PORT of vancouver | Vancouver Fraser Port Authority

IR2020-1.1 RBT2 fish and fish habitat potential offsetting projects

Background

In his letter of August 24, 2020 (CIAR Document #2067[1]), the minister of environment and climate change (the minister) requested additional information regarding "all potential projects that are being considered by the VFPA for the RBT2 fish and fish habitat offsetting plan, all contingency projects, and all other available offsetting opportunities".

In the Roberts Bank Terminal 2 (RBT2) environmental impact statement (EIS), the Vancouver Fraser Port Authority (the port authority) included a conceptual offsetting framework and committed to enhance offsetting at the public comment period during the regulatory stage, based on feedback from Fisheries and Oceans Canada (DFO) and Indigenous groups. The review panel and DFO stated at the public hearing that additional offsetting would be required, reflective of priority species and life stages. The review panel report included recommendations to increase offsetting, alter types of habitat and focus on species of interest for offsetting, and develop offsetting collaboratively with Tsawwassen First Nation (TFN) and Musqueam Indian Band (Musqueam) (recommendations 18-offsetting, 23-Dungeness crab, 25-Pacific salmon; CIAR Document #2062[2]).

Based on this input and an extensive consultation process with Indigenous groups whose traditional territories overlap the project area, the port authority has proposed additional conventional offsetting (an additional 50+ hectares (ha) over the amount conceptually proposed in the EIS), including onsite and offsite offsetting and offsetting from habitat bank projects. Additional offsetting opportunities and contingency measures and projects have been identified, should proposed RBT2 offsetting projects not function as intended and remedial measures be unavailable or unsuccessful. A number of lines of evidence and uncertainty analyses (including consideration of time lag) were undertaken to determine the amount of offsetting required to counterbalance the residual effects of the RBT2 Project on fish and fish habitat. Notably, analysis of the conventional offsetting projects using the productivity model indicates that four times more productivity will be gained by the offsetting projects, as compared to the habitats lost from the RBT2 footprint (i.e., a 4:1 offsetting productivity ratio). When predicted non-footprint related habitat gains were also included, the analysis indicates a resulting offsetting productivity ratio of 18:1. A separate line of evidence has shown that at least a 37 ha net gain in juvenile salmon habitat is predicted through the application of avoidance, reduction, and offsetting measures. The proposed offsetting projects, therefore, more than counterbalance the residual effects of the RBT2 Project on fish and fish habitat (see **IR2020-1.2** for additional information on these and other lines of evidence and analyses).

In addition, the types of offsetting, for both those included in the EIS and the additional offsetting proposed, have been adapted and prioritized to reflect habitats and species of interest. For example, we are proposing more marsh and eelgrass, and have removed sandy gravel beach and mud habitat, based on consultation feedback received.

A key objective of the proposed offsetting plan is to reflect feedback received through consultation and collaborative processes with Indigenous groups. This process is ongoing and the commitment to this approach is being demonstrated in the current collaborations with many Indigenous groups; one example is the work with TFN where continued dialogue is focused on exploring the advancement of TFN priority opportunities. Additionally, this commitment is reflected in the offsetting plan's alignment with Musqueam's vision of creating a mosaic of habitat enhancement (for increased feeding, rearing, and refuge for a range of priority species and life stages throughout

[1] CIAR Document #2067 Letter from the Minister of Environment and Climate Change to the Vancouver Fraser Port Authority re: Information Request. https://iaac-aeic.gc.ca/050/documents/p80054/135827E.pdf
[2] CIAR Document #2062 Report of the Review Panel, Vancouver Fraser Port Authority Roberts Bank Terminal 2 Project https://iaac-aeic.gc.ca/050/documents/p80054/134506E.pdf

the Fraser River estuary). This aligns with Musqueam's responsibility to be stewards of their traditional territory and ensure there are adequate ecological and cultural resources to support the cultural continuity of future generations of Musqueam people.

Information provided in this response supports the minister's request by providing information on all proposed offsetting—including substantial new offsetting commitments (and how they were developed in collaboration with Indigenous groups), other available offsetting opportunities, and potential contingency options (in case proposed offsetting does not function as intended)—and demonstrates how the port authority has adapted offsetting projects to reflect review panel, DFO, and Indigenous group input.

Substantial technical evaluation and reporting supports this response, including existing ecological conditions assessments, archaeological assessments, land access and tenure information, topographic/bathymetric survey work, geotechnical investigations, coastal or fluvial process assessments, and engineering design developments. Much of this information has previously been shared with Indigenous groups and DFO and has been supplemented with additional, recent, and relevant reports. All supporting technical information is provided in the documents as summarized in **Appendix IR2020-1.1-A**.

Information request

Describe all potential projects that are being considered by the VFPA for the RBT2 fish and fish habitat offsetting plan, all contingency projects, and all other available offsetting opportunities, including:

- physical description of offset (e.g., habitat type; creation, restoration, or enhancement; and size);
- preliminary designs and specifications.
- characterization of current habitat characteristics and function (fish use) of sites proposed for restoration or enhancement.
- description of the benefit of the proposed offset to fish, including habitat function for specific species and life stages;
- assessment of the technical feasibility of the offset, including a summary of technical investigations (surveys, engineering reports, archeological investigations). Provide technical reports;
- information on land tenure, access, and evaluation of potential interactions with other land uses; and
- summary of effectiveness of past offsetting projects built by the VFPA and any remedial actions taken.

Response

1. Introduction

All proposed offsetting projects being considered, including onsite offsetting, offsite offsetting, habitat bank projects, other available offsetting opportunities, and potential contingency projects, are summarized in **Table IR2020-1.1-1** below and described in **Sections 2** to **6** of this response. **Section 7** describes effectiveness of past port authority-led offsetting and remedial actions undertaken. All of the offsetting projects currently being advanced for RBT2 are shown on **Figure IR2020-1.1-1** and further described in **Appendix IR2020-1.1-B**. These offsetting projects, as well as fish and fish habitat avoidance and reduction measures, are evaluated quantitatively in **IR2020-1.2.** In summary, **IR2020-1.2** provides productivity balance tables demonstrating that RBT2 will result in net gains in juvenile Chinook salmon productivity (and habitat) as well as overall fish and fish habitat productivity.

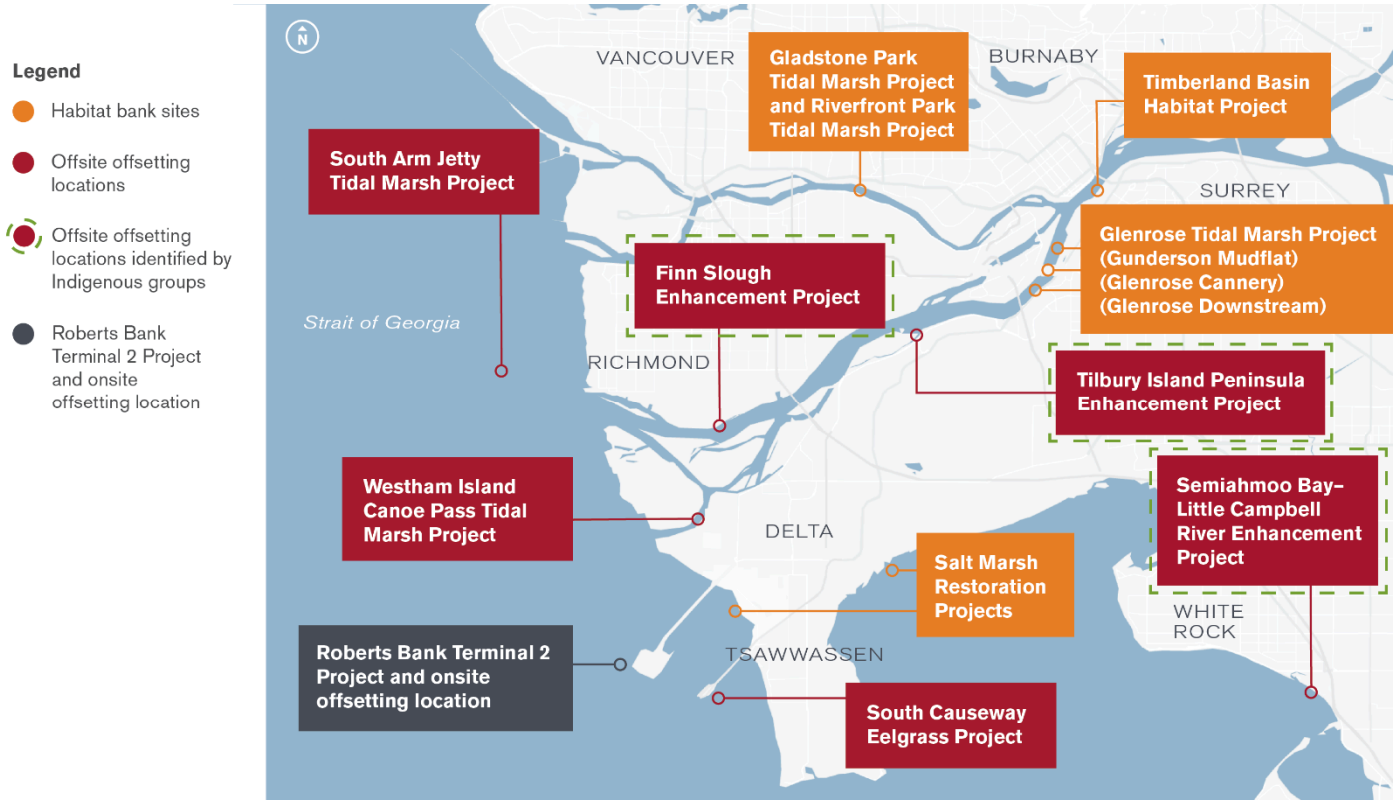
Table IR2020-1.1-1: Summary of all potential offsetting and contingency measures and projects under consideration and described in this response

Name	Primary habitat type	New or adapted from EIS	Approximate area (ha)[a]
Onsite offsetting (Section 2)			
Intertidal Marsh	Marsh	Adapted	12.5 – 13.5
Native Eelgrass	Eelgrass	Adapted	9 – 10
Subtidal Rock Reef	Rock	Adapted	3 – 4
Offsite offsetting (Section 3)			
South Arm Jetty Tidal Marsh Project (Section 3.1)	Marsh	New	30 – 40
South Causeway Eelgrass Project[b] (Section 3.2)	Eelgrass	New	3.5 – 4.5
Westham Island Canoe Pass Tidal Marsh Project (Section 3.3)	Marsh	New	4.0 – 4.5
Tilbury Island Peninsula Enhancement Project (Section 3.4)	Marsh	New	2 – 4
Finn Slough Enhancement Project (Section 3.5)	Marsh	New	0.5 – 1.0
Semiahmoo Bay-Little Campbell River Enhancement Project (Section 3.6)	Marsh	New	1 – 3
Habitat bank projects (Section 4)			
Salt Marsh Restoration Projects	Marsh	New	6.30
Glenrose Tidal Marsh Project	Marsh	New	1.10
Gladstone Park Tidal Marsh Project	Marsh	New	0.35
Riverfront Park Tidal Marsh Project	Marsh	New	0.15
Timberland Basin Habitat Project	Marsh	New	0.40
Other available offsetting opportunities (Section 5)			
Offsetting opportunity recently brought forward by and currently being advanced with Tsawwassen First Nation (Tsawwassen Marshlands Project)	Marsh	New	TBD[c]
Non-Conventional Offsetting Program (NCOP)	N/A	New	N/A
Complementary measure (investigation into local marsh recession)	Marsh	New	N/A[d]
Potential contingency projects (Section 6)[e]			
Additional onsite native eelgrass and/or marsh habitat north of the proposed RBT2 terminal	Eelgrass/Marsh	Adapted	8 – 12

Name	Primary habitat type	New or adapted from EIS	Approximate area (ha)[a]
Additional onsite offsetting through a specific component of the Tsawwassen Marshlands Project (expansion of marsh habitat seaward of the outer dyke and others)	Marsh	New	5 – 10[f]
Future projects under the NCOP	Various	New	TBD
Additional offsite offsetting through Point Grey Tidal Marsh Project	Marsh	New	30 – 40
Additional offsite offsetting through McDonald Tidal Marsh Project	Marsh	New	2 – 3

Notes: a. The port authority is currently advancing up to 86 ha of conventional offsetting for the RBT2 Project. Ranges provided to reflect potential changes associated with further design optimization and input from DFO and Indigenous groups; see accompanying text for more information.
b. The South Causeway Eelgrass Project was previously known as the Tsawwassen Eelgrass Project.
c. An offsetting opportunity (the Tsawwassen Marshlands Project) was recently brought forward by, and is being advanced in collaboration with, TFN – to address TFN interests and priorities. Current collaboration efforts are focused on project definition, conceptual design, and feasibility.
d. Complementary measures by design are not constructed habitat; see **Section 5** for additional details.
e. The size and type of potential contingency project will be dependent on the nature of the requirements in the unlikely event that any of the habitat developed for the offsetting plan does not function as intended and remedial measures are unavailable or unsuccessful; see **Section 6** for additional details.
f. This areal estimate applies to the seaward marsh expansion component of the Tsawwassen Marshlands Project; the areal estimates associated with other components of the Tsawwassen Marshlands Project will be established subject to further evaluation should those components be determined feasible.

Figure IR2020-1.1-1: Locations of offsetting projects currently being advanced for RBT2



Offsetting projects (**Figure IR2020-1.1-1**) are either already built (i.e., the habitat bank sites) or are being advanced through the typical engineering design process (from concept to *Fisheries Act* Authorization (FAA) application-level design; project design stage and level of detail varies). Given this process and anticipated further input from DFO and Indigenous groups on offsetting designs (i.e., leading up to and during the FAA process), the final design details and footprint and, therefore, area of these offset projects may be refined. As part of the overall commitment to working with Indigenous groups to ensure Indigenous knowledge and input guide planning related to the various components of the offsetting plan, the port authority will continue the collaborative advancement of Indigenous priority projects with TFN, Musqueam, and Semiahmoo First Nation. Collaborative planning is currently underway with TFN to explore opportunities related to the Tsawwassen Marshlands Project (more details provided in **Sections 5.1** and **6.1.2**). That project was recently identified as a priority project by TFN but, unlike other offsetting projects brought forward by Indigenous groups earlier in the consultation process (e.g., the Tilbury Island Peninsula Enhancement Project), it remains to be fully defined and designed.

Similarly, changes in RBT2 Project design (e.g., reduction in footprint; addressed in **IR2020-2.1** and **IR2020-2.2** in relation to the minister's request) or future design optimization that may interact with fish and fish habitat, and the offsetting proposed here (e.g., onsite offsetting), will be the subject of consultation and input with DFO and Indigenous groups through the FAA process. Such project design changes would be proposed expressly to reduce effects to fish and fish habitat from what was previously assessed; hence, additional offsetting projects to accommodate these changes are not anticipated and RBT2 offsetting requirements may diminish as a result. DFO will determine the offsetting requirements for the project as part of the FAA process.

The majority of offsetting presented in this response is considered habitat enhancement as opposed to habitat restoration or creation, as more productive habitat, which also benefits species of interest, is proposed to be constructed over existing habitat of lower productivity and which is currently of less benefit to species of interest.

Based on DFO's *Policy for applying measures to offset adverse effects on fish and fish habitat under the Fisheries Act*, habitat enhancement, restoration, and creation can be defined as follows:

- Habitat enhancement: actions taken to improve fish habitat quality
- Habitat restoration: actions taken to return degraded fish habitat to an improved or unimpaired condition
- Habitat creation: the development or expansion of aquatic habitat into a terrestrial area

As described in **IR2020-1.2**, the quantitative net benefits to fish and fish habitat of the offsetting projects being advanced for RBT2 have been, and will continue to be, calculated based on the increased value of the offsetting habitat relative to the value of the underlying (i.e., existing) fish habitat. Underlying fish habitat value may be as low as nil for habitat creation projects, or higher for habitat restoration and enhancement projects depending on existing habitat conditions. As described in **IR2020-1.2**, calculations of the relative productivity of offsetting and underlying habitats are based on estimates of biomass. These biomass estimates were derived from balanced food webs, rooted in local abundance data collected during empirical project surveys in 2012, 2013, and 2019; as well as modelling studies, scientific literature and technical reports.

