average pressure of noise in a given time window.

Criteria recommended by Southall et al. (2007) include peak SPLs and cumulative M-weighted<sup>4</sup> sound exposure level (SEL)<sup>5</sup> thresholds for injury. They did not, however, recommend specific SPL thresholds for marine mammal disturbance. Cumulative injury criteria are specified as originating from single or multiple exposure events over a 24-hour period. A received sound exposure is assumed to cause injury to a cetacean or pinniped if it exceeds either the peak SPL or the SEL criterion, or both. Southall et al. (2007) criteria are provided in **Table 6-10**.

**Table 6-10 Auditory Injury and Disturbance Thresholds for Cetaceans**

Subcomponent Species	NOAA Thresholds RMS SPL (dB re 1 µPa)				Southall et al. (2007) M-weighted 24-Hour SEL Thresholds (dB re 1 µPa <sup>2</sup> s)	Southall et al. (2007) peak SPL Thresholds (dB re 1 µPa)
	Continuous Sounds		Impulsive Sounds		Impulsive Sounds	Impulsive Sounds
	Injury	Disturbance	Injury	Disturbance	Injury	Injury
Cetaceans	-	120	180	160	198	230
Pinnipeds in water	-	120	190	160	186	218

**Sources:** NOAA 2016; Southall et al. 2007.

**Notes:** Db – decibel; RMS SPL – root mean square sound pressure level; µPa – micro Pascal.

**Potential Effects of Underwater Noise during Construction**

Proposed construction activities associated with the Project will generate underwater noise that can potentially injure or result in behavioural disturbances to marine mammals near the PDA.

<sup>4</sup> M-weighting: generalized frequency weightings for various groups of marine mammals, allowing for their functional bandwidths and appropriate in characterizing auditory effects of strong sounds (Southall et al. 2007).  
<sup>5</sup> Sound exposure level: the total acoustic energy received at a given location during an acoustic event, and thus the sound energy to which an organism at that location would be exposed. The sound exposure level is also commonly used to quantify the loudness of noise.

### ***Physical Injury***

Project construction activities that will produce underwater noise include impact pile driving, vibratory pile driving, soil densification, and movement of support vessels during the construction phase. Inwater pile driving is the only activity that is likely to generate sound at levels high enough to disturb or injure the hearing of harbour seal (Hemmera 2016). Underwater noise modeling conducted as part of the George Massey Tunnel Replacement Project Environmental Assessment (Hemmera 2016) suggested that hearing damage to the harbour seal from vibratory pile driving would occur within 9 m of the sound source. For impact pile driving, the zone of injury would increase substantially to a maximum radius of 618 m (from the source) for a worst-case scenario of 100 minutes of impact pile driving (M-weighted 24-hr SEL threshold). Cetaceans are not likely to be affected by increases in underwater noise associated with noisy construction activities as they typically do not occur as far upstream as the PDA, and are unlikely to interact with noisy construction activities (e.g., pile driving). Pinnipeds, however, may experience physical injury from increases in underwater noise associated with the Project as they are known to occur near the PDA. This effect will likely be short term and easily mitigated through ramp-up procedures, implementation of noise dampening mechanisms, and pre-works marine mammal observations.

### ***Behavioural Disturbance***

Underwater noise produced during inwater construction activities could result in behavioural disturbance to pinnipeds given that their distribution overlaps with the Project PDA. The presence of seal and sea lion foraging in the Fraser River typically coincides with seasonal migration of eulachon and salmon. Project-related inwater construction activities will be conducted during the least risk timing window (June 16 to February 28) for this section of the Fraser River. This will help to reduce the likelihood of works corresponding with the migration of salmon and eulachon, thus limiting the potential for Project interaction with foraging pinnipeds.

