B2D2 Project

Marine Fish and Fish Habitat Existing Conditions Report

REP-B2D2-0004

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ACRONYMS AND DEFINITIONS

ACRONYM	DEFINITION
ASI	ASI Marine (A Division of ASI Group Ltd.)
B1	Berth 1
B2	Berth 2
BC	British Columbia
BC CDC	BC Conservation Data Centre
BC ENV	BC Ministry of Environment and Climate Change
CD	Chart Datum
CEMP	Construction Environmental Management Plan
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Fisheries and Oceans Canada
Dynamic Ocean	Dynamic Ocean Consulting Ltd.
ECHO	Enhancing Cetacean Habitat and Observation
Envirochem	Envirochem Services Inc.
EZ	Exclusion zone
FIDQ	Fish Inventories Data Queries
Foreshore	Foreshore Technologies Inc.
FRE	Fraser River Estuary
ha	hectares
HSA	Herring Spawning Area
IBA	Important Bird Area
LCE	Lynn Creek Estuary
NBT	Neptune Bulk Terminals (CANADA) Ltd.
PFMA	Pacific Fisheries Management Area
ppt	Parts per thousand
RCA	Rockfish Conservation Areas
ROV	Remotely Operated Vehicle
SAR	Species At Risk
SARA	*Species at Risk Act*
SeaChange	SeaChange Marine Conservation Society
SoG	Strait of Georgia
SoW	Scope of Work
SRKW	Southern Resident Killer Whale
Stantec	Stantec Inc.
the Port Authority	Vancouver Fraser Port Authority

ACRONYM	DEFINITION
Tsleil-Waututh	Tsleil-Waututh Nation
Westridge	Westridge Marine Terminal
WQO	Water Quality Objectives

1 INTRODUCTION

Neptune Bulk Terminals (CANADA) Ltd. [NBT] is planning upgrades to the Berth 2 (B2) of their North Vancouver Facility (the Terminal). The Terminal is located at 1001 Low Level Road, North Vancouver, British Columbia (BC), on the north shore of Burrard Inlet. NBT is proposing to replace the current B2 shiploader system, which will consist of a new travelling slewing potash shiploader, marine structures B2, and approach conveyors to replace the existing B2 east and west dual quadrant potash shiploaders (the B2 Project). The B2 Project scope also includes the installation of a new combi-wall and ground improvements using stone columns for seismic upgrades on behalf of the Vancouver Fraser Port Authority (the Port Authority). Further details on the B2 Project Scope of Work (SoW) are available in Section 3 of the B2 Construction Environmental Management Plan (CEMP) (NBT, 2023a).

1.1 Project Footprint and Study Area

NBT is on the north shore of Vancouver Harbour in Burrard Inlet's Inner Harbour and is approximately 6.0 km southeast from the Lions Gate Bridge and 2.5 km northwest from the Second Narrows Bridge (49° 18.218'N, 123° 2.913'W).

To consider potential environmental effects, the B2 Project was considered as the B2 Project footprint and the Study Area. The B2 Project footprint is considered the seabed/ground maximum extent of the B2 Project components. The B2 Study Area was defined as the B2 Project footprint plus a 500 m buffer. This buffer is based on the potential exclusion zone (EZ) that will be applied during pile driving activity to mitigate potential effects of underwater sound on marine mammals.

The site location and B2 Project footprint and B2 Study Area are depicted in Figure 1-1.

1.2 Desktop Review

A literature review of existing publicly available information was conducted within Burrard Inlet. The information was compiled, reviewed, and synthesized to describe marine habitat features and potential species presence, and their use of the marine habitats within the B2 Study Area. Key information sources included:

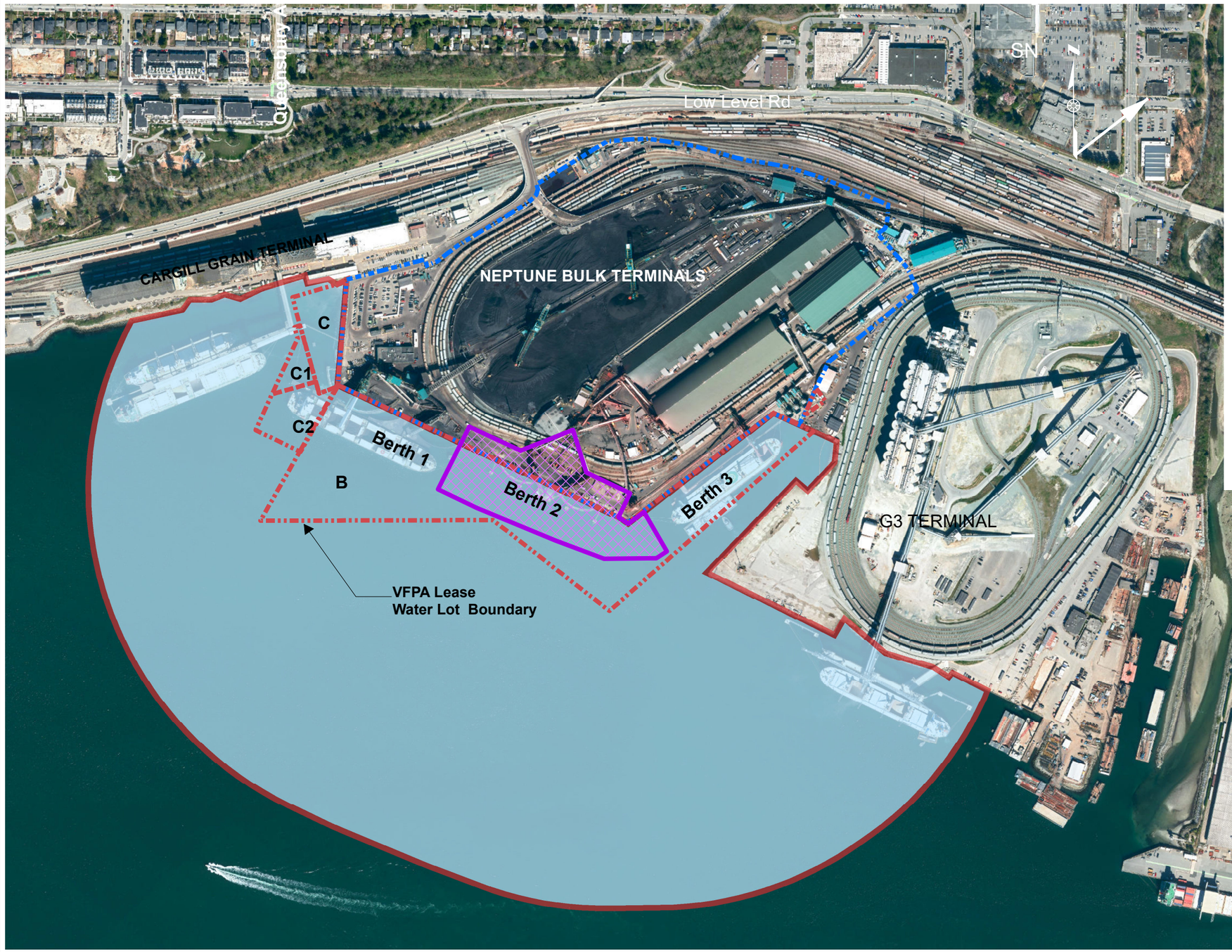
- Berth 2 Marine Survey Report (Stantec, 2018a).
- Berth 1 (B1) Environmental Monitoring Reports from March 2019 to September 2020.
- Amendment Neptune Berth 1 and 2 Wharf Upgrade Projects: Independent Comment for Work Outside Burrard Inlet Fisheries Window (Stantec, 2018b).
- Centerm Expansion Project (AECOM, 2016b).
- Seaspan Vancouver Drydock Waterlot Project – Marine Habitat Assessment (Hatfield, 2021b).
- Fisheries and Oceans Canada (DFO), Pacific Ocean, Aquatic Species At Risk (SAR) maps (DFO, 2023a).

- DFO's Aquatic Invasive Species website (DFO, 2018).
- SAR public registry (Government of Canada, 2023).
- BC Conservation Data Centre (BC CDC), BC Species and Ecosystems Explorer (BC CDC, 2023).
- iMapBC (Government of British Columbia, 2023).
- Fish Inventories Data Queries (FIDQ) (BC ENV, 2020).
- Habitat Wizard (Government of British Columbia, 2022).
- An evaluation of fish habitat in Burrard Inlet, BC (Haggarty, 2001).
- Water Quality Objectives for Burrard Inlet (BC ENV, 2022).
- Burrard Inlet Action Plan (KWL, 2017).

1.3 Document Scope

The B2 Marine Fish and Fish Habitat Existing Conditions Report has been developed to characterize existing conditions of marine fish and fish habitat in the proposed B2 Study Area (defined in Section 1.1) through desktop and site-specific field studies. This report has been informed by the following guidance:

- Vancouver Fraser Port Authority Project and Environmental Review Guidelines – Habitat Assessment (Port Authority, 2015).
- *Fisheries Act* Authorization application of the "Description of Fish and Fish Habitat in the Offsetting Area" (Government of Canada, 2021).



LEGEND

- Property Line
- Water Lot Boundary
- Berth 2 Project Footprint
- Berth2 Study Area

SC ALE:

0 35 70 140 210 280 (m)

Scale: 1:6,000

SOURCE / NOTE:
- Aerial image is downloaded from Google EarthPro.(2021)

PROJECT:

SYSTEM:

ASSET:

DISCIPLINE

REV	YYYY-MM-DD	DESCRIPTION	DRAWN	APPROVED

ISSUES/REVISIONS

VENDOR

envirochem

ISSUED AS RECORD COPY (YES/NO) NO

Neptune TERMINALS

TITLE:

Project Site, Berth 2 Footprint and Study Area

Figure 1-1

SCALE:	SHEET	OF	DRAWING NO:
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Document Name: Project Site, B2 Footprint and Study Area

2 FISH HABITAT

Fish habitat consists of both benthic and pelagic components. Benthic habitats typically consist of a combination of substrates, marine vegetation, or complex organism components (e.g., coral reefs), whereas pelagic habitats are influenced by physical features such as temperature, salinity, currents, and tides.

A desktop review of marine and freshwater habitats and designated habitats within the vicinity of the B2 Study Area are discussed in this section. There is limited information on fish habitat specific to the B2 Study Area and thus desktop reviews presented in the following sections are specific to Burrard Inlet Inner Harbour (see Figure 2-1) where possible and are otherwise focused on Burrard Inlet.

Since 1930, 93% of the original extent of estuary habitat in Burrard Inlet has been lost to development, amounting to a loss of 130 hectares (ha) (Levings & Thom, 1994). Estuaries in the Inner Harbour have seen the largest losses; only 1% remains of the Mackay Creek, Mosquito Creek, Lynn Creek and Seymour River estuaries (K. Ashley, pers. comm in KWL (2017)).

2.1 Pelagic Habitat

Covering approximately 11,300 ha and with a shoreline of 190 km (BIEAP, 2011), Burrard Inlet is an important water body to BC's lower mainland coast. Burrard Inlet is naturally composed of six sub-basins; False Creek, Outer Harbour, Inner Harbour, Central Harbour, Port Moody Arm, and Indian Arm (see Figure 2-1). The Terminal is located in the Inner Harbour, which is separated to the west from the Outer Harbour by the First Narrows, and to the east from the Central Harbour/Indian Arm/Port Moody Arm by the Second Narrows. With the exception of the northern portion of Indian Arm (average of 120 m, maximum of 218 m), Burrard Inlet is relatively shallow with a maximum depth of -45 m in the Outer Harbour to approximately -10 m in Port Moody Arm.