2. Onsite offsetting

2.1. Physical description of offset

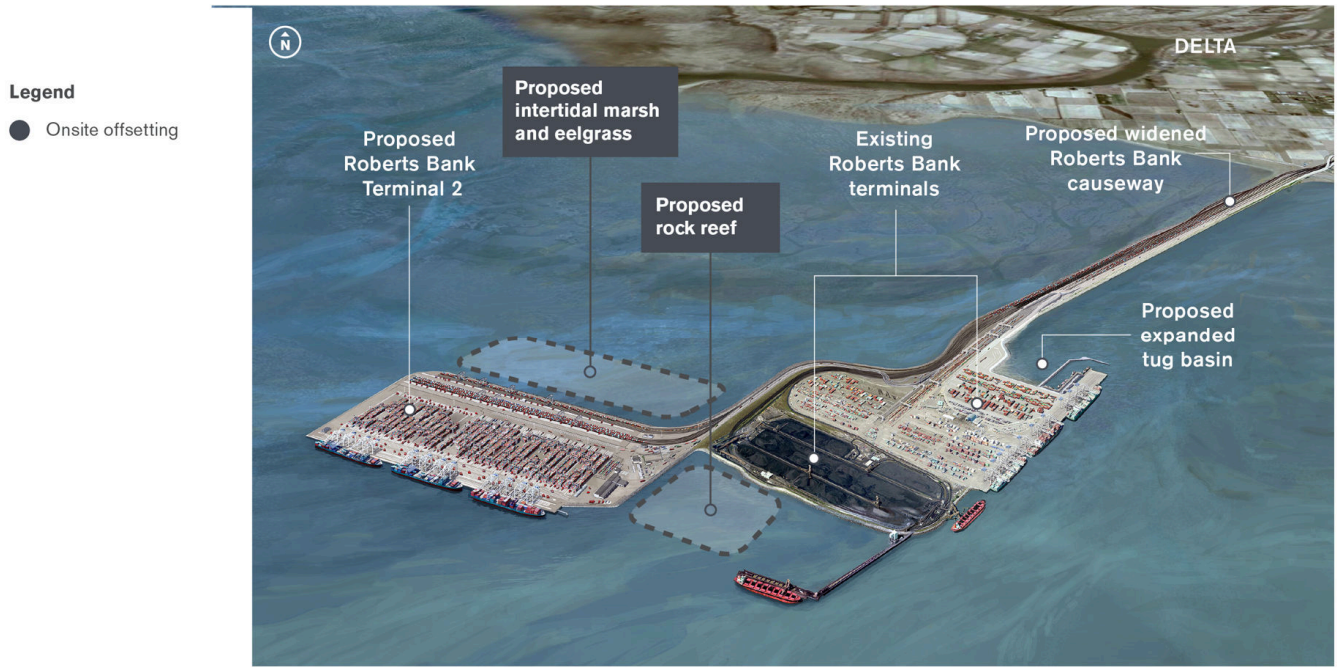
The general location of proposed onsite offsetting is shown in **Figure IR2020-1.1-1** and **Figure IR2020-1.1-2** and the location and layout is provided in Moffatt and Nichol 2020a (i.e., Figure 1-1, Figure 3-2, Figure 3-4; and design drawings in Appendix A).

Based on feedback from DFO and Indigenous groups since the public hearing, onsite offsetting has been altered to provide more habitat for juvenile salmon and Dungeness crab (*Metacarcinus magister*). Proposed onsite offsetting involves habitat enhancement and includes intertidal marsh (12.5 ha to 13.5 ha, including approximately 3 ha of rock containment berm) and shallow subtidal native eelgrass (*Zostera marina*) (9 ha to 10 ha, including approximately 0.5 ha of rock containment berm), and subtidal rock reef (3 ha to 4 ha) (**Table IR2020-1.1-1**). The suitability of eelgrass and marsh habitats onsite is based on years of field data and technical studies.

Due largely to Indigenous groups' input on rock reefs, which indicates a tendency for rock reefs to attract species not naturally occurring in the area as well as predatory reef fish, and potential effects on high suitability Dungeness crab habitat, the port authority will decrease the spatial extent of proposed subtidal rock reefs. The reduction of rock reefs from 5.6 ha to between 3 ha to 4 ha was also informed by input from DFO that suggested the edge effect (whereby benefits in biological productivity from the reef would extend outward to nearby areas) was previously overestimated. The proposed reduction in rock reef habitat gain would be achieved through no longer including the 1.6 ha of edge effect benefit and decreasing the physical footprint of the reef rock placement by some margin up to a 1 ha reduction. The port authority remains committed to continuing to work with Indigenous groups and regulators to understand and address concerns relating to rock reef offsetting, and explore alternative designs and options leading up to the submission of the RBT2 FAA application. Alternative designs could include creating kelp habitat in the area—to provide canopy benefits for fish such as juvenile salmon and spawning habitat for herring—in a way that avoids providing habitat for species not naturally occurring in the area as well as predatory reef fish.

In comparison to onsite habitat proposed in the EIS, the onsite offsetting habitat proposed in this response no longer includes sandy gravel beach and mudflat, based on feedback from Indigenous groups and regulators. Groups such as TFN, Musqueam, Semiahmoo First Nation, Stó:lō Nation, T'suubaa-asatx First Nation, Malahat Nation, and Cowichan Tribes provided input on this habitat type, with some indicating that sandy gravel beach is of relatively low value and might not be self-sustaining. The removal of this habitat type as an onsite offsetting component also avoids areas of increased productivity of existing habitat (e.g., areas of Japanese eelgrass (*Zostera japonica*) expansion).

Figure IR2020-1.1-2: Locations of onsite offsetting proposed for RBT2



2.2. Preliminary designs and specifications

Investigative work contributing to the proposed RBT2 onsite offsetting design has been underway for over five years. A variety of assessment and analytical reports have been produced to document existing conditions and predict future conditions, including a recent engineering design report (Moffatt and Nichol 2020a) and habitat mapping update summary report (VFPA 2020a) provided with this response. Any further input received following the review of these reports by Indigenous groups will be considered in the onsite offsetting design, along with feedback and knowledge shared during Indigenous group offsetting workshops and engagement, which are ongoing.

Proposed onsite marsh and eelgrass habitat benches are expected to be created through the beneficial re-use of dredged material, likely acquired through the Fraser River annual maintenance dredge program. This will be the default source of fill for offsetting projects unless cut and fill is balanced at a given site. As many of the proposed offsetting projects are expected to be implemented over more than one calendar year, and given that the implementation of individual projects will be needed to be staggered to some degree, it is anticipated that the beneficial re-use of dredged material from the Fraser River annual maintenance dredge program can be used to meet the fill needs of all proposed offsetting projects. In the event that this is not the case, a relatively small proportion of imported fill may also be needed. Before fill from the Fraser River is used for offsetting projects, sampling data will be compared against established chemical screening criteria for contaminants.

The proposed subtidal native eelgrass bed is located to the north of the proposed RBT2 terminal, adjacent to existing native eelgrass habitat, and at a design elevation ranging from 0.0 m to –2.0 m chart datum (CD) to match the elevation of the existing eelgrass habitat (Moffatt and Nichol 2020a). Eelgrass shoots would be selectively and sensitively harvested from nearby donor sites and transplanted to the proposed offsetting bed using densities and techniques established based on successful regional precedents (e.g., the approach taken for the ~500 m^2 eelgrass habitat restored by the port authority as part of the Deltaport Third Berth (DP3) Project (**Section 7.2**), and the ~2 ha of eelgrass habitat successfully created south of the BC Ferries Tsawwassen terminal and causeway as offsetting for BC Hydro's Vancouver Island Transmission Reinforcement project).

The intertidal marsh habitat is proposed to be placed adjacent to the south of the proposed eelgrass bed, and directly along part of the northern perimeter of the proposed RBT2 terminal. A design elevation range of +3.6 m to +5.0 m CD is proposed, with containment provided by a rock berm. Given the location of this habitat behind the

proposed RBT2 terminal, no effects on commercial navigation are expected. Proposed marsh plantings are designed to involve native plant species that reflect the community composition of nearby tidal marsh habitat, and currently include saltgrass (*Distichlis spicata*), seaside arrowgrass (*Triglochin maritima*), seacoast bulrush (*Bolboschoenus robustus*), three-square bulrush (*Schoenoplectus pungens*), and pickleweed (*Salicornia Sp.*). The re-establishment of native plant species has been noted as a key priority for Ts'uubaa-asatx First Nation as outlined in Ts'uubaa-asatx's Lake Cowichan First Nation Policy: South Arm of the Fraser River and Approaches June 1, 2018. As with all design elements of the offsetting projects being proposed and described in this document, the port authority continues to welcome input from Indigenous groups on proposed marsh planting prescriptions and will consider how to reflect that input through design refinements leading up to the RBT2 FAA application. For example, the port authority heard interest in the use of wapato (*Sagittaria latifolia*) as part of the planting prescription in relation to intertidal marsh offsetting projects, where ecologically appropriate. This is being explored in the context of specific proposed offsetting projects and their physical and environmental conditions. There is precedent for the use of wapato in the port authority's Glenrose Tidal Marsh Project. Through knowledge sharing workshops and group-specific collaborative processes, the port authority anticipates receiving additional information from Indigenous groups, including TFN and Musqueam, in relation to preferred marsh plant species, which can be reflected in future offsetting-related materials. Numerous Indigenous groups, including TFN, Musqueam, Tsleil-Waututh Nation, Semiahmoo First Nation, Cowichan Nation Alliance, T'suubaa-asatx First Nation, and Halalt First Nation have noted the preference for planting of native species and emphasized the importance of proper invasive plant management at proposed offsetting locations.

The proposed location of the rock reef site is in front of Westshore Terminals, an area adjacent to similar and successful rock reef habitat previously implemented for the DP3 Project (Balanced Environmental 2012). The rock reef habitat implemented for the DP3 Project supports bull kelp (*Nereocystis luetkeana*) and other canopy-forming broad-bladed kelp species. The proposed rock reef configuration would be located at elevations ranging from approximately –2.0 m to –5.0 m CD, consisting of a series of linear boulder features as well as separate smaller mounds of boulders interspersed between the linear features.

2.3. Characterization of current habitat characteristics and function

Updated baseline habitat mapping completed in 2019 (VFPA 2020a) and knowledge shared by Indigenous groups, including TFN and Musqueam, informed the understanding of current habitat characteristics and the location and design of the onsite intertidal marsh and native eelgrass offsetting.

The location of the proposed onsite eelgrass offsetting is currently characterized as bare mud/sand, which has lower productivity[3] compared to vegetated habitats. This is largely also the case for the proposed onsite intertidal marsh offsetting footprint, with the exception of a small offsetting footprint area overlapping with a sparse assemblage of orange sea pens (*Ptilosarcus gurneyi*) (which is becoming progressively sparser over time and was observed at an approximate density of 0.001/m^2 or 10/ha).

The onsite rock reef habitat is proposed to be constructed over subtidal bare mud/sand, and overlaps a sparse distribution of orange sea pens (<0.001/m^2 density; i.e., almost no sea pens present).

2.4. Description of the benefit of the proposed offset to fish

Intertidal marsh provides structural habitat used for shelter and foraging by invertebrates, fish, and wildlife and is important for shoreline stabilization, carbon storage, and nutrient/detrital supply. Species that benefit from intertidal marsh include juvenile salmon, forage fish, small demersal fish, shiner perch (*Cymatogaster aggregata*), shorebirds, and waterfowl.

TFN has suggested the relative lack of intertidal marsh habitat is likely a limiting factor for juvenile salmon productivity in the area. The port authority has prioritized the marsh habitat component among the habitat types that make up the onsite offsetting consistent with this input. Other Indigenous groups, such as Musqueam, have

[3] Biological productivity can be defined as the amount of plant and animal biological material produced within a particular area over a given amount of time.

emphasized the importance of intertidal marsh for juvenile salmon and other species. During flooding tides, the marsh habitat would become increasingly inundated and accessible to fish. At ebbing tides, nutrients, prey, and organic detrital material would be transported from the marsh to habitats both nearby and further afield where they would drive important food webs for salmon and other fish and wildlife in the wider ecosystem. At larger intertidal marsh enhancement sites such as this proposed onsite marsh habitat and many of the other marsh projects proposed for RBT2 offsetting (e.g., South Arm Jetty Tidal Marsh Project, Westham Island Canoe Pass Tidal Marsh Project), tidal channels are proposed within the marsh complex and will provide accessible fish habitat over an even longer part of the tidal cycle, increase habitat complexity, and also support marsh drainage and function (e.g., flushing and conveyance of organic material from the site).

Eelgrass beds are highly productive habitats in the Roberts Bank ecosystem, providing numerous ecological functions, such as shelter, spawning, and rearing habitat for many species. Indigenous knowledge and input received by the port authority align with this understanding. Species that benefit from eelgrass include Dungeness crab, juvenile salmon, Pacific herring (*Clupea pallasii*), bivalves, Brant geese (*Branta bernicla*), and great blue heron (*Ardea herodias*).

The juvenile salmon most likely to benefit from intertidal marsh and eelgrass offsetting habitats, both onsite and offsite, are those that primarily rear in the estuary, namely chum salmon (*Oncorhynchus keta*) as well as ocean-type Chinook salmon (*Oncorhynchus tshawytscha*) of the Harrison River and South Thompson River populations.

Subtidal rock reefs support reef fish populations and assist in meeting fisheries management objectives to alleviate historical declines of regional populations. Rockfish and lingcod (*Ophiodon elongatus*) stocks in the Strait of Georgia are considered to be depressed (e.g., quillback and copper rockfish (*Sebastes maliger, Sebastes caurinus*), which are found in the vicinity of RBT2 (DFO 2012, 2019). Subtidal rock reefs provide surface area for colonization and growth of macroalgal vegetation such as broad-bladed kelp, and provide refuge, feeding, and spawning habitat for a range of invertebrates and fish. As mentioned in **Section 2.1**, some Indigenous groups such as T'suubaa-asatx First Nation have raised concerns with the inclusion of rock reefs and the port authority is working to address these concerns.

Appendix IR2020-1.1-C provides more details on the wide-ranging ecosystem and species/group benefits of intertidal marsh, native eelgrass, and subtidal rock reef habitat types.

2.5. Assessment of technical feasibility

Substantial investigative work has been completed by a range of technical experts (including updated 2019 habitat mapping (VFPA 2020a), and wind-wave, current and salinity analysis (Moffatt and Nichol 2020a)), in consideration of biological design criteria and lessons learned. Containment berms are proposed to retain fill material and provide scour protection in relation to the proposed onsite marsh and eelgrass habitat components. Physical processes associated with the proposed onsite offsetting habitats are within acceptable ranges of biological criteria and only very minor changes in surrounding bed shear stress are predicted as a result of implementation of this offsetting project (Moffatt and Nichol 2020a). In other words, the conclusions from the investigative work are that the proposed offsetting project is suitable for the physical setting, will be self-sustaining, and is not expected to negatively affect surrounding areas.

2.6. Land tenure, access, and interactions with other land uses

As with the RBT2 terminal, the proposed onsite offsetting is located on Federal Crown land under the control of the port authority. The proposed onsite offsetting location will not interfere with RBT2 operations. Construction access to the marsh site is expected to be via the proposed RBT2 terminal. A temporary access berm may be required for placement of the eelgrass bed substrate if it is not pumped into place. Reef construction access would be via marine-based equipment. Long-term monitoring access to the marsh habitat would be via the proposed RBT2 terminal. Eelgrass and reef habitat long-term monitoring would be performed by divers with access via marine vessel.

3. Offsite offsetting

The following describes six offsite offsetting projects currently being advanced for the RBT2 offsetting plan. As mentioned above, these sites are considered to have FAA application-ready designs that are supported by technical work. In addition, three of the projects were specifically brought forward by Indigenous groups as priority offsetting for RBT2, namely the Tilbury Island Peninsula Enhancement Project (**Section 3.4**), the Finn Slough Enhancement Project (**Section 3.5**), and the Semiahmoo Bay-Little Campbell River Enhancement Project (**Section 3.6**). All have benefited from Indigenous group input. The port authority is also working collaboratively with TFN to consider various offsetting opportunities with the intent of advancing a TFN priority project in the context of the offsetting plan.