Seal and sea lion are known to habituate readily to human activity, including underwater noise. Previous monitoring of disturbance of seal and sea lion, at Race Rocks Ecological Reserve (Strait of Juan de Fuca, BC), from underwater noise generated by blasting of explosives during nearby military training indicated that behavioural changes, including displacement from a haul-out, were short term with little or no consequence on long-term use (Demarchi 2010). Shortly after each observable disturbance, animals typically returned to the haul-out, suggesting their resilience to this type of disturbance. With repeated disturbance over a period of a year, individuals continued to use Race Rocks as habitat with no measurable effect on seal or sea lion populations (Demarchi 2010). Behavioural effects of Project-related increases in underwater noise will likely be temporary, minor, and easily mitigated.

## **Potential Effects of Atmospheric Noise during Construction**

Atmospheric noise generated by Project construction activities will not result in underwater noise levels high enough to cause injury or behavioural effects to marine mammals. Project-related noise could, however, adversely affect pinnipeds hauled out onto land in or near the PDA. Behavioural effects of disturbance include alteration of haul-out times, abandonment of haul-out sites, mother-pup separation, interruption of nursing, increased stress, and interruption of rest resulting in lower fitness and health (Calambokidis et al. 1991).

The sea lion has demonstrated a higher level of habituation to human disturbance, while harbour seal is typically more sensitive to disturbance (Wilson n.d., Hemmera 2016). Habituation of harbor seals and sea lions to noise has been observed in direct proximity to regularly scheduled float plane operations in Victoria, BC (S. Meier, personal communication). In addition, both harbour seal and sea lion exposed to regular vessel traffic have been observed habituating to and allowing close approach by touring boats that repeatedly visit haul-out locations (Bonner 1982, Johnson et al. 1989, Kucey 2005).

The distance at which most seals exhibit flushing into water in response to noise disturbance varies, but has been approximated at less than 100 m from the disturbance (Allen et al. 1984), with a sharp decrease in disturbances above 125 m (Calambokidis et al. 1991). Individuals may first become alert to a disturbance (e.g., a vessel) as far as 800 m from the source (Henry and Hammill 2001). For vessel-related disturbances, the distance at which a seal exhibits behavioural disturbance depends on the type and size of vessel, with larger vessels resulting in disturbance at greater distances (Suryan and Harvey 1998, Calambokidis et al 1991, Young 1998, Henry and Hamill 2001, Johnson and Acevedo-Gutiérrez 2007).

Potential behavioural effects on hauled-out stellar sea lion on land are not anticipated due to their low abundance in proximity to noisy land-based construction activities and their general habituation to human activity. Potential behavioural effects on hauled-out harbour seal are more likely, due to a higher abundance within and near the PDA and a higher sensitivity to human disturbances; however, behavioural changes will be short-term (limited to the construction phase) and will not likely result in population-level effects.

## **Potential Effects of Increased Vessel Traffic During Operation**

### ***Vessel Strikes***

Increases in vessel movements associated with the Project's operation phase may result in an increase in vessel strikes for cetaceans and pinnipeds. Species most likely to be struck include SRKW and harbour porpoise near the mouth of the Fraser River, and harbour seal and Steller sea lion in the Fraser River South Arm. Humpback whale is unlikely to be struck given the low likelihood of occurrence within the ZOI.

Humpback whale is the most commonly struck cetacean species in BC (DFO 2013d). A total of 21 vessel strikes involving humpback whale were reported between 2001 and 2008 (Ford et al. 2009), most of which

involved small vessels (less than 10 m long) capable of fast speeds. There are no confirmed reports of humpback whale collisions in BC waters attributed to commercial shipping; however, larger ships are less likely to detect the physical impact of a collision than smaller vessels, and this could account for the lack of reported strikes. Although humpback whale is observed frequently south of Vancouver Island and has been observed near Point Roberts, this species is not common near the mouth of the Fraser River South Arm or within VFPA's jurisdictional waters (DFO 2013d). The potential increase in ship strikes with humpback whale associated with the Project will therefore likely be negligible.