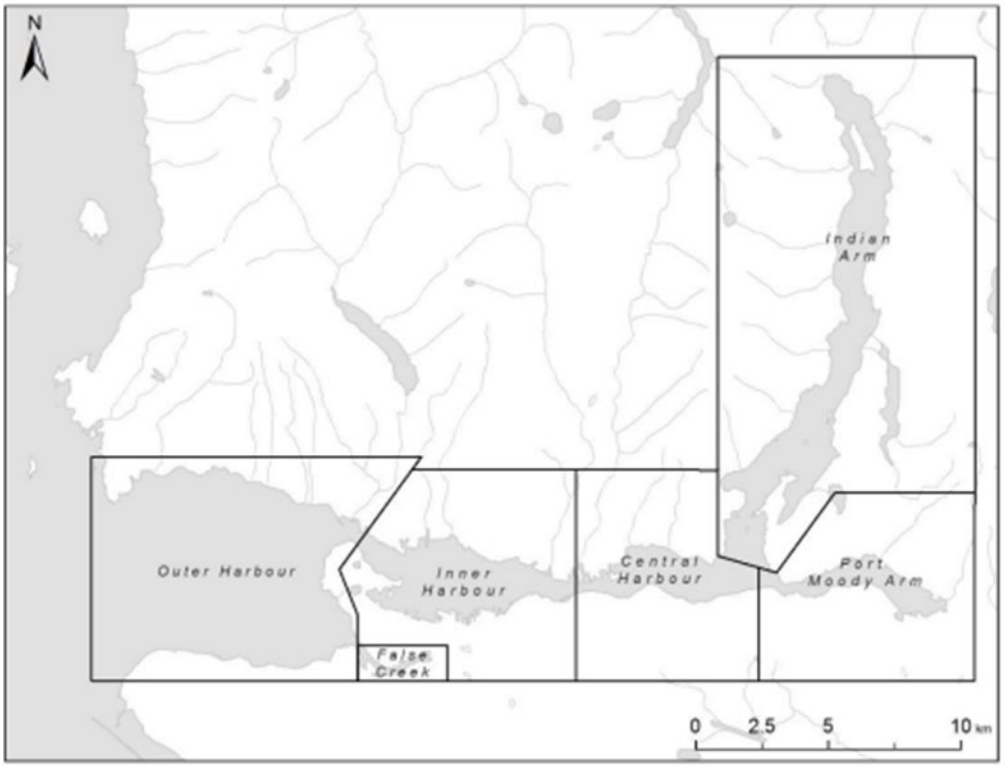


Figure 2-1: Burrard Inlet Sub-Basins

Source: BC ENV and Tsleil-Waututh (2022)

Tides in Burrard Inlet are diurnal and semi-diurnal tidal cycles which produce two low and two high tides per day for most of the year, with a daily mean range of 3.1 m (Burrard Inlet Environmental Action Program, 2011; Davenne & Masson, 2001) and a maximum of 4.8 m (Davidson, 1979). Due to the narrowing at the First and Second Narrows, currents of up to 11 km/hr can result within the Inner Harbour and is also where the greatest tidal mixing occurs (Burrard Inlet Environmental Action Program, 2011).

Burrard Inlet oceanography is heavily influenced by fresh water from the Fraser River and several major rivers (see Section 2.3), which influences salinity (Rao et al., 2019). Water temperature is influenced by the Strait of Georgia (SoG), the Fraser River, tributaries, and runoff, as well as tides and wind. A thermocline occurs around 5 m depth, with shallow waters reaching as high as 20°C in the Outer Harbour and Port Moody Arm during summer, and averaging 6-8°C in the winter (Haggarty, 2001). The salinity of deeper water in Burrard Inlet is usually 29-30 parts per thousand (ppt), while the surface salinity can vary from 20-25 ppt during the winter local run-off period and to less than 10 ppt during the summer when Fraser River run-off is the major dilution factor (Held & Harley, 2019). The highest surface salinity occurs in the Inner Harbour (MOE, 1990) due to turbulent mixing associated with estuarine and tidal flows through the shallow areas. This can also yield lower surface temperatures during the summer and higher surface temperatures during the winter than those which would be found in simpler estuarine environments (MOE, 1990).

Water Quality Objectives (WQO) have been defined for Burrard Inlet through a collaboration between the Tsleil-Waututh Nation (Tsleil-Waututh) and the BC Ministry of Environment and Climate Change (BC ENV), and represents an important collaboration for the protection of this environment (BC ENV & Tsleil-Waututh, 2022).

2.2 Benthic Habitats

Marine habitat geospatial data were explored using available resources with the following benthic habitat types considered important to Burrard Inlet ecosystems:

- Marine vegetation.
- Clam beds.
- Herring spawning areas.
- Forage fish spawning areas.
- Multi-dimensional hard substrates.

2.2.1 Marine Vegetation

2.2.1.1 Kelp

Kelps are a diverse group of marine seaweeds and are an important component of marine food webs and habitat dynamics in BC (Hakai Network for Coastal Ecosystems People and Management, 2011). Kelps provide habitat for a variety of economically and ecologically important fish species such as juvenile Pacific salmon (*Oncorhynchus spp*.), rockfish (*Sebastes spp*.), and Pacific herring (*Clupea pallasii*) (Wheeler & Black, 1990). Kelp species are generally categorized as either canopy forming or understory kelps.

Canopy forming kelps are marine algae that undergo rapid growth to form tall, dense, three-dimensional habitats (BCMCA, 2007). In BC, the two most common forms of canopy kelp are bull kelp (*Nereocystis leutkeana*) and giant kelp (*Macrocystis pyrifera*) (Druel & Clarkston, 2016; PNCIMA Initiative, 2017). Canopy forming kelps generally prefer coastally exposed habitats (NOAA, 1993) and require hard substrates for attachment.

Understory kelps encompass genera including *Laminaria* and *Saccharina* (Wheeler & Black, 1990). They provide habitat for many fish and invertebrate species and influence fluid and particulate transport through the lower parts of the water column (Eckman *et al.*, 1989).

Sugar kelp (*Saccharina latissima*) is an understory kelp that grows on rocks in the low intertidal and shallow subtidal zone (Fretwell, 2016). Sugar kelp is an ecologically

important species as it is a primary producer and provides food and shelter for fish, shellfish, invertebrates, and other algae (Bates, 2004; Christie *et al.*, 2009).

Bull kelp has the potential to form kelp forests in rocky habitats in the subtidal zone along the coast of BC, including in Burrard Inlet. Bull kelp forests are linked to commercially important fish including forage fish such as Pacific herring and Pacific sand lance (*Ammodytes personatus*), as well as salmon species at different life stages (Lamb *et al.*, 2011). The forests are grazed upon and provide shelter for numerous invertebrates and provide shelter and food for various life stages of fish (Connor & Baxter, 1989). Bull kelp forests can reduce current velocities and dampen wave energy, and thus mammals and birds may seek refuge among these forests (Mork, 1996).

Bull kelp is present in the Inner Harbour and has been documented near the Second Narrows bridge and near the Westridge Marine Terminal (Westridge), approximately 2 km and 7.3 km east of the B2 Study Area (Project Noah, 2014; SeaChange & Tsleil-Waututh, 2015). Various species of understory kelps, including sugar kelp, have been observed near Westridge (SeaChange & Tsleil-Waututh, 2015; Stantec, 2013) and are likely to occur throughout Burrard Inlet where suitable hard substrate is present. See Section 4 for documented occurrences of kelps in the B2 Study Area.

2.2.1.2 Eelgrass

Eelgrass (*Zostera marina*) is an important species of marine vegetation that grows on soft sand and mud substrates in the lower intertidal and shallow subtidal zones. Eelgrass serves as both food and habitat for early life stages of several fish, bird, and invertebrate species, including Pacific herring and juvenile Pacific salmon and Dungeness crabs *(Metacarcinus magister*) (DFO, 2023d; Hughes, 2002). It also provides additional ecosystem functions, such as stabilizing shorelines, lessening coastal erosion and improving sediment deposition (District of West Vancouver, 2008). Factors influencing the presence or abundance of eelgrass include light and nutrient availability, depth, substrate, salinity and temperature (Boström *et al.*, 2014; Greve & Binzer, 2004), and eelgrass can survive and grow across a wide range of these conditions. Generally, eelgrass requires high light inputs which correspond to relatively low water column nutrients, soft sediments, salinity above 15 ppt, and temperatures below 25°C; however, thresholds can vary by population (Murphy *et al.*, 2021). In the SoG, eelgrass tends to grow in intertidal and shallow subtidal habitats due to low light levels caused by runoff and anthropogenic influence.

Studies of eelgrass in Burrard Inlet are limited; however, a 2013 Stantec Inc. (Stantec) report and a 2015 collaborative study between SeaChange Marine Conservation Society (SeaChange) and the Tsleil-Waututh have surveyed eelgrass in Burrard Inlet (SeaChange & Tsleil-Waututh, 2015). Eelgrass beds documented to date within Burrard Inlet, include:

- Approximately 5 km east of the B2 Study Area along the northern shore of the Inner Harbour.
- Approximately 8 km east of the B2 Study Area near Cates Park and Gosse Point) at the entrance to Indian Arm.
- Approximately 15 km east of the B2 Study Area in Bedwell Bay in southern Indian Arm.
- There is no known eelgrass present within the B2 Study Area (see Section 4).

2.2.2 Important or Structurally Complex Habitats

2.2.2.1 Clam Beds

Clam beds are ecologically and socio-culturally important features of coastal BC. Clam beds are made up of sessile clam individuals that filter water and provide three dimensional structures for other invertebrate species. Clam beds are generally found in soft substrates (e.g., mud, sand), with depths variable based on species (e.g., intertidal to < -100 m for Pacific geoduck clams [*Panopea Generosa*]).

Clams have also been cultivated and harvested in the region by Indigenous Groups since time immemorial (Morin & Evans, 2022). Historically, there were extensive clam populations in Burrard Inlet; however, since the industrialization of Burrard Inlet there has been a reduction in the abundance of clam beds (Morin & Evans, 2022).

Clam beds are not expected to occur within the B2 Study Area based on observations of substrate conditions (see Section 4.2).

2.2.2.2 Herring Spawning Areas

Coastal BC has been segregated into Herring Spawning Areas (HSA) to facilitate tracking and monitoring of spawning events. The B2 Study Area is broadly within HSA No. 280, where spawning locations have only been documented for Howe Sound. Peak spawning for Pacific herring in HSA 280 occurs from early March to mid-April (DFO, 2015a). Spawning events in HSA 280 have been limited since 2016; however, in 2019, and again in 2022, Tsleil-Waututh documented Pacific herring spawning in Indian Arm, approximately 8.3 km east of the Terminal, for the first time since they were extirpated from Burrard Inlet 130 years ago (Tsleil-Waututh Nation Sacred Trust, 2022).

Pacific herring (described in Section 3.2.2) have large annual spawning events, which provide critical food resources to Indigenous Groups and marine organisms. Herring spawn on hard substrates (natural, anthropogenic [e.g., piles]) and marine algae and macrophytes (e.g., rockweed [*Fucus distichus*], giant kelp, eelgrass) (Hay & Charter,

2013; Thornton *et al.*, 2010). Herring spawning occurs in aggregations in shallow bays and inlets along the coast of BC.

Pacific herring spawning is unlikely to occur in the B2 Study Area due to the limited historical occurrence of spawning events.

2.2.2.3 Forage Fish Spawning Areas

Forage fish are critical energetic links in marine ecosystems, providing food for a variety of larger fish, bird, and mammal species (Bodtker, 2016). Important forage fish in BC include Pacific sand lance, surf smelt (*Hypomesus pretiosus*), Eulachon (*Thaleichthys pacificus*) and Pacific herring. Forage fish require several different types of habitat for spawning, including intertidal and shallow subtidal sand, gravel, cobble, and kelps (Tomlin *et al.*, 2021).

Surf smelt spawning typically occurs from May to September (Port of Vancouver, 2015), but has been known to occur year-round (Government of British Columbia, 2014). Preferred spawning habitat for surf smelt is in the high intertidal of low-sloped shorelines with coarse sand and gravel (1 to 7 mm) (Friends of Semiahmoo Bay Society, 2007), where overhanging vegetation protects the eggs from summer temperatures (Government of British Columbia, 2014). Females deposit their eggs on the gravel in shallow water a couple hours prior to high tide. Males follow and subsequently release their milt nearby. The tidal exchange facilitates burial of the embryos, which develop for approximately two weeks before hatching (DFO, 2002). Recreational fisheries closures are in effect from June 15 to August 15 to protect the peak spawning period (Therriault *et al.*, 2002).