3.1. South Arm Jetty Tidal Marsh Project

3.1.1. Physical description of offset

The proposed South Arm Jetty Tidal Marsh Project is located three kilometres downstream of Steveston, B.C., in a large area between the southern edge of Sturgeon Bank and the Steveston North Jetty, at the mouth of the south arm of the Fraser River (**Figure IR2020-1.1-1**). It is an important fishing area for TFN and Musqueam. The proposed offsetting project involves habitat enhancement through converting 30 ha to 40 ha of lower-value sand flat into an expanded high-value brackish intertidal marsh containing tidal channels and bordered by a protective cobble beach berm. Marsh habitat is expected to be created through the beneficial re-use of dredged material, acquired through the Fraser River annual maintenance dredge program, and the planting of native marsh vegetation to match the existing adjacent marsh community and align with Indigenous group preferences to the extent possible. The potential also exists for habitat restoration through removal of piles, logs, and other debris.

3.1.2. Preliminary designs and specifications

Development of this offsetting project through the port authority's Habitat Enhancement Program has been underway since 2013, with the development of 11 assessment and analytical reports to document existing conditions and predicted future conditions (including recent engineering design and modelling reports; Moffatt and Nichol 2020b). This project was not proposed as offsetting habitat in the RBT2 EIS but is being proposed now as part of the additional 50+ ha of conventional offsetting habitat currently being advanced. The design of this proposed offsetting project complements previous restoration works (breaches of the Steveston jetty) conducted by Raincoast Conservation Foundation (Raincoast). During consultation with Indigenous groups, the importance of the work undertaken by Raincoast in the area was emphasized. The port authority considered the Steveston jetty breach work conducted by Raincoast in the context of the design development of the South Arm Jetty Tidal Marsh Project. This approach, advocated for by Musqueam, considers individual RBT2 offsetting projects in the broader context of the entire Fraser River estuary ecosystem to better support species of interest to Indigenous groups.

Prior to inclusion in the RBT2 offsetting plan, consultation with Indigenous groups included participation from TFN, Musqueam, Tsleil-Waututh Nation, Cowichan Nation Alliance, Lyackson First Nation, Stó:lō Nation, Semiahmoo First Nation, and Ts'uubaa-asatx First Nation. Letters of support were received from Musqueam and Semiahmoo First Nation. Key feedback during consultation included ensuring adherence to least risk fisheries windows, working with groups in planning for construction mitigation and monitoring, implementing an invasive species management plan, committing to a construction communications plan, revegetating intertidal marshes with culturally significant plants, and ensuring community knowledge informs the planning and design of the planting plan.

The project design includes an approximately 190 m long containment berm proposed along the eastern extent of this offsetting project site. In addition, the northern and western fill boundaries would be defined by an approximately 2.4 km long and 60 m wide cobble beach berm designed to contain and stabilize the placed fill, reduce wave energy, and increase habitat diversity (Figure 3-2, Moffatt and Nichol 2020b). The containment berm will comprise a sand inner/core layer and a ~0.5 m thick outer layer of 5 kg cobble (55,500 m^3). The sand fill for the site will comprise 89,100 m^3 of externally-sourced material (e.g., beneficially re-used dredge material) and 39,100 m^3 of onsite regraded material.

Existing intertidal marsh habitat at the offsetting project site will be expanded by the proposed offsetting by creating a substrate surface of a suitable elevation and composition for marsh growth and function (approximately 0.0 m geodetic datum (GD), i.e., mean water level, but intended to vary in elevation to provide opportunities for marsh community upslope migration in response to sea-level rise). Planting will be with native marsh species representative of the neighbouring ecological community and reflective of Indigenous input, use, and preferences. The proposed marsh planting plan reflects Indigenous input provided through earlier engagement, and currently comprises seacoast bulrush, Lyngbye's sedge (*Carex lyngbyei*), Baltic rush (*Juncus balticus*), three-square bulrush, softstem bulrush (*Schoenoplectus tabernaemontani*), and seaside arrowgrass. The port authority will include and consult with Indigenous groups in developing the final planting plan.

There is also the opportunity for habitat restoration through removal of piles, logs, and other debris. In alignment with additional habitat measures and features suggested by Indigenous groups, including TFN, Musqueam, Semiahmoo First Nation, and T'suubaa-asatx First Nation, this opportunity was further investigated at a recent site visit in summer 2020, which confirmed the extent and effects of such material.

Discussion with Indigenous groups on pile removal also focused on the benefits of leaving piles/some piles in place for raptor perching, and whether or not the potential contamination risk associated with that use would outweigh any benefits. The port authority has reviewed this topic and concluded that the potential for raptors to be adversely affected by creosote while perching on treated pilings is very low. The hazardous compounds in creosote are polycyclic aromatic hydrocarbons (PAHs), which are fat soluble (Abdel-Shafy and Mansour 2016). Consequently, it is considered that such compounds would generally need to be ingested by raptors to cause them harm. With regard to the potential for leaching into the aquatic environment, studies show that most leaching occurs during the first few years after a piling is installed as the outer surfaces of treated wood is weathered, where individual chemical constituents are adsorbed, evaporated, photo-oxidized, or dissolved (Werme et al. 2010). Therefore, the risk to the aquatic environment from old piles is considered to be low.

If piles, logs, and other debris are considered to be adversely affecting fish habitat productivity and not providing important habitat for other wildlife, selective removal could be proposed as a synergistic, additional feature to increase the habitat enhancement value of the proposed offsetting project.

The pros and cons of pile removal is the subject of ongoing consultation with Indigenous groups. At a recent Indigenous multi-group workshop, and throughout consultation, the port authority has received input on the removal of piles from TFN, Musqueam, Tsleil-Waututh Nation, Malahat Nation, Cowichan Nation Alliance, Semiahmoo First Nation, and T'suubaa-asatx First Nation, particularly in the context of the potential contamination risk of removal versus leaving in place and the use of piles by wildlife (e.g., perching raptors). The port authority will continue to consult with Indigenous groups on pile removal in the context of this project.

As the area has been identified by TFN and Musqueam as a prime fishing area, the design has also included consideration of continued Indigenous group use of the area and enhanced access as informed by site visits and ongoing consultation.

3.1.3. Characterization of current habitat characteristics and function

Biophysical information on the site was gathered from desktop and field studies undertaken between 2012 and 2017 (Hemmera 2014a, 2018a) and reflects Indigenous knowledge and input shared. As described in Hemmera 2018a, a variety of information sources were consulted during desktop studies (i.e., municipal, provincial and federal databases and mapping tools, as well as scientific and unpublished literature).

In addition to desktop studies, a number of field studies have been conducted, including the list below:

- Intertidal transect surveys to collect the following information:
    - Vegetation presence and composition (including in existing adjacent marsh habitat)
    - Sessile and motile epibenthic organisms
    - In situ infaunal sampling, focusing on bivalve habitat use

    - In situ water and sediment quality monitoring
    - Substrate size and composition (including sediment sample collection for particle size and chemical analysis)
    - Site modifiers (e.g., anthropogenic disturbance features)
    - Physical features (e.g., slope, exposure)
    - Incidental observations of aquatic life and wildlife
- Biofilm sampling and laboratory analysis
- Avian (including shorebird and waterfowl use)

These studies are described in detail in the Existing Ecological Conditions reporting for the site (Hemmera 2014a, 2018a).

Existing ecological conditions reporting will be further updated with results from summer 2020 site assessments, which were designed to confirm the current extent of existing marsh habitat, reconfirm current dominant marsh plant species/communities, and provide an opportunity for additional Indigenous participation and input into the proposed offsetting project. As with all site visits occurring during the COVID-19 pandemic, onsite Indigenous participation was challenging due to health restrictions and concerns. To facilitate Indigenous participation, site visits were recorded and made available to Indigenous groups for input and documentation. Information from each assessment has been shared with Indigenous groups in multi-nation workshops as well as in one-to-one meetings.

The proposed site is a shallow portion of Sturgeon Bank, where a remnant area of dredge material disposal exists from the early 1980s, characterized as sandflat with existing intertidal marsh adjacent to the site. The offsetting project involves the proposed expansion of existing marsh habitat (which comprises Lyngbye's sedge, bulrushes, Baltic rush, arrowgrass, and tufted hairgrass (*Deschampsia cespitosa*) over largely unvegetated low productivity sandflat. Tidal flat areas sampled and underlying the proposed project are predominantly unvegetated with small areas of very sparse marine vegetation (<5% cover) and comprising solely sea lettuce (*Ulva* spp.) and non-native Japanese eelgrass. The sandflat is considered highly mobile, supports few benthic organisms, and has an infaunal community characterized by low density and diversity. No epibenthic sessile or motile organisms were observed during transect surveys. While traversing the offsetting project site during field sampling, amphipods and a single Pacific sand lance (*Ammodytes hexapterus*) were observed (Hemmera 2014a, 2018a).

No provincially- or federally-listed vegetation species were observed on intertidal flat habitats at the offsetting project site. Fish species of conservation concern with the potential to occur at the site are considered to either be unaffected by, or to benefit from, the proposed enhancement. The site is accessible to a range of freshwater-tolerant marine fish species and migratory fish species. Fish species that prefer intertidal flat habitats such as starry flounder (*Platichthys stellatus*) and Pacific sand lance are expected to utilize the site during high tide; however, the tidal channel system proposed for the enhanced marsh will provide enhanced fish habitat opportunities (including more productive foraging habitat for flatfish, inundated for longer periods in the tidal cycle). The offsetting project would increase primary productivity and contributions to estuarine detritus-based food webs, increasing important prey items (e.g., food for juvenile salmon, such as harpacticoid copepods and chironomid larvae; Levings and Nishimura 1997; Roegner et al. 2010; David et al. 2014; Archipelago and Williams 2016; Chalifour et al. 2019). The shorebird use observed in the general area was much lower than elsewhere in the Fraser River estuary. Wildlife species of conservation concern would not be negatively affected by the proposed marsh enhancement. Rather, the enhancement would provide habitat for a wider range of wildlife species, including waterfowl.

Creosote-treated wood and concrete pilings are present in several areas (either embedded or stacked) and could provide restoration opportunities in alignment with expressed Indigenous group preferences relating to log and pile removal in conjunction with proposed offsetting projects. As described in **Section 3.1.2**, TFN, Musqueam, Semiahmoo First Nation, Malahat Nation, and T'suubaa-asatx First Nation have provided comments on this topic.

3.1.4. Description of the benefit of the proposed offset to fish

This enhancement project will benefit species of cultural importance and priority to Indigenous groups (in particular Pacific salmon species like Chinook and chum). Through increasing marsh habitat in the area, the project is also expected to result in a variety of ecological functions and benefits, including but not limited to the following:

- Increasing primary productivity and nutrient availability
- Supporting important detritus-based food webs
- Benefiting a broad range of fish and wildlife species and life stages
- Protecting against shoreline erosion
- Providing a carbon sink

During earlier engagement by the port authority's Habitat Enhancement Program, Musqueam and Semiahmoo First Nation formally supported the South Arm Jetty Tidal Marsh Project based on their assessment of project-related benefits to fish.

The South Arm Jetty Tidal Marsh Project is expected to improve the overall productivity of the area and provide important benefits to key fish species, including estuarine-rearing juvenile salmon (particularly Chinook and chum salmon). As such, this proposed offsetting project aligns well with priorities expressed by Indigenous groups, including Musqueam's long-term stewardship vision for restoration in the Fraser River estuary. Musqueam has indicated that the value of the South Arm Jetty Tidal Marsh Project is enhanced by its contribution to a network of interconnected habitat sites supporting ecological processes, as well as fish of different life histories and life stages in the Fraser River (e.g., the provision of enhanced rearing opportunities for juvenile Chinook salmon out-migrating from the Fraser River).

Intertidal marsh habitat enhancement is considered to be highly effective in providing habitat value for juvenile salmon. The offsetting project would provide high-quality habitat for juvenile salmon as they utilize shoreline habitats in the lower Fraser River estuary rearing corridor prior to entering the marine environment. Benefits include increased feeding opportunities and prey provision, detrital food web support, increased provision of nursery/rearing and refuge/cover habitat, and enhanced opportunities for salinity acclimatization. In turn, this would be expected to increase survival and growth of juvenile stages and recruitment success to the parent stock. Furthermore, as for all proposed offsetting projects or components that benefit Chinook salmon, trophic benefits to southern resident killer whales (*Orcinus orca*) would also be expected through increased prey abundance.

Appendix IR2020-1.1-C provides more details on the wide-ranging ecosystem and species/group benefits of the intertidal marsh habitat.

3.1.5. Assessment of technical feasibility

The design process for this offsetting project dates back to 2014. Since then, the design has been subject to three key updates to reflect the following aspects:

- To avoid a patch of emergent marsh habitat that was identified during the design process
- To avoid biofilm resources and associated shorebird use
- To complement the most westerly breach implemented by Raincoast and to tie-in with the resultant tidal channel

Substantial investigative work has been completed by a range of technical experts, in consideration of biological design criteria and lessons learned. Project engineers developed hydrodynamic computer models to determine and assess the effects of the physical processes acting on the site (e.g., wind-wave exposure, current, salinity) in the context of biological criteria (Moffatt and Nichol 2014a, 2020b, 2020c, and 2020d). The key objectives of this work were to a) confirm the suitability of the site for the offset habitat being proposed, b) confirm the self-

sustainability of the offset habitat, and c) confirm that the proposed offsetting will not negatively influence surrounding areas and habitats (e.g., related to bed shear, scour, and erosion). Hydrodynamic modelling results indicate that the implementation of the offsetting project will maintain existing salinity conditions in the area, and that the inclusion of a cobble beach berm (20H:1V) in the project design will be effective in providing adequate shelter from storm wave energy. Physical processes are considered to be within acceptable ranges in the context of biological design criteria and only very minor changes in surrounding bed shear stress are predicted. In other words, the conclusions from the modelling work are that the proposed offsetting project is suitable for the physical setting, will be self-sustaining, and is not expected to negatively affect surrounding areas.

A preliminary geotechnical assessment was conducted, based on a desktop geotechnical study and limited site reconnaissance, to determine construction feasibility and constraints in relation to substrate stratigraphy and stability (Golder 2014). The preliminary geotechnical assessment indicated that 75 mm to 175 mm of settlement could be expected over an 18-month period following construction. This degree of settlement is incorporated into the design elevations.

An Archaeological Overview Assessment and a Preliminary Field Reconnaissance were conducted for the South Arm Jetty Tidal Marsh Project, to assess the potential for archaeological resources (Stantec 2014, 2015). The Archaeological Overview Assessment concluded that the site had archaeological potential and recommended a Preliminary Field Reconnaissance to further refine the assessment. The Preliminary Field Reconnaissance, however, concluded that the area had a low potential for archaeological resources and that no further archaeological investigation was recommended. Both Musqueam and Semiahmoo First Nation participated in the archaeological fieldwork. Indigenous groups, including TFN, Musqueam, Tsleil-Waututh Nation, Semiahmoo First Nation, and T'suubaa-asatx First Nation have noted the possibility of encountering archaeological resources in areas assessed as low potential. Should this offsetting project advance to construction, the port authority will continue to work with Indigenous groups to plan and implement measures to protect archaeological values. As with all of the offsetting projects, the port authority will work with Indigenous groups to consider Indigenous policies and protocols related to archaeology.[4]

Summer 2020 field assessment confirmed the current extent and species/community composition of the existing marsh habitat to be retained and emulated in the final design. As with all site visits occurring during the COVID-19 pandemic, onsite Indigenous participation was challenging due to health restrictions and concerns. To facilitate Indigenous participation, site visits were recorded and made available to Indigenous groups for input and documentation

3.1.6. Land tenure, access, and interactions with other land uses

The proposed offsetting project is located on Provincial Crown land. A land tenure application was submitted to Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) (submitted 2018, VFPA 2018) and is in advanced stages of reviewing terms and conditions of an agreement. FLNRORD has confirmed that the application review is well advanced (**Appendix IR2020-1.1-D**). This process included Indigenous consultation led by the province. As part of this process, the port authority responded to questions submitted to the province by Indigenous groups.

The design of this offsetting project has changed in recent years to reflect three key considerations: the identification of a small area of existing, patchy marsh habitat; the findings of the biofilm resource and shorebird use studies conducted; and the nearby breaches being implemented by Raincoast (VFPA 2020c). During RBT2

[4] Given the importance of ensuring protection of archaeological resources to Ts'uubaa-asatx, the nation proactively provided their policies for archaeology in the Lower Mainland. This will be considered along with any other archaeological/heritage management-related information, policies, protocols and best management practice documents, provided by Indigenous groups, including Musqueam, TFN, Semiahmoo, and Tsleil-Waututh Nation. The port authority appreciates the proactive approach that Ts'uubaa-asatx has taken to ensuring archaeological priorities and protocols are clearly communicated during planning related to the development of the offsetting plan. This includes the sharing of policies, protocols, and other information during offsetting-related site visits and meetings.

consultation, Indigenous groups highlighted the importance of considering the Raincoast work in the context of design updates for this offsetting project.