Critical habitat for SRKW includes Haro Strait and Boundary Pass and adjoining areas in the Strait of Georgia and the Juan de Fuca Strait (DFO 2008). Increased vessel movement associated with the Project will overlap with this habitat, resulting in an increased risk of vessel strikes for SRKW within the ZOI. The SRKW may be less vulnerable to collisions with large vessels than the larger humpback whale because of the species' greater overall manoeuvrability, ability to echolocate, and social behaviour, which may enhance vessel detection and escape (Lawson and Lesage 2013). Despite this, at least eight killer whale individuals are known or suspected to have been struck by vessels off the Canadian west coast, judging by observed incidents, scarring, or recovery of carcasses, six of which have occurred since 2002. Vessels involved in SRKW collisions range from small high-speed skiffs (6 m to 8 m length) to 20-m-long tug boats (Cetacean Research Program (CRP) – DFO unpublished data). The potential for Project-related increases in vessel strikes with SRKW will likely be low due to the relatively low number of additional ship movements associated with the Project and the high manoeuvrability of this species.

Harbour porpoise spends considerable time in surface waters foraging, socialising, and traveling, and as a result experiences an increased risk of vessel strikes. The tendency of this species to inhabit urbanised marine environments further increases this risk (COSEWIC 2016). Two cases of vessels striking harbour porpoises in Canadian waters have been reported (DFO-CRP unpubl. as cited by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2016). Harbour porpoises are sensitive to vessels and show avoidance behaviours, particularly if the vessels are operating erratically or at high speed (Koschinski 2008). Harbour porpoise habitat overlaps with designated shipping lanes within the Strait of Georgia and the Juan de Fuca Strait. Despite commonly occurring within the western extent of the ZOI (i.e., Roberts Bank), Project-related increases in vessel strikes with harbour porpoise will likely be low due to the relatively low number of additional ship movements associated with the Project and the high manoeuvrability of this species.

Details on mitigation measures to reduce or eliminate potential physical disturbance of cetaceans and pinnipeds within the ZOI from vessel strikes have been provided (**Section 6.1.4**).

### ***Acoustic Masking***

Odontocetes, including SRKW and harbour porpoise, use complex vocalisations such as clicks or whistles to detect prey (echolocation) and communicate or socialise within groups (Richardson et al. 1995). Many studies suggest that noise from vessels can increase ambient underwater noise levels and impair the ability of odontocetes to forage or communicate (e.g., Bain and Dahlheim 1994, Bain et al. 2006, Aguilar Soto et al. 2006). Several vocal modifications have been observed in odontocetes as a response to noisy environments, including longer calls, louder calls, increasing call rates, shifting the frequency of the call outside the noise band, and waiting to call until the noise decreases (Tyack 2008; Brumm and Zollinger 2011).

The Project will produce underwater noise and result in small changes to the acoustic environment during the operation phase (e.g., 185 vessel calls per year). When compared to existing conditions of the acoustic environment, underwater noise levels during Project operation may potentially result in both low-severity behavioural responses (e.g., disturbance to foraging or socialisation) and acoustic masking. The predicted change to the acoustic environment and corresponding behavioural responses and acoustic masking will not likely affect individual SRKW or harbour porpoise or their ability to forage or calve (in the case of harbour porpoise) within the ZOI.

#### **6.1.4.2 Mitigation Measures**

##### **Mitigation Measure #1: Develop and Implement Construction Environmental Management Plan**

A **Construction Environmental Management Plan (Attachment 4.3-B)** will be developed, which will include mitigation of potential effects on marine mammals during Project-related underwater construction activities, and will describe the measures to be followed to minimise underwater noise. Specifically, construction activities such as impact pile driving, which can generate underwater sound at levels that could physically injure marine mammals, will adhere to standard industry and BMPs to prevent exceedance of sound thresholds for the protection of marine mammals (**Table 6-10**). For example, bubble curtains can be installed around piles to reduce underwater noise levels from impact pile driving to below thresholds for physical injury or disturbance.