Surf smelt spawning is unlikely to occur within the B2 Study Area due to the rocky intertidal characteristic of the Terminal shoreline (see Section 4 for description of substrate types). There is no published literature documenting surf smelt spawning within the B2 Study Area.

2.2.2.4 Complex Hard Substrate

Complex hard substrates are three-dimensional habitat-forming features, including pebbles, cobbles, boulders, and calcareous debris (e.g., shell hash). Complex hard substrate in marine ecosystems provides habitat for organisms to feed, find shelter, and reproduce (Menge *et al.*, 1985). A variety of types and sizes of substrate provides more areas for use by organisms of different sizes, thus allowing for higher diversity (Menge *et al.*, 1985). Areas of complex hard substrate are present in Burrard Inlet, though their extent is not well documented (Hatfield, 2021a; SeaChange & Tsleil-Waututh, 2015). Hard substrates present within the B2 Study Area includes rip rap (i.e., scour protection) and anthropogenic structures (e.g., piles), which were shown to have higher diversity than soft substrates. See Section 4 for detailed summary of substrate types and associated biota within the B2 Study Area.

2.3 Freshwater Habitats

Freshwater habitats are important features of coastal BC, and the estuarine zones where fresh and marine waters interact are critical features to many species. Important river systems close to and within Burrard Inlet include the Fraser, Capilano, Seymour and Indian Rivers, which are ecologically linked to Burrard Inlet introducing freshwater, nutrients, and sediments. Likewise, these habitats support the freshwater life cycle of salmonid anadromous species.

2.3.1 The Fraser River

The Fraser River is BC's longest river, stretching for 1,375 km from Fraser Pass near Black Mountain in the Rocky Mountains to its mouth in the SoG. The northern branch flows into the SoG past the North Arm jetty approximately 19 km southwest of the B2 Study Area. The Fraser River Estuary (FRE) provides important habitat for resident and migratory species such as juvenile salmonids, white sturgeon (*Acipenser transmontanus*), eulachon, and migratory birds. It is considered the largest estuary in North America with an estimated size of 21,703 ha, with the intertidal wetlands encompassing 17,000 ha (Flynn et al., 2006). The Fraser River influences Burrard Inlet water chemistry and marine habitats due to its size and flow, particularly during spring freshet. Figure 2-2 shows the sediment transport patterns of the FRE.

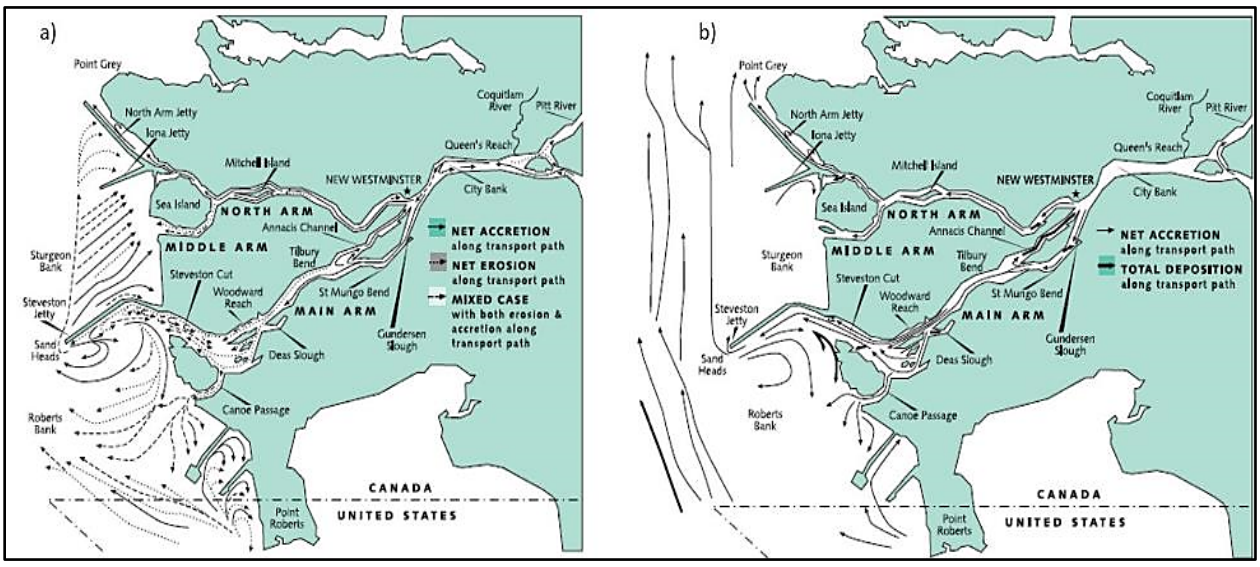


Figure 2-2: Sediment Transport Patterns for Sand in the Lower Fraser River and Delta

Source: Figures 4 and 5 of McLaren and Touminen (1999)

2.3.1 Burrard Inlet Rivers

The main rivers that flow directly into Burrard Inlet are the Capilano, Seymour and Indian Rivers (IBA Canada, 2020), located approximately 6.5 km west, 2.5 km east, and 21.5 km northeast of the B2 Study Area, respectively (see Table 2-1). These rivers provide important habitat to marine species including fish, birds, and mammals. Anadromous fish species such as salmonids are likely to be migrating to and from these river systems as adults and juveniles (Fraser River Action Plan, 1998).

Table 2-1: Main Rivers and Creeks that Flow into Burrard Inlet

RIVER	COORDINATES		PROXIMITY AND DIRECTION FROM THE B2 STUDY AREA
Capilano River	49° 19.244'N	123° 08.458'W	6.5 km W
Mackay Creek	49° 18.777'N	123° 6.128'W	3.7 km W
Mosquito Creek	49° 18.718'N	123° 5.495'W	2.9 km W
Lynn Creek	49° 17.956'N	123° 2.415'W	1 km E
Seymour River	49° 18.021'N	123° 01.401'W	2.5 km E
Indian River	49° 27.847'N	122° 52.905'W	21.5 km NE

2.3.2 Burrard Inlet Creeks and Estuaries

The nearest creeks and estuaries to the B2 Study Area include Mosquito, Mackay and Lynn Creek. The distance and direction of these water courses, in relation to the B2 Study Area, are described in Table 2-1.

The nearest freshwater source to the B2 Study Area is Lynn Creek, which originates in the protected Lynn Headwaters Regional Park, and is the third-largest salmon-bearing river on the North Shore. Lynn Creek is 18 km long with a watershed area of 55 km^2 and is bordered by Seymour River and Mosquito Creek watersheds (Pacific Streamkeepers Federation, 2015a). The lower Lynn Creek Estuary (LCE) is a semi-enclosed body of water where freshwater from Lynn Creek meets the salt water from Burrard Inlet. The existing conditions at the LCE are further detailed within the LCE Fish and Fish Habitat Existing Conditions Report (NBT, 2023b).

Mosquito and Mackay creek are located 2.9 km and 3.7 km west of the B2 Study Area, respectively. The riparian habitat of both creeks has been reduced due to urbanization, channelization, poor water quality, and increases of impermeable areas, resulting in a loss of each creek's estuary (Pacific Streamkeepers Federation, 2015b, 2015c). Both creeks have historically supported salmon and are spawning locations for numerous species of salmon. As such, both creeks have been the focus of numerous habitat enhancement projects to restore the fish habitat and revegetate riparian habitats (Pacific Streamkeepers Federation, 2015b, 2015c).

2.4 Designated Habitats

Critical habitat (or designated habitat) is identified for species listed as endangered or threatened under the *Species at Risk Act* (*SARA*). Critical habitat is defined under Section 2 of *SARA* as:

"…the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

Critical habitat is spatially defined and is a key legislated component of a species' recovery plan.

The B2 Study Area is not within any critical habitats (see Figure 2-3).

2.4.1 Rockfish Conservation Areas

Rockfish Conservation Areas (RCA) are not considered critical habitat areas under the *SARA* but are conservation areas implemented by DFO to help rebuild depleted inshore rockfish populations. No targeted fishing for rockfish is permitted within RCA boundaries (however, other forms of fishing are permitted) (DFO, 2019). The closest RCA to the B2 Study Area is the Eastern Burrard Inlet RCA (DFO, 2015b) located approximately 3.9 km east (see Figure 2-3). Rockfish and their potential to occur in the B2 Study Area is further discussed in section 3.2.4.

2.4.2 Southern Resident Killer Whale Habitat

Southern Resident Killer Whale (SRKW) habitat includes portions of the waters of the southern SoG, the Gulf Islands, the Strait of Juan de Fuca, Haro Strait, Boundary Pass, and offshore waters of Vancouver Island. DFO (2023b) management measures to protect SRKW include a 400 m maximum approach distance for all vessels in southern BC coastal waters, and two interim sanctuaries in the Gulf Islands with no vessel traffic June 1- November 30 (DFO, 2023b). Area based fisheries closures have also been established by DFO, the nearest of which is for a portion of Pacific Fishery Management Area (PFMA) 29-3 at the mouth of the FRE which is closed August 1 to September 30. The voluntary slowdown of both inbound and outbound commercial vessels in Haro Strait, Boundary Pass, and Swiftsure Bank organized by the Port Authority Enhancing Cetacean Habitat and Observation (ECHO) Program continue to be in effect. A similar voluntary vessel slowdown program, Quiet Sound, is being developed in Puget Sound. Additionally, two pilot seasonal slow down (maximum 10 knots) areas are being piloted near Swiftsure Bank from June 1 to November 30 (DFO, 2023b).

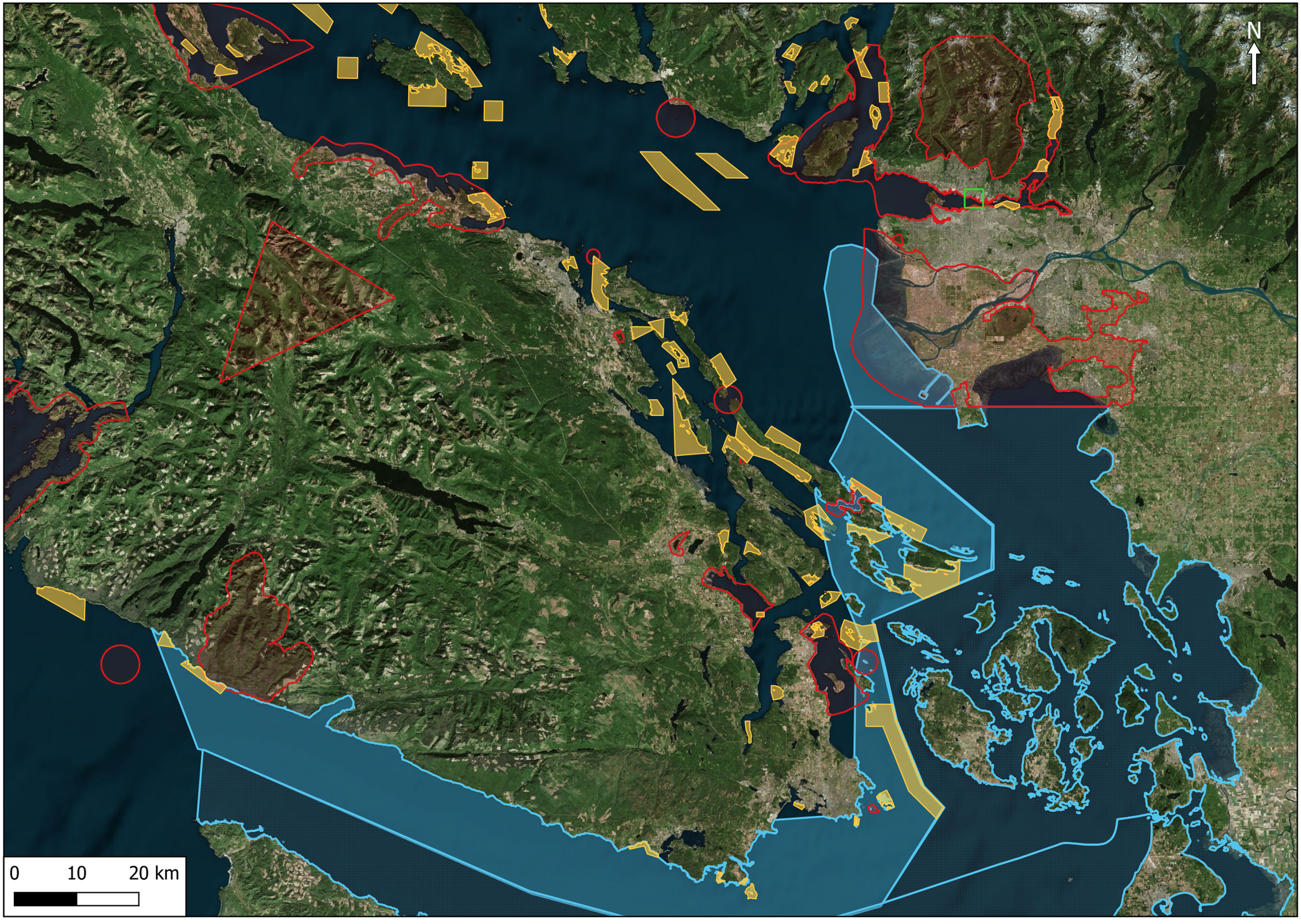
At this time, Burrard Inlet, including the B2 Study Area, is not within the SRKW critical habitat (see Figure 2-3). However, the Tsleil-Waututh have recommended the SRKW habitat be extended to include the FRE and Burrard Inlet (Tsleil-Waututh, 2018). The SRKW critical habitat at the entrance to Burrard Inlet is approximately 16.5 km west of the B2 Study Area.