The Steveston North Jetty (directly adjacent to the South Arm Jetty Tidal Marsh Project) is an eight kilometre long rock jetty at the mouth of the south arm of the Fraser River. The jetty functions to provide safe vessel access to terminals on the Fraser River, minimize the Fraser River main channel's ability to meander, and to improve sediment conveyance seaward, thereby reducing the amount of maintenance dredging required. Raincoast has recently implemented three breaches in the Steveston North Jetty to increase access for out-migrating juvenile salmon to rearing habitat on Sturgeon Bank. Phase 1 of Raincoast's work, which provided an initial lowering of the jetty, was completed in early 2019. Phase 2, which involves lowering all of the breaches to the final design elevation, is understood to be planned to proceed over the next couple of years—after review of the fish monitoring results from Phase 1.

The South Arm Jetty Tidal Marsh Project would create intertidal marsh habitat at the mouth of the Fraser River and interact synergistically with Raincoast's Fraser Connectivity Project to increase the availability of, and access to, juvenile salmon rearing habitat. The port authority is working with Raincoast so that the South Arm Jetty Tidal Marsh Project and Raincoast's breaches are complementary to the overall benefit of out-migrating juvenile salmon, and other fish and wildlife. As such, the eastern extent of the proposed marsh has recently been reduced slightly to avoid interfering with the tidal channel that has developed, and is expected to develop further, to the north of the western breach location (VFPA 2020c). In addition, the tidal channel network proposed to drain the South Arm Jetty Tidal Marsh Project, and provide additional habitat diversity for fish, has been designed to tie-in with the predicted locations and bathymetry of the tidal channels resulting from the western Raincoast breach.

The influence of the Raincoast breaches and potential additional breaches downstream of the proposed offsetting project was assessed using hydrodynamic modelling and found to not markedly change physical conditions (e.g., current speeds or salinity) at the site. Hydrodynamic modelling results indicated that current speeds and salinity within the project area are similar under three modelling scenarios (VFPA 2020a): 1) no breaches, 2) including the three Raincoast breaches to the east, and 3) including the one or two potential additional breaches that have been considered to the west of the proposed offsetting project. As such, it is concluded that a) the Raincoast breaches will not negatively affect the performance of this offsetting project, and b) the hydrodynamic effects of potential additional breaches to the west are limited and, therefore, those breaches are not recommended nor being advanced as part of the design of the proposed offsetting project.

The Sturgeon Bank Sediment Enhancement Pilot Project has recently been proposed (by Ducks Unlimited and others) to the north of the site, with the intent to restore areas of receding tidal marsh along the west side of Lulu Island by increasing the supply of sediment through the targeted deposition of material dredged from the Fraser River (proposed to commence November 2021). Coastal analysis and numerical modelling undertaken to inform the South Arm Jetty Tidal Marsh Project design (Moffatt and Nichol 2020b) indicates that the offsetting project will not affect the sediment dynamics of adjacent areas, including to the north of the site.

Construction access to the South Arm Jetty Tidal Marsh Project site would be via marine-based equipment from the Fraser River. Long-term monitoring access could be via marine vessel, and/or by foot at low tide, from Steveston, Richmond, B.C.

3.2. South Causeway Eelgrass Project

3.2.1. Physical description of offset

The proposed South Causeway Eelgrass Project (formerly known as the Tsawwassen Eelgrass Project) consists of two sites located on Roberts Bank, south of the BC Ferries Tsawwassen terminal and causeway near Delta, B.C. (**Figure IR2020-1.1-1**). This proposed offsetting project involves transforming approximately 3.5 ha to 4.5 ha of lower-value deep subtidal soft bottom habitat into two high-value shallow subtidal eelgrass beds. It is also considered to involve restoring habitat, altered by past activities associated with dredging for the nearby ferry terminal/causeway, that may have previously been suitable for eelgrass. Given the location, the port authority is seeking to advance this offsetting project collaboratively with TFN, acknowledging that the preferred design will

not overlap with TFN's waterlot, and with particular focus on aligning design and construction considerations with TFN's preferences and use.

Development of this offsetting project through the port authority's Habitat Enhancement Program has been underway since 2013, with five assessment and analytical reports having been produced to document existing conditions and predicted future conditions (including a recent engineering design report; Moffatt and Nichol 2020e). This project was not proposed as offsetting habitat in the RBT2 EIS but is being proposed now as part of the additional 50+ ha of conventional offsetting habitat currently being advanced. Indigenous consultation was undertaken through the port authority's Habitat Enhancement Program and by the B.C. Environmental Assessment Office (EAO) as part of their environmental assessment exemption process for this habitat enhancement project. Planning and design at that time was undertaken in collaboration with TFN, resulting in the identification of a preferred design, a letter of support from TFN, and a series of commitments related to TFN involvement in the construction of the offsetting project. Recent discussions have led to a change in preferred design in light of TFN plans and priorities, and the port authority remains committed to working in collaboration with TFN with respect to this project. The preferred design has been included and is described in the design report (Moffatt and Nichol 2020e). Future design development of this offsetting project leading up to the FAA application submission will further reflect the preferred design.

The proposed eelgrass beds are expected to be created through the beneficial re-use of dredged material, acquired through the Fraser River annual maintenance dredge program, placed behind rock containment berms to provide stability. This would be followed by the careful transplanting of eelgrass harvested from nearby donor beds based on established regional protocols (i.e., those successfully used for the nearby eelgrass restoration and offsetting created for the port authority's DP3 Project and BC Hydro's Vancouver Island Transmission Reinforcement project) and under the guidance of regional technical experts. Infilling of the existing seabed depressions would be to an elevation and slope that closely matches adjacent eelgrass beds (-2.05 m CD and -1.2 m CD, and a 20H:1V; Moffatt and Nichol 2020e).

The containment berms would be located adjacent to the existing Tsawwassen boat launch channel (Appendix C, Moffatt and Nichol 2020e) and comprise quarry rock (~43,000 tonnes) and screenings (~5,700 tonnes; to act as a filtering layer) placed at a 2H:1V slope. Fill material to create the eelgrass beds would be discharged as close to the seabed as practical (e.g., using a diffuser) to minimize turbulent dispersal. The total estimated volume of sand fill to be placed is ~133,700 m^3.

Additionally, opportunities for shell hash application in conjunction with the South Causeway Eelgrass Project are being explored, and could have the following habitat benefits:

- Provide an increased rate of settlement of invertebrate pelagic life stages, thereby accelerating recruitment, habitat colonization, and prey availability for important fishery species
- Improve habitat functionality by increasing complexity and microhabitat abundance
- Increase the localized availability of minerals used in shellfish development (e.g., aragonite)
- Tsleil-Waututh Nation and Ts'uubaa-asatx First Nation have indicated support for the proposed use of shell hash as a component of the offsetting project.

3.2.2. Characterization of current habitat characteristics and function

Biophysical information for the site was gathered from desktop and field studies undertaken between 2013 and 2015 (Hemmera 2015) and shared with Indigenous groups, including TFN, for input. As described in Hemmera 2015, a variety of information sources were consulted during desktop studies (i.e., municipal, provincial, and federal databases and mapping tools, as well as scientific and unpublished literature).

In addition to desktop studies, two separate subtidal dive surveys have been completed in the proposed offsetting project area, to characterize existing biophysical conditions. Georeferenced meandering surveys were conducted and information on the relative abundance of flora and fauna, and sediment composition, was recorded. High

definition digital videography was collected to document benthic conditions and habitat variation. These studies and surveys are described in the Existing Ecological Conditions reporting for the site (Hemmera 2015).

The proposed eelgrass bed sites currently consist of low-productivity unvegetated subtidal sand depressions, that are too deep to be naturally colonized by eelgrass (due to limited light penetration), and are acting as a sink for detritus, which is lowering the area's overall productivity and not providing any notable fish habitat value. Fish habitat value in the enhancement areas would be increased through the development of eelgrass habitat.

Existing ecological conditions reporting will be further updated based on input shared by TFN and results from a diver-supported assessment conducted in summer 2020 to confirm if there have been any substantial recent changes to biophysical conditions, though none are understood to have been observed. Underwater video was recorded during the summer 2020 assessment and can be shared with Indigenous groups and DFO.

Although organisms such as Dungeness crab and orange sea pen have been observed at the proposed sites, constructing eelgrass habitat in this location would transform lower-productivity subtidal habitat to higher-productivity habitat and increase the productivity of both adult and juvenile Dungeness crab, as well as other priority species and life stages like estuarine-rearing juvenile salmon, compared to the existing habitat. Sea pens are capable of moving and changing their distribution over time and the proposed offsetting project represents a relatively small change (3.5 ha to 4.5 ha) when compared to the suitable sea pen habitat (i.e., soft sediment subtidal habitat) available at Roberts Bank. Further assessment of existing ecological conditions will be conducted prior to implementation of this offsetting project.

3.2.3. Description of the benefit of the proposed offset to fish

This enhancement project will benefit species of cultural importance and priority to Indigenous groups (in particular Pacific salmon species like Chinook and chum, and Dungeness crab). The importance of eelgrass to priority species has been noted by Indigenous groups, including TFN, Musqueam, Semiahmoo First Nation, T'suubaa-asatx First Nation, Malahat Nation, Cowichan Nation Alliance, and Tseycum First Nation, as well as organizations such as the Lower Fraser Fisheries Alliance. In addition to crab and juvenile salmon, Tsleil-Waututh Nation and Ts'uubaa-asatx First Nation have noted the importance of eelgrass beds to herring, particularly as spawning habitat.

Eelgrass also serves critical functions in estuarine communities. Consequently, through increasing eelgrass habitat in the area, the South Causeway Eelgrass Project is expected to result in a variety of ecological functions and benefits, including but not limited to the following:

- Benthic, epibenthic, and epiphytic production
- Carbon storage and oxygen production
- Canopy structure
- Nutrient cycling and detrital production

The habitat structure and complexity provided by eelgrass beds attracts diverse groups of marine invertebrates, including important prey for juvenile salmon. Eelgrass provides highly productive and important habitat (particularly refuge, foraging, and nursery habitat) for key fish species, including juvenile salmon, forage fish (including Pacific herring), and Dungeness crab, as well as habitat for a range of other fish and invertebrate species, plus other wildlife such as waterfowl and great blue heron.

Appendix IR2020-1.1-C provides more details on the wide-ranging ecosystem and species/group benefits of eelgrass habitat.

3.2.4. Assessment of technical feasibility

Substantial investigative work (including current analysis) has been completed by a range of technical experts. Project engineers developed hydrodynamic computer models to a) assess the potential influence of current on the proposed offsetting project, in the context of biological design criteria and lessons learned (e.g., from the nearby

eelgrass habitat created to offset the Vancouver Island Transmission Reinforcement project), and b) determine the potential influence of the proposed offsetting project on surrounding areas (Moffatt and Nichol 2020e). Wave condition analysis was considered to not be required as localized currents govern physical processes in this subtidal area.

Predicted physical processes are considered to be within acceptable ranges in the context of the target biological community and stability of the proposed habitat. Negligible effect on currents in surrounding areas are predicted. Peak tidal current velocities at the proposed offsetting project locations were determined through numerical modelling to be approximately 0.33 m/s, which is considered well within the tolerance of eelgrass.

Archaeological investigations are not typically undertaken for subtidal marine locations and, accordingly, none were conducted at this site. Further discussions with TFN and other Indigenous groups in relation to archaeological considerations will inform any additional investigation and/or measures.

A desktop geotechnical assessment was completed (Golder 2017). The desktop geotechnical assessment concluded that the depressions that would be filled during offsetting project construction have effectively been preloaded and, as such, the settlement over a six month period following construction is predicted to be a nominal 50 mm. Settlement over the design life of the offsetting project was predicted to potentially be up to 300 mm. This degree of settlement is incorporated into the design elevations.

3.2.5. Land tenure, access, and interactions with other land uses

Based on input received from TFN, the preferred design option is to build the project exclusively within a waterlot that is held by BC Ferries. The port authority has executed an agreement with BC Ferries to permit use of the waterlot for this offsetting project. This preferred option for the project does not require a TFN land agreement.

The proposed eelgrass beds are located near existing eelgrass habitat, including a functioning and vigorous compensatory eelgrass bed previously created as part of BC Hydro's Vancouver Island Transmission Reinforcement Project. There is also a boat channel nearby. This navigation channel will be maintained to allow for marine traffic. Marine traffic signage would be provided by the construction contractor. In addition, navigation markers have been incorporated into the design to delineate the edge of the project for boater safety. This is also an area used by TFN. These aspects will influence the construction approach and methodology. Analysis of physical processes shows that the construction of the proposed eelgrass beds will have a negligible effect on nearby tidal current velocities, and therefore surrounding areas.

Construction access would be via marine-based equipment. Eelgrass habitat long-term monitoring would be performed by divers with access via marine vessel.

3.3. **Westham Island Canoe Pass Tidal Marsh Project**

3.3.1. Physical description of offset

The proposed Westham Island Canoe Pass Tidal Marsh Project is located in Canoe Pass, the southernmost distributary channel of the Fraser River, near the south side of Westham Island in Delta, B.C. (**Figure IR2020-1.1-1**). The project involves converting approximately 4.0 ha to 4.5 ha of lower-value intertidal sand flat into an expanded high-value brackish intertidal marsh habitat, likely through the beneficial re-use of dredged material from a nearby navigation channel followed by the planting of suitable native marsh vegetation to match the existing adjacent marsh that will be retained.

The site was selected based on the potential to benefit a broad range of fish and wildlife species and life stages (including juvenile Pacific salmon such as estuarine-rearing Chinook salmon). Site selection was informed by input from Indigenous groups obtained through the port authority's Habitat Enhancement Program. Indigenous groups, in particular TFN and Musqueam, have emphasized the importance of the proposed offsetting project location for fishing and their interest in continued involvement in the project. Commitments to Indigenous groups made through earlier consultation include the development of a construction communication plan for groups fishing in the area and involvement in the development of the planting plan. The project has received general

support from Indigenous groups. Recently, Indigenous groups, including TFN, Musqueam, Tsleil-Waututh Nation, Cowichan Nation Alliance, Lyackson First Nation, Stó:lō Nation, Ts'uubaa-asatx First Nation, and Semiahmoo First Nation have indicated support for the potential for habitat restoration through removal of piles, logs, and other debris.

3.3.2. Preliminary designs and specifications

Development of this project through the port authority's Habitat Enhancement Program has been underway since 2013, with seven assessment and analytical reports having been produced to document existing conditions and predicted future conditions (including a recent engineering design report; Moffatt and Nichol 2020f). This project was not proposed as offsetting habitat in the RBT2 EIS but is being proposed now as part of the additional 50+ ha of conventional offsetting habitat currently being advanced.

The proposed project involves the construction of a riprap containment berm to retain sand fill placed behind it for marsh bench establishment (Appendix B, Moffatt and Nichol 2020f). The containment berm will encircle the southern end of an existing marsh and extend northwards delineating new marsh habitat. The crest of the berm will be above the mean water level to match the elevation of the existing marsh. The berm will consist of a ~0.2 m thick underlayer of crushed granular sub-base, a ~0.2 m thick layer of filter stone, and a ~0.5 m thick layer of 32 kg riprap stone on top (total rock quantity is ~4,000 m^3). The containment berm is designed to retain the fill and provide protection from erosion.

The marsh bench construction will involve fill placement from an elevation of –0.25 m GD to slope up to meet the existing adjacent marsh habitat at approximately 0.3 m GD. The amount of sand fill needed to create the marsh bench is estimated to be ~46,600 m^3. Planting will be with marsh species representative of the neighbouring ecological community. The proposed marsh planting plan comprises Lyngbye's sedge, common spikerush (*Eleocharis palustris*), Baltic rush, three-square bulrush, and softstem bulrush. The design includes a drainage channel to optimize marsh function and provide increased habitat value and utilization by juvenile salmon like chum and estuarine-rearing Chinook populations.