Additional measures described in the plan to minimise underwater noise generated during marine-based construction activities will include, but will not be limited to:

- Following Best Management Practices for Pile Driving and Related Operations (BCMPDCA and DFO 2003).
- Conducting pile driving from land based equipment whenever possible.
- Avoiding unnecessary idling of marine-based equipment.
- Acoustic monitoring to confirm pile driving activities do not exceed auditory thresholds (see **Mitigation Measure #2: Underwater Noise Monitoring**).

- Establishing and monitoring a 1,000-m radius safety zone around construction activities. Pile driving activities or other noisy activities that can exceed auditory thresholds must be stopped if whales, dolphins, porpoises, or sea lions are present in the safety zone, and will not resume until the marine mammals have not been observed within the safety zone for at least 10 minutes, or have been observed leaving and swimming away from the safety zone. Construction activities will also be halted if seals and other pinnipeds surface within the safety zone and appear to be disturbed.
- Having the EM act as a marine mammal observer during activities that will generate underwater noise, and implementing an underwater noise monitoring program.

### **Mitigation Measure #2: Conduct Underwater Noise Monitoring**

As part of the **Construction Environmental Management Plan (Attachment 4.3-B)**, underwater noise monitoring will be conducted during Project construction activities in the Fraser River that may generate underwater sound levels exceeding auditory thresholds and causing physical injury to marine mammals. Acoustic monitoring should be conducted at the commencement of pile driving and on a selected basis thereafter (depending on site conditions and observations). Per fish safety requirements, and to protect marine mammals, peak SPLs during pile driving should not exceed 206 decibels (dB) per single strike. A safety zone of 1,000 m will be established around any pile driving activities to observe if whales, dolphins, porpoises, or sea lions enter this zone. Works will stop until the marine mammals are observed leaving the safety zone. Hydro-acoustic monitoring of underwater noise levels, within 1 to 2 m of the noise source, will be undertaken for impact pile-driving activities to determine whether levels potentially harmful to marine mammals and fish are occurring.

### **Mitigation Measure #3: Participate in an Environmental Training Program to Reduce Risk of Vessel Strikes during Operation**

Due to the minimal use of the Fraser River by cetaceans, and the ability of pinnipeds to avoid vessels, an increase in the number of vessel strikes of marine mammals in the Fraser River is not likely as a result of additional Project-related shipping traffic. Additional Project-related shipping traffic will likely result in higher risk of vessel strikes of marine mammals, namely SRKW and harbour porpoise in the portion of the ZOI that overlaps with the Strait of Georgia. This is particularly of concern for areas that overlap with SRKW critical habitat. This potential effect will be mitigated through the participation in an Environmental Training Program, which will be used to inform and educate vessel operators traveling to and from the proposed Project terminal on site- and species-specific guidelines for avoiding vessel strikes (e.g. vessel speeds, habitat locations). Guidance will be taken from similar programs produced for nearby shipping-heavy Projects (e.g., Deltaport Third Berth Terminal Project), which have successfully mitigated an increased risk for marine mammal vessel strikes. With the implementation of mitigation measures during Project operation, measurable residual adverse effects from vessel strikes are not anticipated.

#### **Mitigation Measure #4: Maximise Activities during Least Risk Timing Window**

Project-related inwater construction activities should be conducted during the least risk timing window (June 16 to February 28) for this section of the Fraser River. Confining inwater works to this period will help to reduce overlap of works with the migration of salmon and eulachon, thus limiting the potential for Project interaction with foraging pinnipeds within the Fraser River or over Roberts Bank, and with cetaceans near the mouth of the Fraser River.

##### **6.1.4.3 Residual Effects**

Residual Project-related effects on marine mammals are not anticipated. Potential effects of the Project on marine mammals will be temporary, limited to the construction phase, and spatially limited to those activities occurring near the Project footprint; except for increases in ship movements and corresponding risk of vessel strikes within VFPA's jurisdictional waters during Project operation. Mitigation measures described in **Section 6.1.4** will prevent physical injury and minimise the potential for behavioural disturbance of marine mammals associated with the Project. Mitigation will likely be immediately effective in protecting pinnipeds near inwater works from underwater noise levels that could result in injury or mortality. The risk of vessel strikes due to Project-related increases in vessel traffic will likely be negligible.