2.4.3 Important Bird Area

Important Bird Areas (IBA) are discrete sites designated by the Important Bird and Biodiversity Areas Program to support the ongoing productivity of birds. Since 1996, over 600 IBAs in Canada have been identified; however, legal protection is not associated with these areas, though they may overlap partially or entirely with legally protected sites. Important Bird Areas are identified using information about bird

populations, as well as internationally agreed upon, standardized, quantitative, and scientifically defensible criteria to protect specific groups of birds, including threatened birds, large groups of birds, and birds restricted by range or by habitat (IBA Canada, 2011). Important Bird Areas are used to design conservation priorities and networks and are used by governments in assessing impacts and establishing guidelines.

The B2 Study Area is located within the English Bay, Burrard Inlet & Howe Sound IBA (Site: BC020) (IBA Canada, 2020). The 335 km^2 IBA is noted to be globally significant to congregatory species and continentally significant to waterfowl concentration. Designation of this IBA was for three species at the global level: western grebe (*Aechmophorus occidentalis*), Barrow's goldeneye (*Bucephala islandica*) and surf scoter (*Melanitta perspicillata*); and one species at the national level: great blue heron (*Ardea herodias*). Additionally, this IBA supports many coastal and marine bird species characteristic of the Pacific Northwest, including nesting sites for large colonies of pelagic and double-crested cormorants (*Phalacrocorax pelagicus*, *Phalacrocorax auritus*), Ospreys (*Pandion haliaetus*), and Bald Eagles (*Haliaeetus leucocephalus*).



LEGEND:

- Project Location
- Rockfish Conservation Area
- Important Bird Area
- SRKW Critical Habitat (Canada)
- SRKW Critical Habitat (USA)

SOURCE/NOTE:

a) Map digitized by Brian Timmer (2023).

b) Source aerial image from Bing Maps (2023).

c) BC RCA data from BCMCA

d) BC IBA data from IBA Canada

e) SRKW data from Hatfield

Rev	YYYY-MM-DD	DESCRIPTION	DRAWN	APPROVED
A	2023-01-25	draft figures	BT	LB

ISSUES/REVISIONS

VENDOR: Dynamic Ocean Consulting Ltd.

ISSUED AS RECORD COPY (YES/NO): NO

Neptune TERMINALS

TITLE:

Designated Habitats in Proximity to the Berth 2 Dumper 2 Project

Figure 2-3

SCALE:	SHEET	OF	FIGURE NO.	REV.
	1	1		0

3 MARINE ORGANISMS

Numerous species of marine organisms reside in or migrate through Burrard Inlet waters annually. Focal fish and marine mammal species relative to the B2 Study Area were selected based on several variables which included:

- Importance to Indigenous Groups for subsistence and food security.
- Geographic ranges which include the potential to occur in the B2 Study Area.
- Representative role in food chain dynamics.

Species identified as focal are listed in Table 3-1, which also identifies species occurrence probability in the B2 Study Area

Table 3-1: Focal Species

SPECIES		SPECIES SPATIAL CATEGORY	TYPE	SEASONAL OCCURRENCE	HABITAT USE TYPE	LIFE STAGE	B2 STUDY AREA PROBABILITY OF OCCURRENCE	REPORT SECTION
Common Name	Latin Name							
California Sea Lion	*Zalophus californianus*	Migratory	Marine Mammal	Year Round, more common from Sept-May	Opportunistic feeding	Adult	Low	3.3.1
Dungeness Crab	*Metacarcinus magister*	Resident	Invertebrate	Year round	Feeding, residing	Larval, juvenile, adult	Very high, known to be present	3.1.1
Harbour Porpoise	*Phocoena phocoena*	Migratory	Marine Mammal	Year round	Opportunistic feeding	Juvenile, adult	Very low	3.3.3
Harbour Seal	*Phoca vitulina*	Resident	Marine Mammal	Year round	Feeding, residing	Juvenile, adult	High	3.3.2
Pacific Herring	*Clupea pallasii*	Migratory	Fish	Year round, peak spawning March-April	Spawning, migrating	Juvenile, adult	Low	3.2.2
Killer Whale	*Orcinus orca*	Migratory	Marine Mammal	Year round	Opportunistic feeding	Juvenile, adult	Very low	3.3.4
Pacific Salmon: Chum, Coho, Chinook, Sockeye Pink, Cutthroat (trout),	*Oncorhynchus keta*, *O. kisutch*, *O. tshawytscha*, *O. nerka*, *O. gorbuscha*, *O. clarki*, *O. myki*	Anadromous	Fish	Year round, Spawning adults Transit July-December. Juveniles transitioning to marine habitat in spring.	Migrating	Juvenile, adult	Moderate	3.2.1

SPECIES		SPECIES SPATIAL CATEGORY	TYPE	SEASONAL OCCURRENCE	HABITAT USE TYPE	LIFE STAGE	B2 STUDY AREA PROBABILITY OF OCCURRENCE	REPORT SECTION
Common Name	Latin Name							
Steelhead (trout)								
Rock Fish 38 Species in BC (DFO, 2020): Yelloweye, Rougheye	*Sebastes ruberrimus, S. aleutianus*	Resident	Fish	Year round	Feeding, residing	Juvenile, adult	Low	3.2.4
Steller Sea Lion	*Eumetopias jubatus*	Migratory	Marine Mammal	Year round	Opportunistic feeding	Juvenile, adult	Low	3.3.5
Surf Smelt	*Hypomesus pretiosus*	Resident	Fish	Year round	Migrating	Juvenile, adult	Moderate	3.2.3

3.1 Invertebrates

Invertebrates play an important role in the marine ecosystem. They may seek refuge and graze on the macroalgae present, they also process the particulate, organic materials (detritus and small organisms) that are deposited on the seafloor or that are suspended within reach of the organisms (Burd et al., 2008). Invertebrates use a wide range of feeding strategies such as deposit-feeding, suspension-feeding, filter-feeding, or scavenging. Benthic invertebrates may also be predators and herbivores and provide food for fish, birds, and marine mammals. Invertebrates are also useful as indicators of human activities, such as aquaculture.

3.1.1 Dungeness Crab

Dungeness crab is an important subtidal species and one of the oldest invertebrate fisheries in BC (DFO, 2023d). Dungeness crabs occur at subtidal depths of up to -230 m but are commonly found shallower than -90 m in soft sediment habitats (Kashef, 2015). During spawning, larvae are transported primarily by currents and can be carried over substantial distances during the three to four months they remain pelagic before eventually settling in oyster shell and eelgrass beds (Beacham et al., 2008; Hemmera, 2014). Juvenile crabs use nearshore and estuarine habitats as nurseries (Armstrong et al., 2003; Lewis et al., 2021). Dungeness primarily feed on crustaceans and clams as juveniles, and shrimp and fish as adults.

Dungeness crabs have been observed in the B2 Study Area (see Section 4.2.2) and rip rap areas are likely to provide refuge areas for juveniles.

3.2 Fish

Pacific Fisheries Management Areas are geographically defined areas to assist in the management of commercial, recreational, and aboriginal fisheries. The B2 Study Area falls within PMFA 28-10 (DFO, 2022a).

Marine fish species that are found in Burrard Inlet occupy the ocean differentially, either as residents, migratory species or anadromous, as defined below:

- **Migratory:** species that migrate exclusively in the marine environment on an annual or seasonal basis, triggered by local climate, food availability or for mating reasons.
- **Resident:** species that occupy the same general area throughout the year.
- **Anadromous**: the movement of fish between freshwater and marine environments for the purposes of feeding in one environment and spawning in the other.

3.2.1 Pacific Salmon

Salmon are anadromous species that use marine and freshwater habitats during their life cycle, always returning to freshwater to spawn. Five species of Pacific salmon (chum [Oncorhynchus keta], coho [O. kisutch], Chinook [O. tshawytscha], sockeye [O. nerka], pink [O. gorbuscha]) and two species of ocean trout (cutthroat [O. clarki], steelhead [O. mykiss]) are known to use Burrard Inlet during their life cycle (Naito & Hwang, 2000). Spawn timing is variable based on the specific run, but typically begins

and ends between July and December (BC ENV, 2020). During migration from freshwater to marine habitats, juvenile salmon use nearshore habitats for food and cover. A review of existing marine fish and fish habitat for Burrard Inlet indicates seasonal use of shoreline areas by spring migrating juvenile salmon from watercourses along the north shore of the Inner and Central Harbours and Indian Arm (AECOM, 2016a; Haggarty, 2001; Renyard, 1988; Stantec, 2018a, 2018b). A summary of Pacific salmon biology and life stages is presented in Table 3-2.

All species of Pacific salmon have the potential to occur in the B2 Study Area and are most likely to do so during migration between fresh and saltwater habitats. The timing of salmon spawning migrations in the three creeks nearest to the B2 Study Area is provided in Table 3-3. No documented salmon holding areas are located at or in immediate proximity to the B2 Study Area.

Table 3-2: Summary of General Biological and Life History Characteristics of Four Species of Pacific Salmon

LIFE HISTORY CHARACTERISTIC	COHO (*O. KISUTCH*)	PINK (*O. GORBUSCHA*)	CHUM (*O. KETA*)	CHINOOK (*O. TSAWYTSCHA*)
Season when eggs hatch	Spring	Spring	Spring	Spring
Length of stay in freshwater	One to two years; 1 year is common	Virtually none; often straight to ocean	Virtually none; often straight to ocean	Ocean-type: 60-150 days Stream-type: one to two years
Primary rearing habitat	Stream	Estuary	Estuary	Stream/Ocean
Size at ocean migration	10 cm or more	About 3.3 cm	2.8 to 5.5 cm	five to 15 cm
Ocean voyage	four to 18 months	18 months	two to five years	four months to five years
Age at return to freshwater	During 2nd to 4th year	During 2nd year	During 3rd to 5th year	During 2nd to 6th year
Season/month of return	Late summer to January	July to September	July to October	Spring to fall; some rivers support more than one run
Number of eggs per female	2,000-3,000	1,200-2,000	2,000-3,000	2,000-17,000; (generally 5,000-6,000)
Preferred spawning area	Small streams	Close to ocean	Above turbulent areas or upwellings	Very broad tolerances

Source: DFO (2022b)
Note: Sockeye salmon are not included in this table because they are more commonly using the streams that feed into the Fraser River than Burrard Inlet for rearing and spawning.

Table 3-3: Timing of salmon spawning migrations in salmon-bearing streams near the B2 Study Area Watershed

LOCATION	COHO *O. KISUTCH*	PINK *O. GORBUSCHA*	CHUM *O. KETA*	CHINOOK *O. TSAWYTSCHA*
MacKay Creek	Mid-October to late December	Unknown	Unknown	Not present
Mosquito Creek	Mid-September to late December.	Not present	Not present	Not present
Lynn Creek	June to early January	Early September to late October	Early October to late November	Mid-October

Source: DFO (1989); Greenbank *et al.* (2001); Hancock and Marshall (1986); Naito and Hwang (2000)
Note: Sockeye salmon are not included in this table because they are more commonly using the streams that feed into the Fraser River than Burrard Inlet.