The port authority is evaluating opportunities to incorporate additional habitat enhancement features, suggested by, or of interest to, Indigenous groups, into the design and implementation of the offsite offsetting projects. One such feature is the removal of accumulated logs. A review of recent aerial imagery indicates dense accumulations of logs located shoreward of the area of potential intertidal marsh enhancement (i.e., on the southeastern shoreline of Westham Island). This log accumulation appears as an approximately 1,200-m long band, with an estimated average width of 10 m, in the immediate vicinity of the project. The extent and effects of log accumulation will be further evaluated through review of aerial imagery and topographic information collected using drone technology in fall 2020. The careful and selective removal of the accumulated logs may be considered as a synergistic, additional feature to increase the habitat enhancement value of the project by supporting re-establishment of marsh vegetation. This measure aligns with preferences expressed by Indigenous groups relating to the selective removal of logs and piles as part of RBT2 offsetting projects where opportunities exist.

3.3.3. Characterization of current habitat characteristics and function

Biophysical information on the site was gathered from desktop and field studies undertaken between 2012 and 2014 (Hemmera 2014b). Work was informed by Indigenous input and knowledge shared during consultation and through the involvement of groups, including Musqueam, in site assessment. As described in Hemmera 2014b, a variety of information sources were consulted during desktop studies (i.e., municipal, provincial, and federal databases and mapping tools, as well as scientific and unpublished literature).

In addition to desktop studies, a number of field studies have been conducted, including the following:

- Site reconnaissance to characterize existing sand flat and marsh habitats (including dominant marsh plant species/communities)
- Standwatch bird surveys to document bird use at the site

These studies and surveys are summarized and presented in the Existing Ecological Conditions reporting for the site (Hemmera 2014b). Existing ecological conditions reporting will be updated with results from summer/fall 2020 site assessments (which included a drone survey), conducted to confirm the current extent of existing marsh habitat, reconfirm current dominant marsh plant species/communities, assess the potential for log removal, and provide an opportunity for additional Indigenous participation and input into the project. As with all site visits occurring during the COVID-19 pandemic, onsite Indigenous participation was challenging due to health restrictions and concerns. To facilitate Indigenous participation, site visits were recorded and made available to Indigenous groups for input and documentation

The project involves the proposed expansion of existing brackish intertidal marsh habitat, which comprises Lyngbye's sedge, bulrushes, and spikerush. The project site is accessible to a range of freshwater-tolerant marine fish species and migratory fish species. Fish species of conservation concern with the potential to occur at the site are considered to either be unaffected by, or to benefit from, the proposed enhancement. The most common fish species found in unvegetated tidal flat habitat, like that which exists at the proposed project site, are flatfish. The tidal channel system proposed for the enhanced marsh will provide enhanced fish habitat opportunities, including for members of that group. Input and knowledge shared by Indigenous groups such as TFN, Musqueam, Semiahmoo First Nation, and T'suubaa-asatx First Nation aligns with the port authority's understanding of the potential benefits of this project to fish species.

Federally- or provincially-listed wildlife species are not expected to be negatively affected by the proposed marsh enhancement. The project would provide habitat for a wider range of wildlife species, including waterfowl.

3.3.4. Description of the benefit of the proposed offset to fish

This enhancement project will benefit species of cultural importance and priority to Indigenous groups (in particular Pacific salmon species like Chinook and chum). Through increasing marsh habitat in the area, the project is also expected to result in a variety of ecological functions and benefits, including but not limited to the following:

- Increasing primary productivity and nutrient availability
- Supporting important detritus-based food webs
- Benefiting a broad range of fish and wildlife species and life stages
- Protecting against shoreline erosion
- Providing a carbon sink

The removal of accumulations of historically-deposited anthropogenic logs (i.e., saw-cut logs from the forestry sector) will increase the fisheries productivity of existing intertidal marsh habitat, by reversing vegetation smothering and soil compaction, reducing the risk of chemical leaching from creosote-treated logs (if present), and preventing the clogging of tidal channels. Indigenous groups, such as TFN, Musqueam, Tsleil-Waututh Nation, Semiahmoo First Nation, T'suubaa-asatx First Nation, and Malahat Nation have noted concerns with chemical leaching (creosote). Numerous groups have expressed support for efforts to address log accumulation.

The south arm of the Fraser River is an ecologically important area for juvenile salmon. The Westham Island Canoe Pass Tidal Marsh Project is expected to increase the productivity of Canoe Pass and provide high-quality habitat at a prime location for estuarine-rearing juvenile salmon (particularly Chinook and chum). Benefits include increased feeding opportunities and prey provision, detrital food web support, increased provision of nursery/rearing and refuge/cover habitat, and enhanced opportunities for salinity acclimatization. In turn, this would be expected to increase survival and growth of juvenile stages and recruitment success to the parent stock.

Appendix IR2020-1.1-C provides more details on the wide-ranging ecosystem and species/group benefits of intertidal marsh habitat.

3.3.5. Assessment of technical feasibility

Substantial investigative work has been completed by a range of technical experts, in consideration of biological design criteria and lessons learned. A containment berm is proposed to provide fill retention, stability, and scour protection. The flows at the site are dominated by the Fraser River and salinity is, therefore, relatively low. Project engineers developed hydrodynamic computer models to determine the suitability of the site for the proposed project, and whether the project would alter river flows (Moffatt and Nichol 2014b, 2020f). Based on analysis of physical processes, the project is considered to be within acceptable ranges in the context of biological design criteria, suitable for the physical setting, self-sustainable, and is not expected to negatively affect surrounding areas.

A Preliminary Field Reconnaissance was conducted for the Westham Island Canoe Pass Tidal Marsh Project to assess the potential for archaeological resources (Stantec 2013). No archaeological sites were identified during the Preliminary Field Reconnaissance, and no areas within the project footprint were considered to have the potential for buried archaeological materials. Accordingly, no further archaeological investigation was recommended. Musqueam participated in archaeological fieldwork at the time. While no further archaeological work was advised, Indigenous groups, including TFN, Musqueam, Tsleil-Waututh Nation, Semiahmoo First Nation, and T'suubaa-asatx First Nation have noted the possibility of encountering archaeological resources in areas assessed as low potential and advised that further work be undertaken to consider any new assessments and/or relevant information available since the 2013 Preliminary Field Reconnaissance. As a result of feedback and knowledge shared by Indigenous groups during their review of this response, additional archaeological assessment is planned for fall 2021. Should the project advance to construction, the port authority will continue to work with Indigenous groups to plan and implement measures to protect archaeological values.

A preliminary geotechnical assessment was conducted, based on a desktop geotechnical study and limited site reconnaissance, to determine construction feasibility and constraints in relation to substrate stratigraphy and stability (Golder 2013). The preliminary geotechnical assessment indicated that 75 mm to 300 mm of settlement could be expected over the life of the project. This degree of settlement is incorporated into the design elevations.

3.3.6. Land tenure, access, and interactions with other land uses

The project is located on Provincial Crown land. A land tenure application was submitted to FLNRORD (submitted 2014; VFPA 2014) and is in advanced stages of reviewing terms and conditions of an agreement. FLNRORD has confirmed that the application review is well advanced (**Appendix IR2020-1.1-D**). The province has undertaken Indigenous consultation in relation to the land tenure application. The port authority has addressed comments raised by Musqueam that were submitted to the province through the land tenure consultation process.

Analysis suggests the project would not alter local river flow and therefore no changes to sedimentation are expected as a result of this project (Moffatt and Nichol 2020f). The project will also not impact the use of existing farming-related infrastructure in the area and it is concluded that the project would have no material impact on quality or quantity of the current agricultural irrigation water supply obtained from the south arm of the Fraser River in the vicinity of the proposed project (Moffatt and Nichol 2020f). The port authority is in dialogue with the City of Delta and Delta Farmers Institute to ensure concerns related to construction and interactions with the swing bridge infrastructure are addressed. The port authority continues to work with other stakeholders to respond to questions around adjacent land use such as project compatibility with conservation aspirations for the area.

Construction access will be via both marine- and land-based equipment. The project site can be accessed from the end of Trim Road, and this will be how foot access for long-term monitoring would be achieved.

3.4. **Tilbury Island Peninsula Enhancement Project**

3.4.1. Physical description of offset

The proposed Tilbury Island Peninsula Enhancement Project was identified by a number of Indigenous groups, including Musqueam, T'suubaa-asatx First Nation, and Cowichan Nation Alliance, as an important location for

enhancement, and was put forward as a Musqueam priority RBT2 offsetting project. Musqueam expressed this location as being of importance as part of a network of out-migrating juvenile salmon rearing areas in this area of the Fraser River. Musqueam also noted the importance of the area for cultural use. The project is located in the Tilbury Island area of Delta, B.C., in the south arm of the Fraser River (**Figure IR2020-1.1-1**). This project was not proposed as offsetting habitat in the RBT2 EIS but is being proposed now as part of the additional 50+ ha of conventional offsetting habitat currently being advanced.

Habitat enhancement is proposed through the development of 2 ha to 4 ha of brackish marsh and off-channel habitat. Enhancements would focus on an area of lower value unvegetated intertidal flat to the east (upstream) of a peninsula and causeway located at the upstream end of Tilbury Island. Based on a review of historical aerial imagery, the causeway was constructed prior to 1963 (Northwest Hydraulic Consultants 2021a). During a collaborative site visit with port authority technical staff in July 2020, Musqueam identified the east side of the causeway as the preferred area for enhancement since the area to the west of the causeway is showing early signs of transition from tidal flat to marsh habitat. It is estimated that it would take at least several decades for the east side of the causeway to develop similarly to the west side through natural processes (Northwest Hydraulic Consultants 2021a).

3.4.2. Preliminary designs and specifications

To benefit fish and wildlife, the project would involve enhancing existing lower value unvegetated intertidal sand and mud flat into expanded higher-value brackish intertidal marsh habitat. As identified by Musqueam during the July 2020 collaborative site visit, an opportunity exists to create off-channel habitat in a low-lying area of the eastern portion of the peninsula (the peninsula is sometimes referred to as Duck Island) that could be integrated into the proposed marsh habitat.

The project would involve placing fill, expected to be through the beneficial re-use of dredged material acquired through the Fraser River annual maintenance dredge program, behind an approximately 0.5 m high rock berm with a crest elevation of approximately –0.2 m GD. The rock berm is designed to retain the fill and protect against wave-induced erosion. Fill would be placed to create a gently-sloping planting surface of between –0.2 m and 0.8 m GD. Sediments will slope up to blend in with the existing fringing marsh habitat adjacent to the project. Three distinct zones of marsh habitat are proposed:

- An outer low marsh habitat (planted with Baltic rush)
- An inner low marsh habitat (comprising common spikerush and jointed rush (*Juncus articulatus*))
- An upper marsh habitat (composed of Lyngbye's sedge, softstem bulrush, and common cattail (*Typha latifolia*))

Baltic rush was chosen for the outer low marsh zone as it is a mat-forming species that provides resiliency against boat wake. Furthermore, this species is not preferentially grazed by herbivores such as Canada geese (*Branta canadensis*).

Existing tidal channels will be retained and contoured to maintain the existing drainage pattern and support marsh function as well as fish access and utilization. It is proposed that the expanded marsh habitat and tidal channels will be connected to off-channel habitat constructed in the low-lying areas on the peninsula to increase fish habitat complexity and water exchange. The off-channel habitat would be constructed with an invert elevation of 0.7 m GD to increase the duration that these areas are wetted. The off-channels would have a top width of 5 m with 2H:1V side slopes to a bottom width of 1 m. Excavated soil could be used as marsh fill if suitable.

A potential source for marsh growing medium will be the beneficial reuse of dredged material from the Fraser River south arm navigation channel (loamy sand or sandy loam is preferable). The dredged material will require time for settlement prior to transplanting marsh vegetation, anticipated to be one month or more.

The intent of the design is to allow for natural accumulation of sediment to help keep step with sea-level rise and to allow for sufficient room for the vegetation community to naturally migrate upslope in response to sea-level rise (thereby reducing the pace of coastal squeeze[5]).

3.4.3. Characterization of current habitat characteristics and function

A variety of information sources were consulted during desktop studies (i.e., municipal, provincial, and federal databases and mapping tools, as well as scientific and unpublished literature).

In addition to desktop studies, a number of field studies have been conducted to characterize the existing high value vegetated habitats at the site, which the proposed enhancement project seeks to expand. Musqueam conducted a collaborative site visit with port authority technical staff in July 2020. As with all site visits occurring during the COVID-19 pandemic, onsite Indigenous participation was challenging due to health restrictions and concerns. To facilitate Indigenous participation, site visits were recorded and made available to Indigenous groups for input and documentation. As this was a collaborative process from the outset, Musqueam knowledge informed the selection of the site, the preliminary design, and will continue to inform all aspects of the proposed project. Musqueam has stated that it has significant named sites in the area and adjacent to the area. These form part of a network of place names and the study area is adjacent to an 8,500-year-old village site. Musqueam's late Elders spoke of a time when this area was all water before the delta formed.

The shoreline surrounding the proposed project is classified as high productivity habitat and the shoreline at the tip of the peninsula to the north is classified as low productivity habitat (FREMP n.d.). Existing wetland vegetation communities around the edge of the site are dominated by Lyngbye's sedge, Baltic rush, softstem bulrush, hardstem bulrush (*Schoenoplectus acutus*), common spikerush, and pointed rush (*Juncus oxymeris*). The area proposed for marsh expansion is lower value unvegetated intertidal sand and mud flat. Existing terrestrial vegetation communities on site include a mix of riparian trees and shrubs along with deciduous or mixed woodland forests farther from shore.

The south arm of the Fraser River provides habitat for a variety of resident and migratory fish species across all life stages, including but not limited to salmonids (Chinook, chum, coho (*Oncorhynchus kisutch*), pink (*Oncorhynchus gorbuscha*), and sockeye salmon (*Oncorhynchus nerka*), and cutthroat (*Oncorhynchus clarkii*) and rainbow/steelhead trout (*Oncorhynchus mykiss*)), forage fish (e.g., eulachon (*Thaleichthys pacificus*), surf smelt (*Hypomesus pretiosus*)), flatfish (e.g., starry flounder), white sturgeon (*Acipenser transmontanus*), carp, stickleback, prickly sculpin (*Cottus asper*), and brown bullhead (*Ameiurus nebulosus*).

3.4.4. Description of the benefit of the proposed offset to fish

This enhancement project will benefit species of cultural importance and priority to Indigenous groups (in particular Pacific salmon species like Chinook and chum). The project is located in an area representing an important stopping point for estuarine-rearing juvenile salmon (i.e., Chinook and chum) as they acclimatize to increasing salinity while out-migrating from the Fraser River to the marine environment. In this context, and as recently highlighted by Musqueam, in conjunction with other proposed or implemented habitat enhancements in the area (e.g., the port authority's proposed Finn Slough Enhancement Project and Glenrose Tidal Marsh Project, respectively), the Tilbury Island Peninsula Enhancement Project will help restore an important link in the juvenile salmon rearing network in this area of the Fraser River. Musqueam also noted that the project will increase the benefits of existing and future restoration projects in the network of connected sites Musqueam is advancing.

Increasing marsh habitat in the area is expected to result in a variety of ecological functions and benefits such as improving the condition of juvenile salmon prior to out-migrating and entering the marine environment; increasing juvenile salmon feeding, rearing, and refuge habitat; facilitating salinity acclimatization of migratory fish; supplying

[5] Coastal squeeze can be defined as intertidal habitat loss that arises due to the high-water mark being fixed by a defence and the low water mark migrating landwards in response to sea-level rise.

nutrients, prey, and detritus; and providing improved habitat for a range of other wildlife species (e.g., raptors, waterfowl, great blue heron).

Appendix IR2020-1.1-C provides more details on the wide-ranging ecosystem and species/group benefits of intertidal marsh habitats.

3.4.5. Assessment of technical feasibility

Key physical processes influencing the proposed site include the morphology of the Fraser River, the sediment balance in the river and existing mud flat area, water levels affected by Fraser River discharge and the tidal cycle, and waves caused by vessel use of the Fraser River. The project has been subject to preliminary assessment in the context of these processes by a professional engineer and is considered to be technically feasible and suitable for the physical setting (Northwest Hydraulic Consultants 2021a).

The Fraser Basin Council's two-dimensional HECRAS-2D numerical model (Northwest Hydraulic Consultants 2019) was used to assess the hydraulic conditions at the site, and an analytic study was undertaken to assess the potential erosive impacts of vessel waves. The site is tidally influenced and experiences water level fluctuations up to 3 m during winter flow conditions and 2 m during moderate freshet conditions. Peak freshet and winter velocities are approximately 0.2 m/s (Figures 3.7 and 3.10; Northwest Hydraulic Consultants 2021a). Vessel wake in the project area is predicted to be up to 0.43 m.