##### **6.1.5 Species of Conservation Concern**

The potential effects (e.g., potential for water quality effects) outlined in the components above (i.e., Fraser River fish and fish habitat or marine mammals) apply to aquatic species of conservation concern.

##### **6.1.5.1 Mitigation Measures**

Project-related mitigation measures, which encompass protection of these species, are outlined in **Section 6.1.1 (Table 6-3)** and **Section 6.1.4** (under Mitigation Measures). More detailed mitigation measures will be outlined in Project-specific management plans (**Section 6.2**).

##### **6.1.5.2 Residual Effects**

With implementation of the mitigation measures described above, no residual effects to species of conservation concern are anticipated during construction or operation of the Project.

##### **6.1.6 Commercial, Recreational, and Aboriginal Fisheries**

##### **6.1.6.1 Potential Project-related Effects**

The Fraser River South Arm supports a variety of marine uses including CRA fishing. To assess potential effects to CRA fishing resulting from an increase in river traffic, baseline traffic information for the Fraser River South Arm was analysed using Automatic Identification System<sup>6</sup> data and deep-water vessel data

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<sup>6</sup> Per the Navigation Safety Regulations (SOR/2005-134), Automatic Identification Systems are required on: every ship of 150 tons or more that is carrying more than 12 passengers and engaged on an international voyage;

gathered between July 2010 and June 2011. This information is provided in the Fraser River Tanker Traffic Study undertaken by Det Norske Veritas on behalf of VFPA (DNV 2012). Over the one-year study period, there were approximately 7,706 tracked ship movements in the south arm of the Fraser River, between FSD and the open ocean. A ship movement is considered as one direction, up or down river, while a ship call is considered both an up and down river movement (1 call = 2 movements). When operating at maximum capacity, it is anticipated that the Project will result in an increase of 185 vessel calls per year (i.e., 370 ship movements) in the Fraser River. Based on the results of the DNV (2012) study, the Project will likely result in an approximate 4% to 5% increase in large marine traffic volume and frequency. This increase in shipping is consistent with VFPA's goals to accommodate trade growth by intensifying activity at existing terminals; however, this increase in marine traffic may interfere with CRA fishing, in particular salmon gill netting in the lower Fraser River when nets may be set across the active navigational channel. Gill net fisheries openings in the Fraser River are relatively short, depending on run strength, and these gill net fisheries may be affected by increased ship movements during Project operation (e.g., if fishing operators need to haul in their nets to facilitate passage of a vessel).

#### **6.1.6.2 Mitigation Measures**

Mitigation measures as outlined under **Section 6.1.1 (Table 6-3)**, will be implemented to protect Fraser River fish and fish habitat including fish species of CRA concern. In addition to the mitigation listed in **Section 6.1.1**, the following section outlines measures to be implemented to minimise conflict with CRA fishing activities.

All vessels within VFPA navigational jurisdiction must currently abide by the *Canada Shipping Act, SC 2001*, c. 26, and its regulations as outlined in the Port Information Guide (VFPA 2016). Project-related ship movements outside of FSD will be restricted to the navigational channel of the Fraser River. Commercial vessels are required to stay in the proper upriver or downriver designated channel to reduce conflict with fishing vessels engaged in net fisheries. To mitigate potential effects to CRA fishing vessels during Fraser River gill net openings, all commercial traffic movements will be broadcast on VHF channel 74, which provides warnings of ship movements along the Fraser River to allow fishers to plan accordingly. Fishing operators within the Fraser River navigational channel are required to monitor this station (VFPA 2016). Operators of all vessels are also required to take early and substantial action to keep clear of all other vessels and gear, including reducing speeds around fishing vessels to prevent danger or injury by bow wave or wash to such craft (VFPA 2016).