3.2.2 Herring

Pacific herring is an important forage fish species in BC and are an ecologically and culturally important species. Pacific herring supports food chain dynamics, and has significance to recreational, indigenous and commercial fisheries (DFO, 2023c). They are a pelagic species utilizing both inshore and offshore waters from Baja California to the Beaufort Sea (DFO, 2023c). Predators include sea bird, larger fish and marine mammals (DFO, 2023c).

There is the potential for Pacific herring to be present in the B2 Study Area, however, they are most likely to be migrating through as no spawning has been documented near the B2 Study Area (See Section 2.2.2.2 for a description of Pacific herring spawning).

3.2.3 Surf Smelt

Surf smelt are distributed from Long Beach, California to Prince William Sound, Alaska and utilize near shore habitats throughout all phases of their life cycle (Therriault *et al.*, 2002). Surf smelt feed on both zooplankton and zoobenthos such as amphipods, crab larvae, worms and fish eggs (Therriault *et al.*, 2002). Surf smelts are in turn important prey of salmon, marine mammals and birds (Therriault *et al.*, 2002). To avoid predators, these fish bury themselves in soft, gravely sediments, with preference given to sediments free of contaminants such as oil, and which allow for adequate water flow (Pinto *et al.*, 1984).

The shoreline at the B2 Study Area is rocky intertidal habitat which surf smelt are unlikely to use for spawning (see Section 2.2.2.3) or predator avoidance.

3.2.4 Rockfish

Rockfish are a long-lived, low-fecundity species of groundfish, with some species' lifespans exceeding 100 years (DFO, 2021). There are 38 species of rockfish along the coast of BC; midwater and inshore species can be found between 0 to -600 m while deep benthic species can be found at depths of -100 to -2000 m within rocky habitats (DFO, 2020). Primary threats to rockfish include commercial and recreational fishing as rockfish are uniquely susceptible to barotrauma due to their closed swim bladders (DFO, 2021). In order to combat the effects of barotrauma, DFO now requires recreational anglers to use descending devices to reduce rockfish mortalities (DFO, 2021).

Monitoring of rockfish populations has indicated that inshore BC rockfish stocks are at low levels, potentially making it more difficult for populations to recover even after fishing has stopped (Parker *et al.*, 2000). Two species of rockfish are listed as Special Concern under the *SARA* (Yelloweye rockfish [*Sebastes ruberrimus*] and Rougheye rockfish [*Sebastes aleutianus*]). Due to their long lifespans and slow growth and reproduction rates, rockfish in BC are protected within 162 RCAs (DFO, 2019). RCAs are further discussed in section 2.4.1.

Rockfish have not been documented within the B2 Study Area (see Section 4.2.2) and are unlikely to occur due to limited suitable habitat.

3.3 Marine Mammals

The diversity and abundance of marine mammals in the Inner Harbour are generally low, with the exception of harbour seals (*Phoca vitulina)*. However, several marine mammals have the potential to occur in the B2 Study Area and are discussed in this section.

3.3.1 California Sea Lion

California sea lions (*Zalophus californianus*) are observed throughout coastal BC from the fall through to the spring months, although it is typically only males that seasonally migrate to BC waters (Ford, 2014). The northbound migration beginning late August following the breeding season in California and Mexico (Gearin *et al.*, 2017). This species can often be seen in the nearshore environment as they make use of cliffs, rocky shores, and docks to haul out (Ford, 2014). California sea lions have a diverse prey base, and opportunistically feed on fish (including Pacific herring, salmonids and lingcod [*Ophiodon elongatus*]) and invertebrates such as squid and octopus (Ford, 2014). California sea lion movements are believed to be driven by prey (Gearin *et al.*, 2017). Spawning aggregations of Pacific herring are a major attractant for California sea lions in the winter and early spring (Ford, 2014).

During B1 construction in 2019/2020, there was one observation of a California sea lion near the Terminal, as well as two other unidentified sea lions (NBT, 2020a). There is potential for California sea lion to occur in the B2 Study Area, but their presence is likely limited to the winter and spring months and would likely be related to prey availability.

3.3.2 Harbour Seal

Harbour seals are the most ubiquitous marine mammals in coastal BC (Ford, 2014), and are frequently sighted in Burrard Inlet year-round (Butler *et al.*, 2015; Stantec, 2018a, 2018b). Solitary harbour seals are regularly observed along shorelines or hauled out on log-booms, rocks, or piers as they have a preference for nearshore areas where they can haul out (Ford, 2014). The harbour seal diet varies seasonally and is predominantly made up of fish and invertebrates (Ford, 2014).

During B1 construction (Mar-2019 to Sept-2020), 94% of all marine mammal sighting reports were harbour seals (NBT, 2020b). Harbour seals are likely to occur within the B2 Study Area throughout the year.

3.3.3 Harbour Porpoise

Harbour porpoise (*Phocoena phocoena*) are present year-round in coastal BC waters, including waterways close to urban centres, such as Vancouver (Hall, 2011). These small mammals feed on a variety of fish (predominantly Pacific herring) and invertebrates (Nichol *et al.*, 2013). Harbour porpoise are relatively common in the nearshore waters of the southern SoG, but are only occasionally sighted in Burrard Inlet (Butler, 2015 in AECOM, 2016b).

Harbour porpoise occurrence within the B2 Study Area would be infrequent, and likely related to predator avoidance or prey abundances.

3.3.4 Killer Whale

Southern Resident Killer Whales are regularly present in the southern SoG, which is part of the designated critical habitat for this population (see Section 2.4.2). Southern Resident Killer Whales feed exclusively on fish, with Chinook salmon being a primary prey species that have been associated with the survival of this population (Ford *et al.*, 2010). DFO (2023b) measures to protect SRKW list Chinook, chum and coho as essential to SRKW diet. Localized abundances of SRKWs are often related to prey distribution, and in the southern SoG SRKW are most likely to occur during the summer and early fall when migratory salmon aggregations are greatest.

Transient (also known as Bigg's) killer whales also inhabit the southern SoG. Transient killer whales can occur year-round, and occurrence in Burrard Inlet has been reported with individuals and small groups observed (AECOM, 2016b; City News, 2019; Global News, 2018). Transient killer whales prey exclusively on other marine mammals, including seals, sea lions, porpoise, and occasionally baleen whales.

Both SRKW and transient killer whales have been reported in Burrard Inlet (AECOM, 2016b). During B1 construction (Mar-2019 to Sept-2020), a pod of killer whales were observed 300 m from the construction barge on April 23, 2019 (NBT, 2019). However, presence of either SRKW or transient killer whales within the B2 Study Area is unlikely to occur since SRKW need deeper waters to swim and would therefore stay south of the Terminal.

3.3.5 Steller Sea Lion

Steller sea lions (*Eumetopias jubatus*) are present in BC year-round, but most often occur in the SoG in the fall, winter and early spring months, when they are either hauled out or feeding (Ford, 2014). In May to August reproductively mature Steller sea lions are unlikely to occur in Burrard Inlet as all five breeding areas in BC are located in the Queen Charlotte Sound and Hecate Strait (COSEWIC, 2013). The Steller sea lion diet is diverse and includes fish (including Pacific herring and salmonids), invertebrates, and even seal pups and gulls (Ford, 2014). Pacific herring spawning events are major attractants for this species in the winter and early spring months (Ford, 2014).

During B1 construction (03/2019 to 09/2020), two sightings of unidentified sea lions were reported (NBT, 2020b). Steller sea lions may occur in Burrard Inlet occasionally, and their presence within the B2 Study Area is most likely to occur during the winter to spring months and during prey species spawning events.

3.4 Designated Species

A review of federal and provincial SAR was undertaken using available online resources, such as the BC CDC website (BC CDC, 2023) and the SAR registry. The spatial scale of these online resources is not refined to the level of the B2 Study Area. However, based on the site-specific field survey and observed habitat characteristics, informed decisions can be made on the probability of presence of these species. Although these species have the potential to exist in the Inner Harbour, there were no observations of SAR during the site-specific field surveys (see Section 4.2).

Table 3-4 outlines federal and provincial conservation status categories and definitions. Table 3-5 summarizes designated species found within Burrard Inlet and their associated conservation statuses.

Table 3-4: Provincial and Federal Conservation Status Definitions

STATUS		DEFINITION
COSEWIC and *SARA* (Federal)	Endangered (E)	A species facing imminent extirpation (no longer exists in Canada) or extinction (no longer exists).
	Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
	Special Concern (SC)	A species that is particularly sensitive to human activities or natural events but is not endangered or threatened.
BC CDC (Provincial)	Red	Any indigenous species, subspecies or plant community that is extirpated, endangered, or threatened in BC.
	Blue	Any indigenous species, subspecies or community considered to be of special concern in BC. Blue listed elements are at risk, but are not extirpated, endangered, or threatened.
	Yellow	Any indigenous species, subspecies, or community considered to be secure in BC. Encompasses all those not listed as red or blue.

Source: BC CDC (2023)
Definitions: COSEWIC = Committee on the Status of Endangered Wildlife in Canada, *SARA* = Federal *Species at Risk Act*, CDC = Conservation Data Centre

Table 3-5: Marine SAR Potentially Found within Burrard Inlet

COMMON NAME	SCIENTIFIC NAME	BC LIST	COSEWIC STATUS	*SARA* STATUS
Basking shark	*Cetorhinus maximus*	No status	E	E
Bluntnose sixgill shark	*Hexanchus griseus*	No status	SC	SC
Green sturgeon	*Acipenser medirostris*	B	SC	SC
Grey whale	*Eschrichtius robustus*	B	Non-active	SC
Harbour porpoise	*Phocoena phocoena vomerina*	B	SC	SC
Humpback whale	*Megaptera novaeangliae*	B	SC	SC
Killer whale	*Orcinus orca, resident*	R	E	E
Killer whale	*Orcinus orca, transient*	R	T	T
Leatherback sea turtle	*Dermochelys coriacea*	R	E	E
Longspine thornyhead	*Sebastolobus altivelis*	No status	SC	SC
Northern abalone	*Haliotis kamtschatkana*	R	E	E
Rougheye rockfish Type I and II	*Sebastes sp.*	No status	SC	SC
Steller sea lion	*Eumetopias jubatus*	B	SC	SC
Tope shark	*Galeorhinus galeus*	No status	SC	SC
Yelloweye rockfish	*Sebastes ruberrimus*	No status	T	SC

Note: Reviewed January 2023

Source: Species at Risk Public Registry (Government of Canada, 2023), Pacific Ocean, Aquatic SAR Maps (DFO, 2023a), BC Species Ecosystem Explorer (BC CDC, 2023)
Definitions: R = red, B = blue; T = threatened, E = endangered, SC = special concern

3.5 Invasive Species

Invasive species with the potential to occur in the Pacific North Coast waters as per DFO's Aquatic Invasive Species website (DFO, 2018) are listed below:

- Soft shell clams (*Mya arenaria*).
- Manila clams (*Lajonkairia lajonkairii*).
- Japanese wireweed (*Sargassum muticum*).
- Pacific oyster (*Magallana gigas*).
- European Green crab (*Carcinus maenas*).
- Boring sponges (*Cliona* sp., *Sycon* spp.).
- Three byozoans and ascidians.
- Japanese skeleton shrimp (*Caprella mutica*).
- America shad (*Alosa sapodissima*).

The only observations of an invasive species during the site-specific field surveys was Japanese wireweed at the western and eastern end of the B2 face (T20, T20A, and T21A) during the remotely operated vehicle (ROV) surveys (see Section 4.2, Figure 4-2). While no other occurrences of invasive species are expected within the B2 Study Area invasive species mitigation measures will be in place during construction.