The following factors make the site suitable for the proposed project:

- Relatively straightforward access for construction and monitoring
- Protection from the main South Arm channel—reducing the influence of high currents or direct vessel-generated waves
- The area is subject to natural sediment accretion and the addition of an elevated intertidal marsh area would enhance this characteristic, providing protection against sea-level rise
- The potential to develop off-channel habitat within the peninsula itself creates increased and synergistic value in the area
- There is easy public access to the site, which lends itself to the implementation of interpretive signage to help educate about the importance of intertidal marsh habitat and the fish and wildlife species it benefits

Based on the above aspects, including input from Indigenous groups, as well as the similarities between this project and the successful Glenrose Downstream component of the port authority's Glenrose Tidal Marsh Project (located a short distance upstream near the Alex Fraser Bridge (VFPA 2020b)), this site provides an excellent opportunity to construct high-quality intertidal marsh habitat to benefit fish (especially juvenile salmon) and wildlife in the South Arm of the Fraser River. Musqueam has noted that the long-term intent of the project is to re-establish habitat in a natural location and state to be productive for salmonids, especially juveniles on their out-migration—an important part of Musqueam's vision for stewardship of the area. The Tilbury Island Peninsula Enhancement Project will help accomplish this by enhancing shoreline stabilization and nutrient supply as well as providing structural habitat used for shelter and foraging by invertebrates, fish, and wildlife. TFN has also noted great interest in the project area, as it lies within the Tsawwassen Territory and the Tsawwassen Fishing Area as established by the TFN Treaty. TFN has expressed support for the Tilbury Island Peninsula Enhancement Project, particularly in light of the existing and proposed industrial developments on Tilbury Island and ongoing concerns that those developments may act cumulatively with other projects in the lower Fraser River to adversely affect the fish, wildlife, and their habitats enduring in the area.

As part of the collaborative work with Musqueam and TFN on this joint priority project, further archaeological work is planned for fall 2021. The assessment will be led by Musqueam and TFN. Should the project advance to construction, the port authority will continue to work with Indigenous groups to plan and implement measures to protect archaeological values.

3.4.6. Land tenure, access, and interactions with other land uses

The project is located on Provincial Crown land. A land tenure application was submitted to FLNRORD and is under review (submitted early 2021; see **Appendix IR2020-1.1-D**). Ongoing discussions are taking place with the City of Delta, and the habitat enhancement is expected to align well with the existing and anticipated future land use in the area.

The site is accessible from the south arm of the Fraser River via the end of the peninsula. Temporary berthing facilities could be developed to allow delivery of equipment and material. Ground access would also be possible via Huston Road or Berg Road and the City of Delta's dyke, on Tilbury Island itself, and this is how the site is proposed to be accessed for long-term monitoring purposes.

Musqueam has identified this enhancement project and their collaboration with the port authority in its development as an important component of their stewardship vision.

3.5. **Finn Slough Enhancement Project**

3.5.1. Physical description of offset

This proposed project was identified as a potential opportunity for inclusion in the offsetting plan by Musqueam and T'suubaa-asatx First Nation. It was brought forward as a Musqueam priority project. Musqueam has noted that the project is *"an important part of Musqueam's vision for stewardship of the area [is] to rehabilitate the slough. The long-term intent of the project is to re-establish habitat in its natural location and state to be productive for salmonids, especially juveniles on their egress. This will be accomplished by enhancing shoreline stabilization and nutrient supply as well as providing structural habitat used for shelter and foraging by invertebrates, fish and wildlife"* (personal communication, Councillor Morgan Guerin, Musqueam, 2020). This project is being proposed as part of the additional 50+ ha of conventional offsetting habitat currently being advanced.

The proposed Finn Slough Enhancement Project is located near the junction of Dyke Road and No. 4 Road on the south shore of Richmond, B.C., in the south arm of the Fraser River (**Figure IR2020-1.1-1**). Finn Slough is a mud-bottomed backwater channel between so-called Gilmour (also known as Tiffin) Island and Dyke Road. The slough is tidally connected to the Fraser River on the west (downstream) side of Gilmour Island. The project would enhance an area of approximately 0.5 ha to 1.0 ha through the creation of intertidal habitat—specifically through natural expansion of the existing brackish marsh through removal of accumulated logs, and improving fish habitat provision, access, and tidal circulation by improving the upstream connection of Finn Slough with the south arm of the Fraser River.

3.5.2. Preliminary designs and specifications

The proposed project has two components leading to the identification and prioritization of the project by Musqueam and T'suubaa-asatx First Nation. Firstly, the removal of excess accumulated rafted logs (including saw-cut material) that are currently preventing brackish marsh vegetation growth in two key areas where this accumulation is most concentrated and preventing re-accumulation. Secondly, the project would also involve reconnecting the back channel at the upstream end of Finn Slough, which is currently poorly-defined and grown in (as a result of sediment accumulation and vegetation growth), with the Fraser River—to expand intertidal estuarine habitat, improve fish access, and enhance tidal circulation and water quality.

Logs would be selectively and sensitively removed from the area of the Finn Slough inlet and the upstream section of the Gilmour Island shoreline, and in the downstream section of the Gilmour Island shoreline (Figures 2-3 to 2-5 and Appendix A – Project Drawings; Moffatt and Nichol 2021). This measure aligns with expressed Indigenous group preferences relating to the selective removal of logs and piles as part of RBT2 offsetting projects where opportunities exist. DFO is also supportive of this measure, although they have indicated during engagement that any such log removal would need to provide self-sustaining fish habitat benefits and, therefore, be associated with either a mechanism to prevent re-accumulation or analysis demonstrating that re-accumulation is unlikely. As logs would likely re-accumulate in these areas over time in the absence of a preventative

mechanism, a variety of shear booms and deflectors were considered during the preliminary design phase for the two key log removal areas described above.

The four types of boom or deflector considered were pile dyke, debris screen, floating pile (i.e., log boom), and poly-pipe (described in detail in Moffatt and Nichol 2021). The different approaches are associated with tradeoffs between factors such as robustness, effectiveness, potential to restrict fish passage, adaptability to climate change-induced sea-level rise, construction disturbance, and visual impact. Pile dyke and debris screen were discounted due to visual impact and construction disturbance, and potential to restrict fish passage, respectively, leaving the floating pile or poly-pipe approaches as feasible options. Floating pile structures are more common but are considered less robust and effective than the less common poly-pipe structure. Although poly-pipe structures may be considered less aesthetically pleasing than other options, such as floating pile structures, two sections of poly-pipe boom are currently proposed for this enhancement project (at the upstream and downstream ends of Gilmour Island) due to their expected higher performance (Moffatt and Nichol 2021). The port authority, however, welcomes input from Indigenous groups and DFO on this approach, which will be subject to further consideration as the project design work continues.

The poly-pipe shear booms would be located outside of the navigation channel with orientations parallel to river flow. These shear booms would involve the installation of approximately 100 piles (24 inch; 610 mm diameter) with a combined aquatic footprint of approximately 29 m^2. The small footprint of the piles is not expected to alter hydrodynamics nor sediment transport in the area. Standard best management practices would be expected to appropriately reduce potential effects of pile installation on underwater noise (verified through monitoring), which would also be expected to be relatively low in this shallow water location close to the shoreline, in part due to attenuation by the riverbed and banks.

3.5.3. Characterization of current habitat characteristics and function

A variety of information sources were consulted during desktop studies (i.e., municipal, provincial, and federal databases and mapping tools, as well as scientific and unpublished literature). In addition to desktop studies, boat-based site reconnaissance was conducted in August 2020 and a drone survey to collect aerial imagery and preliminary topographic information was conducted in September 2020. Site visits were undertaken by Musqueam and T'suubaa-asatx First Nation prior to the COVID-19 pandemic, resulting in the identification of the site for the RBT2 offsetting plan and the sharing of information with the port authority regarding the use of the site by fish and wildlife and the potential benefits of enhancement. Musqueam conducted an additional collaborative site visit with port authority technical staff and Finn Slough residents in February 2021. Opportunities for Indigenous participation in additional work will be provided; however, due to COVID-19 restrictions, video footage will continue to be made available to Indigenous groups for input and documentation.

As described in **Section 3.4.3**, the south arm of the Fraser River provides habitat for a variety of resident and migratory fish species across all life stages.

Of these, higher value fish species/groups/life stages such as juvenile chum and Chinook salmon, flatfish, and cutthroat trout are likely to be using the existing Finn Slough channel. Like cutthroat trout, other listed fish species likely to occur at the site are considered to either benefit from or be unaffected by the proposed enhancement.

Based on the drone survey, existing marsh elevation ranges from approximately 1.0 m GD to 2.0 m GD. Based on observations made during the boat-based site reconnaissance and project team's experience of nearby brackish marsh sites, the existing marsh community amongst the accumulated logs along the foreshore of Gilmour Island is expected to be dominated by Baltic rush, Lyngbye's sedge, common cattail, softstem bulrush, and spikerush.

3.5.4. Description of the benefit of the proposed offset to fish

This enhancement project would involve removing excess logs, installing shear booms to prevent log re-accumulation, establishing brackish marshes, and reconnecting the back channel at the upstream end of Finn Slough with the Fraser River.

The removal of accumulations of historically-deposited anthropogenic logs (i.e., saw-cut logs from the forestry sector) will increase the fisheries productivity of existing intertidal marsh habitat, by reversing vegetation smothering and soil compaction, reducing the risk of chemical leaching from creosote-treated logs (if present), preventing the clogging of tidal channels, and improving light penetration to and oxygenation of underlying soils. Input from Indigenous groups to date indicates support for measures to address log accumulation and chemical leaching. Specifically, TFN, Musqueam, Semiahmoo First Nation, Malahat Nation, and T'suubaa-asatx First Nation have provided comments on this topic.

In combination, the proposed activities will benefit species of cultural importance and priority to Indigenous groups, in particular all Pacific salmon species and populations, especially juvenile Chinook and chum salmon, as they migrate through the Fraser River. Other species/groups that could benefit from project activities include cutthroat trout, flatfish, raptors, waterfowl, and great blue heron.

Re-established marsh habitat would improve shoreline stabilization and nutrient supply, as well as provide structural habitat for shelter and foraging by invertebrates, fish and wildlife.

Appendix IR2020-1.1-C provides more details on the wide-ranging ecosystem and species/group benefits of intertidal marsh habitats.

3.5.5. Assessment of technical feasibility

Substantive investigative and design work has been completed by professional engineers and biologists with significant experience in this region. This work includes physical process assessment and engineering design to confirm site/setting suitability, self-sustainability, and performance confidence (Moffatt and Nichol 2021).

The Finn Slough Enhancement Project site is relatively sheltered from wind-generated waves. Vessel-generated wave height is estimated to be approximately 0.6 m, resulting in limited shoreline erosion (Moffatt and Nichol 2021). The rock revetment along the length of Gilmour Island provides existing wave protection. The maximum depth-averaged ebb current speed at the site during Fraser River peak flow is estimated to be approximately 1.0 m/s (Moffatt and Nichol 2021), which is considered acceptable with regards to the proposed enhancement. Preliminary design work indicates that the proposed project is suitable for the physical setting, will be self-sustaining (with the inclusion of the proposed shear booms), and is not expected to negatively affect surrounding areas.

Desktop preliminary archaeological evaluations have been completed. Musqueam has noted the importance of further assessment in this area and, as this is a Musqueam priority project, will be leading additional archaeological work planned for fall 2021. Should the project advance to construction, the port authority will continue to work with Indigenous groups to plan and implement measures to protect archaeological values.

3.5.6. Land tenure, access and interactions with other land uses

The project is located on Provincial Crown land. A land tenure application was submitted to FLNRORD and is under review (submitted early 2021; see **Appendix IR2020-1.1-D**). Ongoing discussions are taking place with the City of Richmond to advance synergies between the project and potential future municipal flood defense work in the same area.

Site ingress/egress for construction personnel, materials and equipment for log removal and channel reconnection, collection of materials for offsite disposal, as well as for long-term monitoring would be land-based via No. 4 Road and Dyke Road. Shear boom installation would be conducted from the Fraser River.

3.6. Semiahmoo Bay-Little Campbell River Enhancement Project

> *"It is important to know that SEMIAHMA are saltwater people, our home is now here at Semiahmoo Bay and at the mouth of the TAT-A-LU. Our connection to our lands and waters and to the resources are an important aspect of our life. As stewards of the land, air and waters we want to ensure this habitat is remediated and monitored with our involvement in every way"*
>
> – Councillor Joanne Charles, Semiahmoo First Nation, 2020

3.6.1. Physical description of offset

Semiahmoo First Nation identified this enhancement project to align with identified priority fish species and habitats, and investigative and design work has been and will continue to be undertaken in partnership with the nation. The Semiahmoo Bay-Little Campbell River Enhancement Project is located in and around the Semiahmoo First Nation Reserve in Surrey, B.C.—just over one kilometre north of the Canada-U.S. border (**Figure IR2020-1.1-1**). Semiahmoo Bay is located south of the City of White Rock and the Little Campbell River flows into the north-eastern region of Semiahmoo Bay. This project was not proposed as offsetting habitat in the RBT2 EIS but is being proposed now as part of the additional 50+ ha of conventional offsetting habitat currently being advanced.

The primary objective of this proposed offsetting project is to enhance habitat in a way that contributes to offsetting the residual effects of the RBT2 Project on fish and fish habitat in alignment with information on the values, priorities, and preferences shared by Semiahmoo First Nation. Semiahmoo First Nation notes the tide cycle that comes in and out of the river twice a day and their hope to be able to increase fish habitat along the shoreline that is now filled with sediment resulting from upstream urbanization.

Various intertidal habitat enhancement and restoration opportunities (approximately 1 ha to 3 ha in total) are being advanced near the mouth of the Little Campbell River to benefit fish and wildlife—including the removal of derelict wood structures (e.g., piles), and construction of marsh bench tidal channels, large-woody debris complexes, tidal salt marsh habitat, and forage fish spawning habitat. These opportunities are as follows (Appendix A of Northwest Hydraulic Consultants 2021b):

1. Large woody debris complexing
2. Pile and derelict wood removal
3. Inter-island channel and salt marsh
4. East salt marsh
5. East river bank protection
6. Sediment lobe removal
7. Western foreshore enhancement
8. Eastern foreshore enhancement

In addition to contributing to offsetting the residual effects of the RBT2 Project on fish and fish habitat, and providing general benefits to fish and other wildlife, this work is expected to provide the following important cultural and community benefits to Semiahmoo First Nation:

- Removing some of the remnants of historical industrial activities in the area
- Enhancing Indigenous fisheries
- Improving traditional access between the Semiahmoo First Nation Reserve and Semiahmoo Bay
- Reducing flooding and erosion risk (e.g., to the main community access road)
- Increasing food security (important from both cultural and community health perspectives)

3.6.2. Preliminary designs and specifications

The preliminary designs and specifications relating to the habitat enhancement and restoration opportunities being advanced are as follows (Appendix A of Northwest Hydraulic Consultants 2021b):

1. Large woody debris complexing
    - Large woody debris complexes will consist of a matrix of logs with intact root-wads attached, anchored to the outer edge of the river channel
    - Logs of between 5.0 m and 8.0 m in length, and 0.5 m to 0.9 m in diameter are proposed
    - Western red cedar (*Thuja plicata*) is the recommended wood species due to its relatively long design life, with hemlock (*Tsuga heterophylla*) or Douglas fir (*Pseudotsuga menziesii*) as the next best alternatives
    - Logs will be attached to several large-diameter ballast rocks by cables that will run through the logs
    - Large woody debris complexes will be arranged such that root-wads are closest to the river channel side to promote pool formation and maximize the provision of fish cover, and to provide void spaces to create additional fish cover
    - The source of this material has not been determined. Semiahmoo knowledge and input is actively informing the development of plans, including selection and sourcing of materials.
2. Pile and derelict wood removal
    - Derelict pile and wood is currently proposed to be removed using hand tools
    - The precise location and quantity of materials to be removed will be determined in the detailed design phase in collaboration with Semiahmoo First Nation
    - Material testing will be conducted prior to removal to determine suitable measures for disposal
    - Special consideration will be made for wood that currently serves to retain shoreline materials, to protect against shoreline erosion or reduced river bank stability, and it may be deemed beneficial to retain some piles to provide raptor perches
3. Inter-island channel and salt marsh
    - Suitable soils may include dredged material or imported soil from an upland source, including onsite soil
    - To capture the full tidal range for growth of salt marsh vegetation in the area, and allow for some settlement, marsh habitat benches are proposed to be constructed between 0.6 m and the present day Higher High Water Large Tide of 1.8 m GD
    - Marsh soil will be gently sloping to ensure adequate drainage at low water
    - Marsh channel banks will be faced with small rock to retain marsh and provide erosion protection
    - Marsh vegetation is proposed to be planted at 0.5 m spacing
    - The proposed marsh planting list includes Lyngbye's sedge, plantain (*Plantago maritima*), Pacific silverweed (*Argentina pacifica*), pickleweed, gumweed (*Grindelia* sp.), arrowgrass, and Douglas' aster (*Symphyotrichum subspicatum*)
    - The port authority will continue to engage with Semiahmoo First Nation on the incorporation of culturally-important vegetation species
4. East salt marsh
    - The marsh construction details above will apply