While fishing operators in the active navigational channel would be required to haul in their net if impeding the passage of a larger vessel (VFPA 2016), to mitigate potential effects to these fisheries the Project will consider CRA net fishery openings in Fisheries Management Area 29-13 of the Fraser River in scheduling of vessel movements. As directed by the Owner and VFPA, engagement with Aboriginal and stakeholder

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every ship of 300 tons or more, other than a fishing vessel, that is engaged on an international voyage; and, every ship, other than a fishing vessel, of 500 tons or more that is not engaged on an international voyage.

groups will help to add clarity and precision with respect to critical timing and spatial interaction of fishing vessels with shipping to and from the Project site.

### **6.1.6.3 Residual Effects**

With further engagement and implementation of a **Construction Environmental Management Plan (Attachment 4.3-B)** residual Project-related effects on CRA fisheries are still anticipated. Although, potential effects of the Project during construction will be temporary, and spatially limited to those activities occurring near the Project footprint, CRA fishing activities in the ZOI during operations of the Project has the potential for residual effects. While CRA fishing is not known to occur within the PDA, which is located within an active marine terminal, fishing in the main channel of the lower Fraser River will have the potential for additional interruptions during operations of the Project, due to increased vessel traffic. Spatial and temporal avoidance of key CRA fishing activities, in the lower Fraser River, will reduce the potential effects to CRA fisheries during Project construction and operations, but due to increased vessel traffic during operations, disruptions to fishing in the lower Fraser River, within the TSA, remains.

## **6.2 PROJECT-SPECIFIC MANAGEMENT PLANS FOR AQUATIC RESOURCES**

Throughout all phases of the Project, BMPs will be employed to reduce or eliminate adverse effects on aquatic resources. In addition to these BMPs, several Project-specific management plans are being developed to mitigate potential effects of the Project, including effects to aquatic resources. These plans are outlined below.

### **6.2.1 Construction Management Plans**

- **Construction Environmental Management Plan (Attachment 4.3-B):** A Construction Environmental Management Plan will be prepared for the Project. The plan will include BMPs to prevent adverse effects to sensitive environmental resources relating to aquatic species and habitat, as well as vegetation and wildlife. Some construction aspects that the plan will address include: site access, mobilisation and laydown areas, air quality, noise and vibration, machinery and equipment, erosion and sediment control, contaminated soil and groundwater management, concrete works and grouting, and inwater works. This plan will also include fueling and fuel management near watercourses, as well as waste management procedures.
- **Soil and Groundwater Management Plan (Attachment 4.3-B, Appendix C):** A Soil and Groundwater Management Plan will be prepared to provide guidance on construction activities that may involve contaminated soil and groundwater. This plan will address soil management, soil sampling, stockpile management, contaminated soil disposal, and groundwater management to minimise potential effects to sensitive receptors.
- **Spill Prevention and Emergency Response Plan (Attachment 4.3-E):** A Spill Prevention and Emergency Response Plan will be prepared and implemented by the Project contractor. The plan will identify potential hazards onsite; develop systems for preventing accidents including appropriate training; provide mechanisms for minimising risks, loss, and damage from incidents; and provide an incident management structure to guide response activities in the event of an accidental release. The plan will also include emergency communication, an environmental emergency plan, and spill response plan.

## 6.2.2 Operation Management Plans

- **Marine Traffic Information Requirements Report:** A Marine Traffic Information Requirements Report (**Attachment 4.1-D**) will be developed, which will address mitigation of potential effects from increased Project-related vessel traffic. This management plan could include measures such as ensuring vessels adhere to speed limits within port jurisdiction and scheduling of shipping to reduce conflict with fishing operators, where possible, during important periods of commercial or Aboriginal fishing.
- **Stormwater Pollution Prevention Plan:** A Stormwater Pollution Prevention Plan (**Attachment 4.3-A**) will be prepared to identify BMPs to improve the quality of stormwater discharged from Project facilities during operation. These BMPs include reducing the amount of stormwater discharged to the environment, preventing or reducing the pollutant loading of stormwater, and treating or otherwise managing stormwater if pollutant loading cannot be prevented. The management strategy includes good housekeeping, preventive maintenance, containment, reduction, spill prevention and response, and treatment.