4 FIELD PROGRAM

Three site specific field programs have been undertaken to support the B2 Project to confirm seabed substrate characteristics and assess species biomass and biodiversity within the B2 Project footprint. Surveys were undertaken with either a ROV or by a surface-supply dive team. These surveys were compared to a 2018 survey undertaken as a part of a marine habitat survey for Berth 1 to 3 (Stantec, 2018a). Survey dates, equipment type and supporting consultant are as described below:

- November 18, 2021 – ROV – ASI Marine (a division of ASI Group Ltd. [ASI]).
- December 1 and 3, 2021 – Surface supply dive team – Foreshore Technologies Inc. (Foreshore).
- August 15, 2022 – ROV – Dynamic Ocean Consulting Ltd. (Dynamic Ocean).

The ROV surveys provided subtidal video of the seabed along the entire length of each respective transect, whereas dive surveys focused on nearshore areas by collecting qualitative and quantitative data for a subset of the ROV transects. An additional ROV survey was undertaken in August 2022 specifically to ground truth the habitat map produced from the earlier survey and to confirm any habitat variation during the summer when annual kelp species (e.g., bull kelp) could be present.

4.1 Methodology

Ten transects were established and numbered as assigned by Stantec (2018a), eight of which were replicates of the Stantec (2018a) survey. Nine transects were perpendicular to shore, to evaluate habitat variations due to bathymetry. Depth range of perpendicular to shore transects was -2.0 m to -16.5 m chart datum (CD). Transects were approximately 20 m to 50 m apart. When performed with the ROV, transect length was 50 m, and when performed by divers the transect length ranged from 20 m to 38 m. All nine perpendicular to shore transects were performed by the ROV with five repeated by the dive team. One transect was parallel to shore (T22) to evaluate habitat characteristics along a similar bathymetry line (~ -19 to -20.5 m CD). Transect 22 was approximately 45-50 m from the berth face and was 250 m long. The parallel to shore transect was conducted with the ROV during the November survey.

During August 2022 ROV surveys, in addition to repeating the nine original transects from 2018 and 2021, five additional transects were undertaken parallel to shore, at approximately -1.6 m CD and ranged between 10 m to 20 m in length. Transects were numbered in accordance with the perpendicular to shore transect that was closest to the start and ran in an east or west direction. When kelp was observed the perimeter of the kelp was documented with GPS by a combination of visual observation from the surface and real-time viewing on the ROV monitor.

A visual depiction of the transects along with the details are provided in Figure 4-1 and Table 4-1.

LEGEND:

- Transect
- Contour
- B2 project water lot footprint
- Water lot boundary

SOURCE / NOTE:

a) B2 project water lot footprint, digitized by Hatfield (2022) using Figure 3 (Appendix A), "Berth 2 Marine Fish and Fish Habitat Existing Conditions Report", Neptune BulkTerminals, August 2022.
b) Water lot, digitized by Hatfield (2022) using Figure 1 (Appendix A), "Site Location and Marine Survey Area", Neptune Bulk Terminals, January 2022.
c) Contours, Neptune Bulk Terminals, January 2022.
d) Transects, digitized by Hatfield (2022), T10, T11, T15, T16,T17, T18, T19, T20, T21, T22 from Envirochem 2022, T10A, T15A, T17A, T20A, T21A from Dynamic Ocean Consulting Ltd. 2022.
e) Background, Orthophoto 10 cm, 13 April 2021, Esri Online Service.

PROJET:
SYSTEM:
ASSET:
DISCIPLINE:

REV	YYYY-MM-DD	DESCRIPTION	DRAWN	APPROVED

ISSUES/REVISIONS

VENDOR: Hatfield

ISSUED AS RECORD COPY (YES/NO) NO

Neptune TERMINALS

TITLE: Berth 2 Subtidal Transect Survey Locations

Figure 4-1

SCALE:	SHEET	OF	DRAWING NO.	REV:
	1	1		A

K:\Data\Project\NBT11583-NV\A MXD\NBT11583 Transect Map 20221011 v1 1 TD.mxd

Table 4-1: Field Survey Transects at Berth 2

TRANSECT NUMBER	GPS COORDINATES				DIRECTION RELATIVE TO SHORE	SURVEY TYPE	TRANSECT LENGTH (M)	DEPTH (M CD)	
	Start		Stop					Min	Max
	Latitude	Longitude	Latitude	Longitude					
T10	49° 18.227'N	123° 3.194'W	49° 18.203'N	123° 3.211'W	Perpendicular	ROV/Dive	50	-4.4	-20.4
T10A	49°18.227'N	123°3.197'W	49°18.224'N	123°3.187'W	Parallel	ROV	10	-1.0	-1.6
T11	49° 18.234'N	123° 3.217'W	49° 18.212'N	123° 3.235'W	Perpendicular	ROV	50	-4.5	-22.1
T15	49° 18.183'N	123° 3.053'W	49° 18.157'N	123° 3.052'W	Perpendicular	ROV/Dive	40	-4.6	-19.8
T15A	49° 18.179'N	123° 3.040'W	49° 18.175'N	123° 3.027'W	Parallel	ROV	10	- 1.6	-2.2
T16	49° 18.194'N	123° 3.088'W	49° 18.170'N	123° 3.104'W	Perpendicular	ROV	50	-4.6	-19.2
T17	49° 18.200'N	123° 3.106'W	49° 18.176'N	123° 3.124'W	Perpendicular	ROV	50	-4.5	-19.3
T17A	49° 18.196'N	123° 3.096'W	49° 18.187'N	123° 3.067'W	Parallel	ROV	20	-0.6	-5.3
T18	49° 18.206'N	123° 3.125'W	49° 18.182'N	123° 3.143'W	Perpendicular	ROV/Dive	45	-4.5	-19.5
T19	49° 18.211'N	123° 3.142'W	49° 18.187'N	123° 3.160'W	Perpendicular	ROV	45	-3 .1	-20.0
T20	49° 18.222'N	123° 3.176'W	49° 18.197'N	123° 3.194'W	Perpendicular	ROV/Dive	40	-3.7	-21.3
T20A	49° 18.216'N	123° 3.161'W	49° 18.208'N	123° 3.139'W	Parallel	ROV	20	-2.6	-3.6
T21*	49° 18.179'N	123° 3.014'W	49° 18.155'N	123° 2.995'W	Perpendicular	ROV/Dive	50	-2.0	-19.2
T21A	49° 18.176'N	123° 3.021'W	49° 18.182'N	123° 3.007'W	Parallel	ROV	15	-1.6	-11.6
T22*	49° 18.210'N	123° 3.238'W	49° 18.153'N	123° 3.052'W	Parallel	ROV	250	-19.1	-20.5

Note:

Transects start at T10 because 2018 survey was across multiple NBT berths.
Transect numbers were maintained for comparison to previous and consistency for future surveys.
*Not conducted in 2018.

4.1.1 Survey Techniques

4.1.1.1 ROV

For ROV surveys, the pilot navigated in a straight heading along each transect using both video and imaging sonar. Imagery of the seabed and aquatic fauna and flora was collected for the entire length of each transect.

4.1.1.2 Dive Surveys

For dive surveys, a transect tape was laid out from the base of the sheet pile wall at the same start point as the associated ROV survey. Substrate types and species presence/abundance were qualitatively assessed along the transects within a 2 m wide belt (1 m on each side of the transect). Two to four quadrats (1 m^2) were established along each transect at specific points away from the berth face based on substrate type and/or flora and fauna type/abundance changes. Quantitative species data (i.e., abundance and diversity) were collected for each quadrat.

Divers also collected video of twelve timber and five steel piles located within the existing shiploader infrastructure, from the mudline up to +/- 2 m (vertical distance). The subset of marine structures was included to characterize the vertical habitat available to marine species.

4.1.2 Habitat and Biota Characterization

The DFO manual titled 'Coastal/Estuarine Fish Habitat Description and Assessment Manual' (DFO, 1990) was used to assess both substrate conditions and species abundance (Table 4-2, Table 4-3). Transitions between substrate types were noted, and their respective distances from the berth face were recorded. Several substrate types were added that are typical in coastal BC. Substrate data were then used to estimate the spatial distribution of each substrate type within the B2 Project footprint to support the development of a habitat map (see FIG-HAT-Berth 2 Habitat Map.pdf Figure 4-2). Within each quadrat, organisms were identified to genus (where possible) and assigned an abundance category, percent areal coverage, and individuals per square metre based on DFO (1990). Organisms were identified during the survey and from photographs/video. Abundance levels for selected organisms or biota groups were assigned based on the criteria presented in Table 4-3.

Habitat quality around the B2 Study Area was categorized based on observed seabed substrate characteristics with the following considerations:

- Habitat use by fishes for their various life-history stages (e.g., nursery habitat, migratory routes) and life processes (e.g., feeding).
- Characteristics of the substrate in terms of diversity and multidimensional features (e.g., eelgrass, boulders).

- Habitat availability in terms of its uniqueness in comparison with nearby habitats.
- The extent of anthropogenic influence.

Table 4-2: Substrate Categories

SUBSTRATE TYPE	DIAMETER (MM)
Mud	<0.625
Sand	0.625 to <2
Gravel	2 to <64
Cobble	64 to < 255
Boulder	>255
Rip rap (scour protection)	>255
Woody debris	NA
Shell hash	NA

Source: Tripp *et al.* (2020)

Table 4-3: Biota Abundance Categories

ABUNDANCE CATEGORY	PERCENT AREAL COVERAGE (PAC)	INDIVIDUALS PER SQUARE METRE (IPM)
Rare	<5%	1
Sparse	5% to 25%	2 to 5
Few	26% to 50%	6 to 10
Common	51% to 75%	11 to 30
Abundant	>75%	> 30

Source: DFO (1990)

4.2 Results

4.2.1 Substrate (Habitat)

Substrate in the B2 Project footprint was comprised of rip rap cobble and boulders near the berth face transitioning into silt/sand away from the berth face (FIG-HAT-Berth 2 Habitat Map.pdf Figure 4-2). Where cobble and boulders were present, they were >50 % covered by silt and sand (FIG-HAT-Berth 2 Habitat Map.pdf Figure 4-2). Silt/sand was the predominant substrate along the seaward extent of the B2 Project footprint.

Rip rap extended approximately 20 m seaward from B2 face on the western side (transects T10, T11, and T20) and extended 4 m to 11 m seaward at all other transects. A wire mesh covered the rip rap adjacent to the subtidal pony wall along the western side of B2 (T10, T11, and T20) (FIG-HAT-Berth 2 Habitat Map.pdf Figure 4-2, Panel 2 in

Photo 4-1: Demonstrative Photo Panel of Berth 2 Footprint). Rip rap present at less than -8 m CD consisted of boulders, which then transitioned to a mix of cobble and boulders up to -11 m CD. From -11 m to -14 m CD, substrate consisted of a mixture of cobble, gravel, sand, and silt (FIG-HAT-Berth 2 Habitat Map.pdf Figure 4-2, Panels 3, 4, 13, 14, 15 and 21 in Photo 4-1: Demonstrative Photo Panel of Berth 2 Footprint). Seaward from the rip rap (greater than -14 m CD), substrate transitioned to shallow slopped mud and occasional scattered anthropogenic debris (FIG-HAT-Berth 2 Habitat Map.pdf Figure 4-2, Panel 5 in Photo 4-1: Demonstrative Photo Panel of Berth 2 Footprint).

4.2.2 Fauna and Flora

Species diversity decreased across all transects seaward of the anthropogenic hard substrates (Panel 5 and Panel 6 in

Photo 4-1: Demonstrative Photo Panel of Berth 2 Footprint). Hard substrates were largely provided through anthropogenic structures which included vertical surfaces (i.e., piles, sheetpile wall) and rip rap (Panels 6 to 12 in Photo 4-1: Demonstrative Photo Panel of Berth 2 Footprint).

Diversity and abundance were generally observed to be higher on hard substrates (shallower than -14 m CD) as compared to soft substrates, with overall diversity lowest on the flat mud substrate (deeper than -14 m CD). Species diversity on rip rap substrates included six algal taxa, 37 invertebrate taxa, and eight fish species (see Appendix A). Species diversity observed was similar across transects and ranged between 23 species and 32 species (Appendix B). The greatest species diversity occurred on the western side of B2 (T20) and was driven by a higher diversity of seaweeds and molluscs, likely due to it being shallower than other transects. Species abundance was considered either rare, sparse, or few for all but four taxa; green sea urchin (*Strongylocentrotus droebachiensis*), mottled star (*Evasterias troschelii*), calcareous tubeworms (*Serpula columbiana*), and coonstripe shrimp (*Pandalus danae*) were the only species described as common in respective quadrats (categorized in Table 4-3). No SAR were observed in the B2 Project footprint.