5. East river bank protection
    - The existing slope will be regraded prior to placement of rock filter and armour layers, including larger rock on the seaward edge to protect against wave-induced erosion
    - Special consideration has been, and will continue to be, given to potential project interactions with the Burlington Northern and Santa Fe Railway (BNSF) infrastructure in the vicinity (interactions are expected to be neutral or potentially beneficial; e.g., in relation to reducing scour and sediment accretion in certain locations in the vicinity of the rail bridge, and improving overall flow conveyance in that area)
6. Sediment lobe removal
    - The design assumes a removal of approximately 1,740 m^2 of mixed sand and gravel material that is accumulating at the mouth of the Little Campbell River due to longshore drift
    - There is an opportunity to expand the excavation footprint to include material seaward of the rail bridge to potentially further facilitate traditional access between the Little Campbell River estuary and Semiahmoo Bay
7. Western foreshore enhancement
    - Subject to testing, material removed from the sediment lobe is proposed to be beneficially re-used and supplemented with sand to nourish foreshore areas in conjunction with control structure (rock groyne) placement to improve forage fish spawning potential (i.e., for surf smelt and sand lance)
8. Eastern foreshore enhancement
    - The western foreshore enhancement construction details above will apply

3.6.3. Characterization of current habitat characteristics and function

A variety of online resources were consulted during desktop studies (i.e., municipal, provincial, and federal databases and mapping tools, as well as scientific and unpublished literature). The Little Campbell River drains an area of 74 km^2, flows at an average monthly rate of 0.9 m/s^3, and discharges into Semiahmoo Bay. Current habitat function of the area in and around the mouth of the Little Campbell River is influenced by historic anthropogenic changes brought about through railway and mill construction and operation. Existing plant communities on site include a mix of intertidal and riparian salt and freshwater marsh and meadow near the water's edge, and riparian shrubs, and deciduous woodland forests farther from shore (FREMP n.d.).

A salmon and trout hatchery is located approximately eight kilometres upstream of the project location. In a typical year, the hatchery produces 10,000 steelhead, 35,000 Chinook salmon, 100,000 coho salmon, and 15,000 cutthroat trout; over 3,500 spawning salmon return to the Little Campbell River annually (Semiahmoo Fish and Game Club 2020). Around 1,000 to 2,000 of returning fish are coho salmon, although records suggest that runs once surpassed 10,000 (Warren 1978).

Little Campbell River and the surrounding ocean provide important aquatic habitat for a variety of resident and migratory fish species across all life stages, including but not limited to salmonids (Chinook, chum, coho, pink, and sockeye salmon, cutthroat trout, rainbow trout/steelhead), forage fish (e.g., eulachon, surf smelt, herring), flatfish (e.g., starry flounder), rockfish, lingcod, carp, stickleback, and prickly sculpin.

Listed fish species likely to occur at the site (e.g., cutthroat trout) are considered to either be unaffected by, or to benefit from, the proposed enhancement.

In addition to desktop studies, a number of field studies have been conducted in collaboration with Semiahmoo First Nation to characterize the existing and high-value vegetated habitats at the site, which some of the proposed offsetting components seek to expand or increase, and gain an understanding of Semiahmoo First Nation's preferences for habitat enhancement and their Indigenous use of the area. Existing vegetated habitat in the area includes the following:

- Salt marsh fringing the existing mud channel on the left bank of the Little Campbell River mouth—dominated by pickleweed and dune grass
- Intertidal marsh farther upstream near the secondary Little Campbell River channel—dominated by Baltic rush
- Green filamentous algae in the intertidal area of the mainstem upstream of the secondary channel
- Intertidal marsh benches between the secondary channel and the 8th Avenue pedestrian bridge—dominated by Lyngbye's sedge
- A patch of sea lettuce on the foreshore west of the Little Campbell River mouth

Existing conditions underlying proposed offsetting components range from terrestrial habitat to low-productivity unvegetated tidal mud flat habitat.

With regards to physical conditions at the project site, dominant longshore morphological processes have resulted in the formation of a sediment lobe that extends under the railway bridge on the west side of the river mouth (Northwest Hydraulic Consultants 2020).

3.6.4. Description of the benefit of the proposed offset to fish

Through the collaborative work being undertaken with Semiahmoo First Nation, the following key benefits of the proposed project have been identified:

- Intertidal habitat enhancement in this area would benefit juvenile salmon, forage fish, and other fish species that use estuarine habitats and are of cultural importance and priority to Indigenous groups (in particular Pacific salmon species like Chinook and chum). Additional fish and wildlife species that are expected to benefit from project activities include surf smelt, sand lance, shiner perch, bivalves (e.g., clams and mussels), western sandpiper (*Calidris mauri*), and great blue heron.
- The benefits of large woody debris complexing include increased geomorphological and habitat complexity to provide additional cover and holding areas for migratory fish. The benefits of derelict wood removal include improving the visual landscape and reducing the potential for chemical leaching into aquatic habitats.
- Salt marsh habitat development and deeper more consolidated tidal channels would improve drainage, help stabilize the areas, and increase the quality and quantity of available fish habitat across a wider tidal range. **Appendix IR2020-1.1-C** provides more details on the wide-ranging ecosystem and species/group benefits of intertidal marsh habitat.
- The removal of accumulated sediment at the mouth of the Little Campbell River would directly increase the availability of aquatic habitat in that area. Groyne placement and beach nourishment as part of the western and eastern foreshore enhancements would reduce the risk of problem sediment re-accumulation at the mouth of the Little Campbell River, and instead increase the availability of, and encourage the future deposition of, forage fish spawning sediment at appropriate locations on the Semiahmoo Bay foreshore. The area adjacent to the mouth of the Little Campbell River has previously been identified as having good potential for forage fish spawning habitat enhancement (de Graaf 2006/2007).

3.6.5. Assessment of technical feasibility

Substantial investigative work has been completed by a dedicated team of technical experts. This work includes physical process assessment and engineering design to confirm site/setting suitability, self-sustainability, and performance confidence (Northwest Hydraulic Consultants 2021b).

Preliminary design work, including analysis of river discharge, wave characteristics, and tidal and wave-driven currents indicates that the proposed project is suitable for the physical setting, will be self-sustaining, and is not expected to negatively affect surrounding areas. The synergies resulting from some of the components of this

project (e.g., the east river bank protection and sediment lobe removal, or the sediment lobe removal and the western foreshore enhancement), as well as the inherent self-sustaining nature of some of the habitat types (e.g., intertidal marsh) further serve to increase the self-sustainability of the project.

Desktop preliminary archaeological evaluations have been completed. Ensuring appropriate archaeological work and protocols are undertaken is a key priority for Semiahmoo First Nation. Further archaeological work will be undertaken in collaboration with Semiahmoo First Nation prior to construction, as required. Should the project advance to construction, the port authority will continue to work with Indigenous groups to plan and implement measures to protect archaeological values.

3.6.6. Land tenure, access and interactions with other land uses

This site is partially located on the reserve lands of Semiahmoo First Nation (Federal Crown land) and partially on Provincial Crown land. Processes are underway to obtain the appropriate approvals (i.e., license) to undertake work on Semiahmoo First Nation reserve lands and the port authority is working closely with Semiahmoo First Nation in that regard. A land tenure application was submitted to FLNRORD and is under review (submitted early 2021; see **Appendix IR2020-1.1-D**).

Engagement with the rail operator (BNSF) is underway to discuss the potential for proposed enhancement works to interact with their infrastructure and operations (which is considered to be low), as well as to plan for construction access.

The port authority will continue to work closely and collaboratively with Semiahmoo First Nation to advance the design and consider construction methods, staging, sequencing, and access.

At this time, it is anticipated that access and egress for construction materials, equipment, and personnel, as well as for long-term monitoring, would be via 8th Avenue and Beach Road.

4. Habitat bank projects

Current DFO offsetting policy describes a fish habitat bank as a “formalized approach for a proponent to create measures to offset, for their own use, in advance of the adverse effects on fish and fish habitat resulting from the carrying on of proposed works, undertaking or activities in order to counterbalance those adverse effects". The *Fisheries Act* defines a fish habitat bank as “an area of a fish habitat that has been restored, enhanced or created by the carrying on of one or more conservation projects within a service area and in respect of which area the Minister has certified any habitat credit”.

DFO offsetting policy provides the following additional details on fish habitat banking:

> *“The benefits accumulated in the fish habitat bank are counted as credits, while death of fish or harmful alteration, disruption or destruction resulting from the proponent’s works, undertakings or activities are considered debits. The proponent that has established the fish habitat bank may withdraw certified habitat credits from the fish habitat bank to offset the death of fish or harmful alteration, disruption or destruction of fish habitat resulting from the carrying on of their works, undertakings or activities within the service area. When the balance of habitat credit in the habitat bank reaches zero, the bank is closed and no more “withdrawals” can be made.”*

As described in DFO’s offsetting policy, one of the benefits of habitat banking is that the bank is established in advance of the adverse effects taking place. Consequently, there is less uncertainty related to the effectiveness of the measures to offset or the time required for the measures to offset to become functional.

In alignment with DFO’s offsetting policy, which now prioritizes the use of habitat bank credits, the following sites from the port authority’s habitat bank (**Figure IR2020-1.1-3**) have been selected based on current functionality,

geographic relevance, habitat type, and species benefited (i.e., Chinook salmon), and in some cases Indigenous group support, as previously proposed (CIAR Document #2001[6], commitments #40 and 41):

- Salt Marsh Restoration Projects (five sites at Roberts Bank and Boundary Bay): ~6.3 ha – sites were enhanced by removing accumulated logs and woody debris that was suppressing salt marsh growth
- Glenrose Tidal Marsh Project (three sites in the south arm of the Fraser River): ~1.1 ha – habitat enhancement through construction of freshwater intertidal marsh
- Gladstone Park Tidal Marsh Project: ~0.3 ha – habitat enhancement through construction of brackish intertidal marsh
- Riverfront Park Tidal Marsh Project: ~0.1 ha – habitat enhancement through construction of brackish intertidal marsh
- Timberland Basin Habitat Project: ~0.4 ha – habitat enhancement through construction of freshwater intertidal marsh

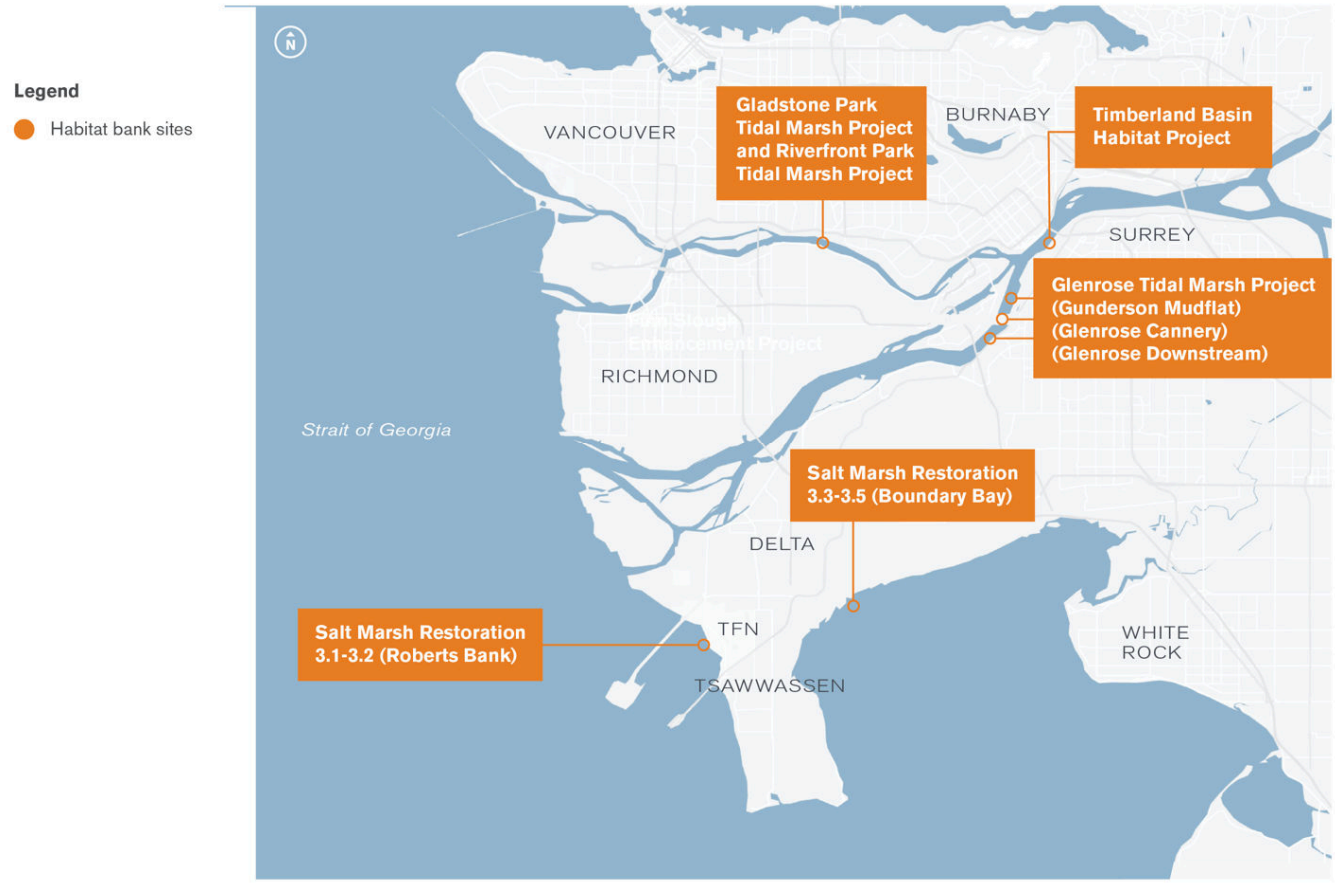
These habitat bank sites are considered to be well-established and functional, with at least five to seven years of post-construction performance monitoring. They provide key benefits to fish and wildlife, especially to estuarine-rearing juvenile salmon through the provision of feeding, rearing, refuge, and salinity acclimatization opportunities, and detrital food web support. The Gladstone, Riverfront, and Timberland projects were constructed in the 1990s and have been stable and functioning since that period. Detailed monitoring reports pertaining to the more recently implemented Salt Marsh Restoration Projects and Glenrose Tidal Marsh Project are also provided to DFO on an annual basis for all projects currently administered under the port authority's habitat bank (including all projects listed above). This is a requirement of the port authority's habitat banking arrangement with DFO (VFPA 2020b). The withdrawal of credits associated with these habitat bank projects was not proposed as offsetting habitat in the RBT2 EIS but is being proposed now as part of the additional 50+ ha of conventional offsetting habitat currently being advanced.

Much of the requested information outlined in the minister's request does not apply to the habitat bank sites (e.g., preliminary designs and specifications, assessment of technical feasibility, land tenure/access considerations) as they are already built and functioning as fish habitat. As these habitats are already built and functional, they are not associated with DFO offsetting policy considerations such as uncertainty and time lag. These sites can be reached through a combination of land vehicle and foot access.

The port authority understands that confirmatory assessments of those habitat bank sites proposed for credit withdrawal in the RBT2 FAA application will be coordinated with DFO during the application review stage, to confirm final habitat credits.