## 7.0 SUMMARY AND CONCLUSION

A summary of potential Project-related effects, proposed mitigation measures, and any associated residual effects is provided for each aquatic resource component in **Section 6.0**. Potential effects associated with Project activities include alteration of fish or marine mammal habitat, direct mortality or injury to fish or marine mammals, sensory disturbance to fish or marine mammals, and degradation of water and sediment quality.

The Project may result in construction and operation-phase disturbances to the six aquatic resource components assessed (Fraser River fish and fish habitat, Upland fish and fish habitat, benthic invertebrates, marine mammals, species of conservation concern, and CRA fisheries); however, with the application of appropriate mitigation and appropriate best management practices, most construction effects on aquatic resources associated with the Project are anticipated to be of short duration.

Effects to Fraser River fish and fish habitat (which may affect benthic invertebrates and species of conservation concern, and may indirectly affect CRA fisheries) may occur during temporary removal of shoreline protection material and pile driving required along the existing Berth 9. In addition, installation of an inwater transfer tower will also result in alteration and shading of approximately 188 m<sup>2</sup> of Fraser River habitat under the new tower. Although the shading and installation of new piles will not likely result in serious harm to fish, BHP will submit, as a precautionary measure, a DFO Request for Project review with sufficient detailed habitat information to support this review.

The proposed terminal railway track overlaps with approximately 700 m<sup>2</sup> of daylighted instream and 3,250 m<sup>2</sup> of riparian features; however, none of the daylighted features in the PDA are classified as fish habitat by the City of Surrey (i.e., they are considered non-fish-bearing aquatic habitat with no significant food or nutrient input to downstream fish habitats). The Project will involve re-alignment of one culverted drainage (i.e., Berth 9 Ditch) that conveys food and nutrient value to downstream habitat in the Fraser River; no loss

of fish habitat will result from this work. Any resulting changes in water quality and base flows will likely be mitigated with the application of appropriate measures and adherence to water quality guidelines and BMPs. It is recommended that disturbed riparian vegetation on remaining ditches be replaced, where possible, with suitable native vegetation, as soon as feasible after disturbance.

Project-related effects to benthic invertebrates is anticipated to be limited to potential direct mortality and physical disturbance due to sediment re-suspension from inwater pile driving, as well as associated adverse effects to water quality (namely increases in TSS) from these works. These effects will be limited to the Project's construction phase.

Effects from the Project's construction phase on marine mammals includes the potential for physical injury or behavioural disturbance from increases in underwater and in-air noise, primarily from noisy construction activities such as pile driving. Effects on marine mammals during the Project's operation phase are anticipated to be limited to an increased risk of vessel strikes near the mouth of the Fraser River South Arm, along with potential acoustic masking for SRKW and harbour porpoise in the portion of the Strait of Georgia that overlaps with the ZOI.

Project-related effects are largely anticipated to be minor. With the application of appropriate mitigation measures and adherence to BMPs, residual effects are not anticipated for any of the aquatic resource components.

## 8.0 CLOSING

This work was performed in accordance with Contract 8500085638 between Hemmera Envirochem Inc. (Hemmera) and BHP Billiton Canada Inc. (BHP), dated September 11, 2015. This report has been prepared by Hemmera, based on fieldwork and desktop work conducted by Hemmera, for the sole benefit and use by BHP. In performing this work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and Project terms of reference; further, the findings are time sensitive and are considered valid only at the time the report was produced. The conclusions and recommendations contained in this report are based on the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

We sincerely appreciate the opportunity to have assisted you with this Project. If there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

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