Isolated sugar kelp was observed during the 2021 field surveys of the B2 Project footprint on two transects (see Appendix A). Subsequent ROV surveys were undertaken in August 2022 (peak growing season for most seaweeds) where distinct patches bull kelp and sugar kelp were observed near the sheetpile wall growing at approximately -0.6 to -5.3 m CD on cobble and boulders (16 to 20 in Photo 4-1: Demonstrative Photo Panel of Berth 2 Footprint). There were two distinct patches of bull kelp observed, one in the western and the other in the eastern quadrant beams, which were separated by approximately 45 m lineal distance. The bull kelp beds in the western and eastern B2 quadrant were approximately 26.0 m x 6.0 m (156 m^2, density estimated at 0.25 individuals/m^2) and 39.0 m x 2.4 m (93.6 m^2, density estimated at 0.17 individuals/m^2) for a total footprint of 249 m^2. Within the B2 footprint, sugar kelp

covered an area of approximately 340 m^2, with small patches of sugar kelp observed immediately west and east of the B2 quadrant, and a small patch near the northwest corner of the water lot. Bull kelp and sugar kelp were often observed within the same spatial areas with bull kelp forming the canopy and sugar kelp forming the understory.

A summary of species observed during the dive surveys, including species observations based on substrate type (e.g., transect, piles, sheet pile wall), are provided in Appendix A, while species presence and abundance data for quadrats (dive surveys) are provided in Appendix B.

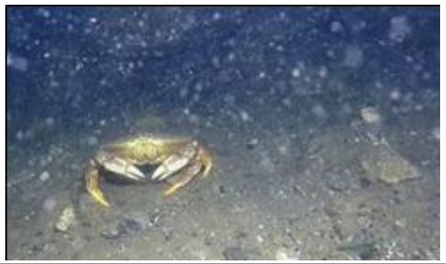
Panel 1: B2 marine survey area, looking North	Panel 2: Wire mesh associated with subtidal pony wall	Panel 3: T21: Boulders along existing sheet pile wall	Panel 4: T21: Rip rap[1]
			
Panel 5: T20: Silt/substrate [1]	**Panel 6: T21: Silt/salt (~-11 m CD)**	**Panel 7: Sea urchins on anthropogenic surfaces**	**Panel 8: Mussels and barnacles on anthropogenic surfaces (timber pile)**
			
Panel 9: Timber piles beneath B2	**Panel 10: Various invertebrates on rip rap (barnacles, anemones)**	**Panel 11: Various invertebrates on anthropogenic surfaces (sea stars)**	**Panel 12: Plumose anemones on vertical steel pipe pile**
			

Photo 4-1: Demonstrative Photo Panel of Berth 2 Footprint

[1] ASI: ROV Survey

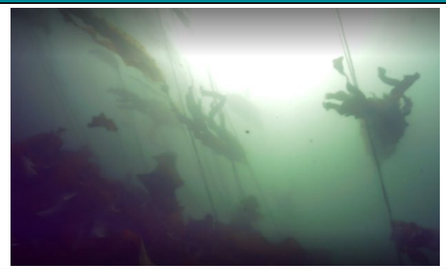
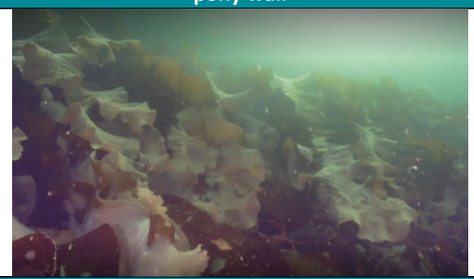
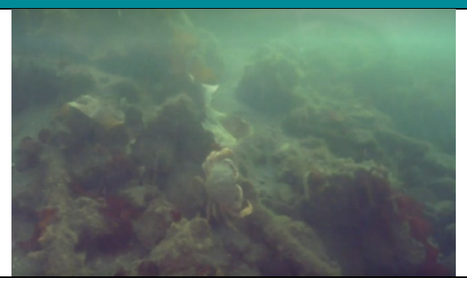
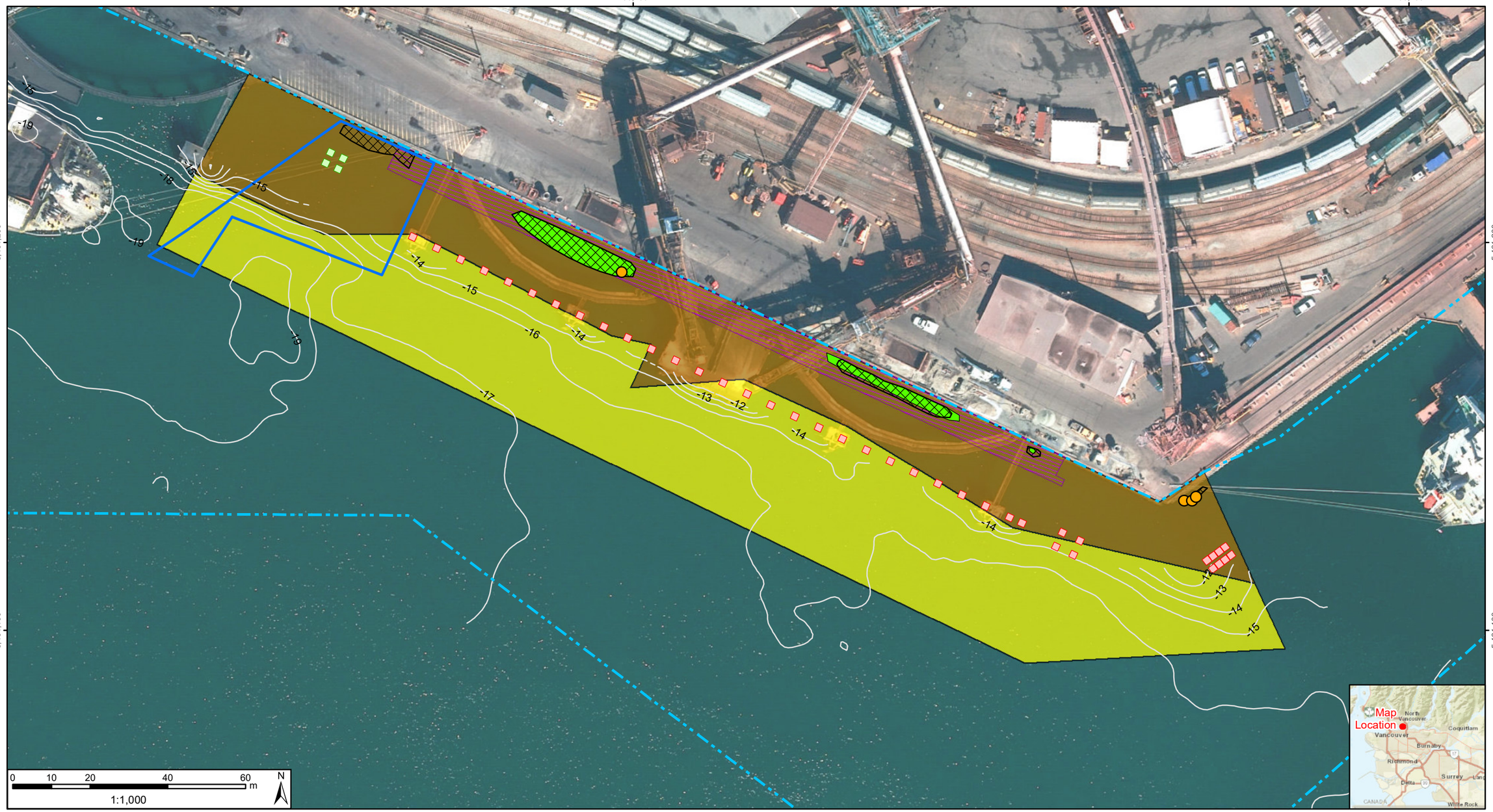
Panel 13: Silt covered boulders	Panel 14: *Sargassum muticum* on shallow boulders	Panel 15: T21: Silt/sand substrate interspersed with cobble and occasional boulders	Panel 16: T20A: Dense bull kelp with sugar kelp understory
			
Panel 17: Understory red and brown seaweeds	**Panel 18: T20A: Bull kelp**	**Panel 19: T17A: Patchy sugar kelp**	**Panel 20: T10A: Dense sugar kelp covering wire mesh near pony wall**
			
Panel 21: T21: Dungeness crab amongst rip rap			
			

Photo 4-1: Demonstrative Photo Panel of Berth 2 Footprint



LEGEND:

- Sargassum
- Sugar kelp
- Bull kelp
- Infill area
- Piles to be installed (permanent)
- Piles to be installed (temporary)
- Water lot boundary
- Pony wall and Chain link
- Contour

Habitat Substrates

- Cobble and boulders >50% covered by Silt/Sand
- Silt/Sand

SOURCE / NOTE:

a) Habitat areas, digitized by Hatfield (2022) using Figure 3 (Appendix A), "Berth 2 Marine Fish and Fish Habitat Existing Conditions Report", Neptune Bulk Terminals, August 2022.
b) Water lot, digitized by Hatfield (2022) using Figure 1 (Appendix A), "Site Location and Marine Survey Area", Neptune Bulk Terminals, January 2022.
c) Infill area and piles, digitized by Hatfield (2022) using Seabed Footprint Modifications Demolition and Construction Works Plan Map, Neptune Bulk Terminals, January 2022.
d) Contours, Neptune Bulk Terminals, January 2022.
e) Bull Kelp, Sugar Kelp, Sargassum Pony wall and Chain link, Hatfield, August 2022.
f) Background, Orthophoto 10 cm, 13 April 2021, Esri Online Service.

PROJET:

SYSTEM:

ASSET:

DISCIPLINE:

REV	YYYY-MM-DD	DESCRIPTION	DRAWN	APPROVED

ISSUES/REVISIONS

VENDOR: Hatfield

ISSUED AS RECORD COPY (YES/NO) NO

Neptune TERMINALS

TITLE:

Berth 2 Habitat Map

Figure 4-2

SCALE:	SHEET	OF	DRAWING NO.	REV:
	1	1		A

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5 DISCUSSION AND CONCLUSION

5.1 Fish

Species diversity observed during ROV and dive surveys were typical of nearshore habitats in Burrard Inlet. Fish and invertebrate diversity on dive transects was low with only four species commonly observed. Species diversity and abundance documented along Transects 15-20 in 2018 were similar to 2021 field survey results, suggesting that habitat is stable. Similar to findings from the 2018 survey, the majority of species occurrences are considered either rare, sparse or few. In general, species distribution was relatively uniform as most species were closely associated with hard substrates, either on rip rap (boulders) or on the vertical surfaces (e.g., steel sheetpile wall/bulkhead and piles). However, existing piles supported limited species colonization and encrusted algae.

Across multiple subtidal surveys (2018, 2021, 2022), the B2 Project footprint has shown low abundance of fish and invertebrates. The species of fish and invertebrates observed are common species throughout Burrard Inlet. There have been no field observations of sensitive species, including juvenile salmon, herring, and smelt. Listed species, including sturgeon and abalone, do not occur in the B2 Study Area. There are no habitats supporting spawning, but the B2 Study Area may be used as a migratory corridor for salmon to/from Lynn Creek, Seymour River, and other upstream spawning habitats.

5.2 Fish Habitat

Kelp provides habitat, including nursery environments for fish. The presence of kelp depends largely on substrate type (i.e., hard substrate for attachment) and light availability, the latter of which is often determined by depth. Substrate types observed during the ROV and dive surveys were found to be typical of nearshore subtidal areas along Burrard Inlet industrial Vancouver waterfront (Hemmera, 2014; Stantec, 2018a, 2018b) and consisted primarily of soft substrates, which are not conducive to kelp growth. Nearshore areas consisted of consolidated substrates (i.e., cobble, boulder) in shallow waters (-0.6 to -10 m CD), but these hard substrates were greater than 50% covered by silt/sand. The cobble and boulders transitioned to silt/mud seaward from the berth face (-15 to -18 m CD). Previous dive surveys conducted at Berths 1 and 2 identified similar subtidal habitat (Stantec, 2018a, 2018b).

Based on surveys of existing kelp beds in Burrard Inlet undertaken by Tsleil-Waututh, bull kelp grows at elevations between 0 and -5 m CD in Burrard Inlet, with a mean elevation of -2.2 m CD (NHC, 2019). The depth of the hard substrates (cobble and boulders) within the B2 Project footprint is suitable for bull kelp to adhere to. Although approximately 62 individual bull kelp stipes were observed in the B2 Project footprint, the high degree of sedimentation on the cobble and boulders and the disturbance observed is believed to limit the extent and value of the kelp growing in the B2 Project footprint.

6 CLOSURE

Regulatory professionals from Envirochem, Hatfield, and NBT (through Dynamic Ocean) have contributed to developing supporting documents specific to *Fisheries Act* compliance.

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APPENDIX A: TRANSECT AND STRUCTURE SPECIES DIVERSITY

COMMON NAME	SCIENTIFIC NAME	TRANSECT NUMBER														
		10	10A	11	15	15A	16	17	17A	18	19	20	21	21A	PILES	SHEETPILE WALL
MARINE ALGAE																
Sugar Kelp	*Saccharina latissima*	X	X		X	X			X			X		X		X
Wireweed	*Sargassum muticum*				X							X		X		
Iridescent Seaweed	*Mazzaella splendens*											X				X
Sea Lettuce	*Ulva spp.*	X			X											
Filamentous red algae	*Unidentified*											X			X	X
Red bladed algae	*Unidentified*	X	X	X	X	X			X	X		X	X	X	X	X
Bull Kelp	*Nereocystis luetkeana*				X				X							
BRYOZOANS																
Kelp-Encrusting Bryozoan	*Membranipora serrilamella*	X	X		X	X			X			X		X		
ARTHROPODS																
Common Acorn Barnacle	*Balanus glandula*	X			X					X		X	X		X	X
Dungeness Crab	*Cancer magister*	X		X	X		X	X		X	X	X			X	
Candystripe Shrimp	*Lebbeus grandimanus*	X														
Squat Lobster	*Munida quadrispina*	X														
Red Rock Crab	*Cancer productus*	X			X				X	X		X	X			
Coonstripe Shrimp	*Pandalus danae*	X		X	X					X		X	X		X	
Graceful Decorator Crab	*Oregonia gracilis*	X			X								X		X	X
Shrimp	*Unidentified*	X			X							X	X			
Rhinoceros Crab	*Rhinolithodes wosnessenskii*				X											
MOLLUSCS																
Pacific Blue Mussel	*Mytilus trossulus*				X					X		X			X	X
Smooth Pink Scallop	*Chlamys rubida*				X											
Lined Chiton	*Tonicella sp.*				X					X		X	X		X	X
Blue-Line Chiton	*Tonicella undocaerulea*				X							X			X	X
Woody Chiton	*Mopalia lignosa*				X					X		X			X	X
Green False-Jingle	*Pododesmus macrochisma*	X			X							X	X		X	
Frosted Nudibranch	*Dirona albolineata*									X						
Tiny White Nudibranch	*Unidentified*				X								X			
Shag-Rug Nudibranch	*Aeolidia papillosa*									X					X	
Golden Dirona	*Dirona pellucida*															
Ringed Leopard Dorid	*Diaulula sandiegensis*											X				
Red Dendronotid	*Dendronotus rufus*	X														

COMMON NAME	SCIENTIFIC NAME	Transect Number														
		10	10A	11	10	15A	16	10	17A	18	10	20	21	10	PILES	SHEETPILE WALL
Limpet	*Unidentified*											X				
Noble Sea Lemon	*Peltodoris nobilis*											X				
Yellow-Rimmed Nudibranch	*Cadlina luteomarginata*											X				
ECHINODERMS																
Green Sea Urchin	*Strongylocentrotus droebachiensis*	X			X	X				X		X	X		X	X
Leather Star	*Dermasterias imbricata*			X	X					X		X	X		X	X
Mottled Star	*Evasterias troschelii*	X			X		X	X		X		X	X	X	X	X
Ochre Star	*Pisaster ochraceus*	X			X	X				X		X	X	X	X	X
Juvenile sea stars	*Unidentified*									X						
Feather duster tubeworm	*Unidentified*														X	
Calcareous Tubeworm	*Serpula columbiana*	X			X					X		X	X		X	X
CNIDARIANS																
Giant Plumose Anemone	*Metridium farcimen*	X			X					X		X	X		X	
Short Plumose Anemone	*Metridium senile*				X											
Painted Anemone	*Urticina crassicornis*	X			X					X		X	X		X	X
TUNICATES																
Broadbase Tunicate	*Cnemidocarpa finmarkiensis*	X			X					X		X	X		X	X
Transparent Tunicate	*Corella willmeriana*									X		X				
Hairy Tunicate	*Boltenia villosa*	X			X					X		X	X			X
VERTEBRATES – FIN FISH																
Flatfish	*Unidentified*						X						X			
Blackeye Goby	*Rhinogobiops nicholsii*				X					X		X	X			
Kelp Greenling	*Hexagrammos decagrammus*			X								X				
Bay Pipefish	*Sygnathus leptorhynchus*	X														
Sculpin	*Unidentified*	X			X					X		X	X			
Whitespotted Greenling	*Hexagrammos stelleri*												X			
Pile Perch	*Rhacochilus vacca*				X											
Striped Perch	*Embiotoca lateralis*	X	X	X	X	X						X		X		
Kelp Perch	*Brachyistius frenatus*	X	X			X							X	X		
SPECIES DIVERSITY		**23**			**27**					**23**		**32**	**23**		**21**	**18**

APPENDIX B: QUADRAT SPECIES PRESENCE AND ABUNDANCE

TRANSECT 10 (30M TOTAL LENGTH)								
Quadrat Number	Transect Distance (m)	Depth(m CD)	SubstrateType	Substrate Coverage (%)	Biota (Common name)	Abundance*	Abundance Collection	Notes
Quadrats were not completed due to the wire mesh obstructing access to the bottom. Large boulder substrate from sheetpile wall up to 14m transect distance and an elevation of -8.9m CD. From there until the end of the transect (30m length) the substrate is 50% boulders and 50% cobble.								

TRANSECT 15 (30M TOTAL LENGTH)								
Quadrat Number	Transect Distance (m)	Depth(m CD)	SubstrateType	Substrate Coverage (%)	Biota (Common name)	Abundance*	Abundance Collection	Notes
1	17	-7.1	Boulder	100	Red bladed algae	Sparse	PAC	
					Green sea urchin	Sparse	IPM	
					Smooth pink scallop	Rare	IPM	
					Tiny white nudibranch	Sparse	IPM	
					Coonstripe shrimp	Few	IPM	
					Acorn barnacle	Sparse	PAC	
					Short plumose anemone	Rare	IPM	
					Mottled star	Sparse	IPM	
					Broadbase tunicate	Rare	IPM	
					Hairy tunicate	Sparse	IPM	
					Calcareous tubeworms	Few	PAC	
2	26.5	-11.3	Boulder	60	Blackeye goby	Rare	IPM	
			Cobble	20	Coonstripe shrimp	Common	IPM	
			Sand/Silt	20	Calcareous tubeworms	Sparse	PAC	

TRANSECT 18 (22M TOTAL LENGTH)								
Quadrat Number	Transect Distance (m)	Depth(m CD)	SubstrateType	Substrate Coverage (%)	Biota (Common name)	Abundance*	Abundance Collection	Notes
1	6	-2.2	Sand/Silt	100	Ochre star	Few	IPM	Pile is within quadrat
					Leather star	Rare	IPM	
					Painted anemone	Sparse	IPM	
					Shag-rug nudibranch	Sparse	IPM	
					Acorn barnacle	Sparse	PAC	
					Coonstripe shrimp	Few	IPM	
					Green sea urchin	Sparse	PAC	
					Blackeye goby	Rare	IPM	
2	15	-8.9	Boulder	50	Mottled star	Common	IPM	
			Cobble	20	Coonstripe shrimp	Few	IPM	
			Gravel	10	Painted anemone	Sparse	IPM	
			Sand/Silt	20	Blackeye goby	Rare	IPM	
					Acorn barnacle	Sparse	PAC	
					Calcareous tubeworm	Sparse	PAC	
					Sea star (unidentified)	Sparse	IPM	
					Frosted nudibranch	Sparse	IPM	
					Ochre star	Rare	IPM	
					Sculpin	Rare	IPM	
3	21	-12.9	Boulder	20	Coonstripe shrimp	Rare	IPM	
			Cobble	20	Mottled star	Sparse	IPM	
			Gravel	20	Shrimp (unidentified)	Rare	IPM	
			Sand/Silt	40	Short plumose anemone	Rare	IPM	
					Calcareous tubeworms	Sparse	PAC	
					Painted anemone	Rare	IPM	
					Red rock crab	Sparse	IPM	

TRANSECT 20 (27.5M TOTAL LENGTH)								
Quadrat Number	Transect Distance (m)	Depth(m CD)	SubstrateType	Substrate Coverage (%)	Biota (Common name)	Abundance*	Abundance Collection	Notes
1	12	-4.1	Boulder	100	Tiny white Nudibranch	Sparse	IPM	
					Red bladed algae	Few	PAC	
					Barnacle	Sparse	PAC	
					Blue-line chiton	Few	IPM	
					Lined chiton	Rare	IPM	
					Mottled star	Sparse	IPM	
					Green-false jingle	Rare	PAC	
2	16.5	-6.6	Boulder	40	Red bladed algae	Sparse	PAC	
			Cobble	10	Sculpin	Sparse	IPM	
			Sand/Silt	50	Dungeness crab	Rare	IPM	
					Mottled star	Sparse	IPM	
					Calcareous tubeworms	Sparse	PAC	
					Broadbase tunicate	Sparse	IPM	
					Hairy tunicate	Sparse	IPM	
					Green sea urchin	Rare	IPM	
3	25	-10.8	Boulder	10	Mottled star	Rare	IPM	
			Cobble	50	Sculpin	Rare	IPM	
			Gravel	10	Dungeness crab	Sparse	IPM	
			Sand/Silt	30	Coonstripe shrimp	Common	IPM	

TRANSECT 21 (38M TOTAL LENGTH)								
Quadrat Number	Transect Distance (m)	Depth(m CD)	SubstrateType	Substrate Coverage (%)	Biota (Common name)	Abundance*	Abundance Collection	Notes
1	17	-4.5	Boulder	80	Red bladed algae	Sparse	PAC	
			Cobble	20	Barnacles	Sparse	PAC	
					Calcareous tubeworm	Few	PAC	
					Sculpin	Rare	IPM	
					Green sea urchin	Common	IPM	
					Broadbase tunicates	Sparse	IPM	
					Hairy tunicates	Sparse	IPM	
					Nudibranch (unidentified)	Sparse	IPM	
					Lined chiton	Sparse	IPM	
					Coonstripe shrimp	Sparse	IPM	
2	25	-8.8	Boulder	100	Calcareous tubeworm	Common	PAC	
					Hairy tunicates	Few	IPM	
					Sculpin	Rare	IPM	
					Red bladed algae	Sparse	PAC	
					Coonstripe shrimp	Sparse	IPM	
					Broadbase tunicates	Sparse	IPM	
					Whitespotted greenling	Rare	IPM	
3	31	-11.8	Boulder	20	Coonstripe shrimp	Rare	IPM	
			Cobble	50	Blackeye goby	Rare	PAC	
			Sand/Silt	30	Mottled star	Rare	IPM	
					Leather star	Rare	IPM	
					Giant plumose anemone	Rare	IPM	
4	37	-14.6	Cobble	50	Coonstripe shrimp	Sparse	IPM	
			Gravel	20				
			Sand/Silt	30				

Note: See Table 4-3 for a description of the different biota abundance categories; PAC = Percent Areal Coverage, IPM = Individuals per Square Metre
Source: Tripp *et al.* (2020)