[6] CIAR Document #2001 From the Vancouver Fraser Port Authority to the Review Panel re: Updated Project Commitments (See Reference Documents #1738 and #1934). https://iaac-aeic.gc.ca/050/documents/p80054/130776E.pdf

Figure IR2020-1.1-3: Locations of habitat bank projects proposed for RBT2 offsetting



5. Other available offsetting opportunities

Other available offsetting opportunities have been identified, including the following. Additional offsetting opportunities that are being considered as potential contingency projects are described in **Section 6**.

5.1. Tsawwassen Marshlands Project

The port authority and TFN are working collaboratively on the RBT2 offsetting plan. This collaboration is guided by TFN's Offsetting Vision[7] which expresses the importance of reflecting TFN perspectives and traditional knowledge in offsetting planning. It addresses both the physical needs of the environment as well as TFN members' access to and use of lands, waters, and resources consistent with their Treaty rights and in a way that benefits the holistic health and well-being of the TFN community.

Through this collaboration, TFN recently proposed an RBT2 offsetting opportunity—the Tsawwassen Marshlands Project. The Project comprises several interrelated components that align with TFN's Offsetting Vision in and near marshlands located along the foreshore of the TFN community. The port authority is committed to exploring, planning, and advancing the Tsawwassen Marshlands Project in collaboration with TFN.

[7] The TFN Offsetting Vision is intended to guide Proponents' approaches to developing and implementing offsetting plans where required to mitigate project effects. It was developed in consultation with TFN members.

Components of the Tsawwassen Marshlands Project could include opportunities to:

- Increase fish habitat value and utilization by enhancing tidal channel habitat in the southern reaches of the marshlands. This entails channel modification and/or large woody debris placement—an opportunity that is anticipated to be included in the RBT2 *Fisheries Act* authorization offsetting plan.
- Expand the marshlands seaward of the outer dyke fronting the TFN community to restore the historical extent of that marsh and seek to provide a range of additional ecological and/or TFN community benefits, which may include clam gardens, improvements to TFN community shoreline access (e.g., enhanced canoe access), and potential synergies with future TFN flood mitigation and management planning in the area. This opportunity is being considered as a potential future contingency project (see **Section 6.1.2** for more details).
- Enhance tidal channels in the northern reaches of the marshlands and their connectivity to marine waters with a view to improving juvenile salmon habitat[8] (see **Section 6.1.2** for more details).
- Remove large woody debris (driftwood) from areas where accumulations of such are hindering the establishment and growth of marsh plants that provide fish and wildlife habitat[8] (see **Section 6.1.2** for more details).

5.2. Complementary measure

Fisheries Act policy provides for use of complementary measures for up to 10% of a project's offsetting requirements. Complementary measures entail data collection and scientific research related to maintaining or enhancing the conservation and protection of fish and fish habitat. Subject to additional engagement and consultation with DFO and Indigenous groups, a potential complementary measure has been identified and is described below. Consistent with DFO policy and precedent, complementary measures proposed in the RBT2 FAA application would be conducted after issuance of the RBT2 FAA; however, additional detail, including relating to alignment with DFO offsetting policy, would be provided in the RBT2 FAA application in the event that a complementary measure is advanced, including the following information:

- Rationale for complementary measure use in the context of DFO offsetting policy
- Complementary measure objectives
- Identification of the principal investigator and research team
- Financial costs and associated credit calculations
- Detailed complementary measure work plan and schedule
- Plan to document and disseminate results and outcomes (with the intent to make information publicly available, and the target of publication in a reputable journal)

TFN has identified a need to investigate the causes of local marsh recession; the port authority intends to work collaboratively with TFN to further evaluate this complementary measure concept, and additional effort is required to evaluate feasibility and establish potential terms of reference.

5.3. Non-Conventional Offsetting Program

The Non-Conventional Offsetting Program (NCOP) is proposed as an innovative and enduring regional program to be advanced in conjunction with the RBT2 Project. The intent of the NCOP would be to deliver projects that benefit fish and fish habitat, with a particular focus on projects that deliver the best conservation and enhancement outcomes for priority species and habitats, by addressing limiting factors, bottlenecks, and emerging needs. The port authority will continue to develop the NCOP as part of the offsetting plan, as per DFO's

[8] This opportunity has been identified by TFN. Further advancement of this opportunity is subject to focused work proposed in collaboration with TFN to further evaluate feasibility in the context of a range of factors, including effectiveness, site suitability, self-sustainability, and potential implications for surrounding areas.

input, and by design would be 'non-conventional' in nature and related projects may or may not be habitat focused. The NCOP could also play an important role in the assessment of, and identification of actions to help address, regional cumulative effects to fish and fish habitat. There are a number of pressures in the Fraser River estuary and part of the establishment of the NCOP could involve assessing those and identifying future targeted non-conventional offsetting project opportunities.

The port authority is exploring the NCOP with DFO and Indigenous groups. Support for the program has been expressed by multiple Indigenous groups and representative bodies. Elements required to establish the NCOP, include the following:

- Development of a governance model
- Establishment of equivalency formulae
- Technical studies to demonstrate how, and to what degree, potential non-conventional offsetting projects could benefit fish and fish habitat. These could include the following:
    - Determination of limiting factors
    - Assessment of emerging issues, pressures and priorities
    - Identification of suitable non-conventional offsetting project options

Advancement of these elements will help to fill significant knowledge gaps regarding fish and fish habitat conservation and protection such that fisheries management objectives, local restoration priorities, and fish species and habitats of cultural importance and priority to Indigenous groups may be established, and to provide benefits that are in addition to any existing research or data collection programs.

Examples of the types of offsetting project that could be delivered through the NCOP are described in **Section 6.2**.

5.4. Indigenous group projects and initiatives

The port authority will continue to work with Indigenous groups in relation to RBT2 FAA submission to explore other potential opportunities and initiatives, both in the context of current offsetting plan projects and new opportunities, with a focus on some of the relatively few fish species and groups for which the current proposed RBT2 offsetting plan would not result in a net productivity gain (e.g., bivalves and herring).

6. Potential contingency measures and projects

Long-term performance monitoring will be undertaken to assess offsetting habitat effectiveness. In the unlikely event that any of the habitat developed for the offsetting plan does not function as intended, and remedial measures are unavailable or unsuccessful, potential contingency offsetting projects would be considered through consultation with DFO and Indigenous groups. Given the port authority's expertise and experience in developing successful conventional offsetting and habitat enhancement projects, potential contingency projects are not anticipated to be required. However, in response to comments received from DFO and Indigenous groups on the draft **IR2020-1.1**, the port authority is identifying several potential contingency offsetting projects (see **Table IR20201.1-1** and the descriptions below). The port authority will engage with DFO and Indigenous groups on long-term offset monitoring as well as the process associated with the consideration and use of potential contingency measures and projects (see **IR2020-1.2** Appendix IR2020-1.2-C for this proposed process). Notwithstanding this, the size and type of potential contingency project would be dependent on the nature of the requirements. These details would be confirmed in consultation with DFO and Indigenous groups.

6.1. Onsite contingency projects

The port authority has identified two potential contingency projects that are close to the proposed project (i.e., onsite, within the EIS local assessment area).

6.1.1. Additional onsite native eelgrass and/or marsh habitat north of the proposed RBT2 terminal

This potential contingency project opportunity could entail changes to or expansion of existing proposed onsite eelgrass and marsh offsetting habitat (in terms of habitat type and/or areal extent) in the context of the proposed RBT2 terminal footprint reduction. There is also an opportunity to transplant eelgrass to another location near the proposed RBT2 terminal—an unvegetated area adjacent to existing eelgrass habitat that is suitable for eelgrass establishment and growth and for which the port authority has applied for provincial land tenure. In combination, this contingency project opportunity would be associated with up to 8–12 ha of high value areal habitat gain that would increase the productivity of numerous species, including juvenile Chinook salmon and Dungeness crabs.

6.1.2. Additional onsite offsetting through Tsawwassen Marshlands Project components

Additional onsite contingency offsetting for RBT2 could be achieved through components of the proposed Tsawwassen Marshlands Project that enhance habitat values in ways that also support the TFN Offsetting Vision.

Analysis of aerial photos confirms that the leading edge of the Tsawwassen Marshlands seaward of the outer dyke has receded in most locations over the past century, reducing the amount of marsh habitat by up to ~10 ha. The hummocky nature of the outer-marsh surface, together with forecasted rise in sea-level, suggest that recession will continue unless restoration measures are taken. There is an opportunity to restore the historical extent of this marsh habitat, or sections thereof, in combination with a leading-edge protection and containment structure. The primary ecological objective would be to improve the quantity and quality of juvenile salmon habitat in the area via the proven approach of placing dredge spoils, sourced from the Fraser River annual maintenance dredge program, behind a containment structure. Native marsh species would then be planted in the new substrate created by the dredge-spoil deposits.

Additionally, and in alignment with TFN's Offsetting Vision, several other opportunities associated with the seaward marsh expansion component are being explored with TFN to further enhance TFN members' use of and access to culturally-relevant areas and resources in a way that benefits the priorities identified by TFN of holistic health and well-being of the TFN community. Several opportunities are at a conceptual stage of planning, and include:

- Enhancement of bivalve habitat and harvest opportunities by constructing clam gardens as the leading edge of a containment structure protecting the sediments that support plant growth necessary for seaward marsh expansion.
- Integration with TFN flood mitigation planning—the seaward marsh expansion opportunity could contribute to shoreline dyke protection through a phased implementation that sequentially increases proposed and/or existing marsh habitat elevation through thin-layer placement[9] to improve sea-level rise resiliency in a way that broadly aligns with the living dyke approach[10].

TFN has also identified other potential components of the Tsawwassen Marshlands Project, including removal of large woody debris (driftwood) from areas where accumulations of such are hindering the establishment and growth of marsh plants that provide fish and wildlife habitat, and enhancement of tidal channels in the northern reaches of the marshlands and their connectivity to marine waters with a view to improving juvenile salmon habitat and their access to and from it. Further advancement of these opportunities is subject to focused work proposed in collaboration with TFN to further evaluate feasibility in the context of a range of factors, including effectiveness, site suitability, self-sustainability, and potential implications for surrounding areas. TFN has noted

[9] Thin-layer placement can be described as episodic deposition of fine sediment (e.g., suitable dredged material) to a depth that vegetation can withstand or recover quickly from (~10–20 cm) for marsh nourishment and maintenance/restoration/enhancement of surface elevation in response to/anticipation of sea-level rise.
[10] The living dyke approach can be described as broadening and naturalizing dyke infrastructure (e.g., by restoring, creating, or expanding marsh habitat) to provide an ecosystem-based solution to flood defence, avoid or reduce the need for raising of existing dyke infrastructure, and reduce the extent of coastal squeeze of marsh habitat (as it is forced to retreat up to hard infrastructure in response to sea-level rise).

that it is anticipated the component relating to the enhancement of tidal channels in the northern reaches of the marshlands would benefit greatly from a breach in the terminal causeway. **IR2020-2.2** provides further information on potential breach locations along the causeway and at the terminal, along with the feasibility of such.

The seaward marsh expansion component of the Tsawwassen Marshlands Project could generate up to 5–10 ha of high-value areal habitat gain that would increase the productivity of numerous species and life stages, including juvenile Chinook salmon. Areal and/or biomass gains of the remaining offsetting opportunities will be estimated as planning advances. Depending on the location of a given component, the need for agreements with landowners (e.g., Province of BC, TFN) is an anticipated requirement of these offsetting project components.

In alignment with TFN's Offsetting Vision, the Tsawwassen Marshlands Project components will be advanced in a way that considers improvements to TFN community shoreline access to facilitate cultural practices (e.g., harvesting, transportation via canoes).

6.2. Non-Conventional Offsetting Program (NCOP) projects

As indicated earlier, the port authority will continue to develop the NCOP as part of the offsetting plan, as per input from DFO. Offsetting projects delivered through an operational (i.e., established) NCOP could be considered potential contingency projects. Projects that could be delivered through the NCOP could be designed to target various existing and emerging regional threats to fish and fish habitat, including invasive species, sea-level rise and climate change (including rising water temperatures), water quantity and quality, and natural and anthropogenic barriers to fish migration. Furthermore, the NCOP could deliver priority Indigenous species enhancement projects (e.g., relative to identified limiting factors). In addition, NCOP projects could make beneficial use of Fraser River dredged material in the context of supporting living dyke concepts—to achieve a more naturalized and ecosystem-based solution to sea-level rise and flood defense. The possibility also exists to focus potential NCOP projects on some of the relatively few fish species and groups for which the current proposed RBT2 offsetting plan would not result in a net productivity gain, like bivalves and herring (see **IR2020-1.2** for a description of these species/groups).

6.3. Offsite contingency projects

The next most technically well-developed, suitable, and available Habitat Enhancement Program projects could be considered contingency projects. The port authority's Habitat Enhancement Program maintains a list of potential enhancement projects, focused on the port authority's jurisdictional area, that are at varying stages of design development. Two notable examples of such projects are the Point Grey Tidal Marsh Project and the McDonald Tidal Marsh Project (described further below), which are considered suitable as offsite offsetting contingency and are in an advanced stage of development.

6.3.1. Point Grey Tidal Marsh Project

The proposed Point Grey Tidal Marsh Project is located along the eastern portion of the Point Grey Booming Grounds, on the north side of the Fraser River (north arm) in close proximity to the Musqueam's main community, within an area that has been occupied by Musqueam since time immemorial. The site is currently used by Musqueam members for fishing and harvesting of waterfowl and plants. The site was formerly used as a log booming storage area. Although the west end of the Point Grey Booming Grounds is still actively used for log booming by the forest industry, the eastern end of the property (where the project would be situated), has not been actively used for this purpose in several decades. Immediately east of the property, there is an established intertidal brackish marsh which this project would seek to expand.

This potential habitat enhancement project involves the placement of fill material (suitable naturally-occurring sand dredged from the Fraser River) over existing mudflat/wood waste, followed by planting, to create up to approximately 40 ha of intertidal brackish marsh habitat. The project would benefit a broad range of fish (including juvenile salmon) species and ecological functions (see Table IR2020-1.1-C1 in **Appendix IR2020-1.1-C** for more details).

Numerous supporting technical materials have been developed including detailed design drawings and reporting, coastal engineering assessment, geotechnical reporting, existing ecological conditions assessment, and archaeological reporting. A B.C. Environmental Assessment Office exemption (2016) and disposal at sea exemption (2014) have been obtained for this project.[11] It has been identified by Musqueam as one of several current priority projects in the context of Musqueam's stewardship vision.

6.3.2. McDonald Tidal Marsh Project

The proposed McDonald Tidal Marsh Project is situated on Sea Island, north of Vancouver International Airport (YVR) and upstream of the mouth of McDonald Slough along the Fraser River (north arm), in close proximity to the Musqueam's main community, within an area that has been occupied by Musqueam since time immemorial.

This project would involve the conversion of up to approximately 3 ha of historically-impacted upland and subtidal area into productive fish habitat (comprising brackish marsh, tidal channels, and riparian habitat). The site is currently characterized as a grassland habitat with some invasive plant species and sparse, scattered shrubs and trees. The shoreline is armored with riprap and provides limited foreshore habitat values. The project would benefit a broad range of fish (including juvenile salmon) species and ecological functions (see Table IR2020-1.1-C1 in **Appendix IR2020-1.1-C** for more details).

Numerous supporting technical materials have been developed including detailed design drawings and reporting, geotechnical reporting, existing ecological conditions assessment, and archaeological reporting. This project has also been identified by Musqueam as one of several priority projects in the context of Musqueam's stewardship vision[11].

7. Summary of effectiveness of past port authority offsetting projects and remedial actions taken

The port authority's mandate to protect the environment extends to preserving and enhancing the ecological health and integrity of the Fraser River estuary. As part of its Habitat Enhancement Program, the port authority currently operates the largest habitat bank in Canada and is recognized as a leader in the development of offsetting and habitat banking. The Habitat Enhancement Program works closely with Indigenous groups, regulators, environmental organizations, and local municipalities.

Habitat projects that have been constructed as part of the Habitat Enhancement Program include the Salt Marsh Restoration Project, Glenrose Tidal Marsh Project, and New Brighton Park Shoreline Habitat Restoration Project. The Habitat Enhancement Program has also recently implemented the Maplewood Marine Restoration Project (**Section 7.3.4**).

These and other past enhancement and offsetting projects, including legacy habitat bank projects (Fraser River north and south arm) (**Section 7.1**) and offsetting (referred to as compensation at that time) for the DP3 Project (**Section 7.2**), demonstrate the port authority's extensive knowledge and understanding of the Roberts Bank and Fraser River environments. They also illustrate the port authority's commitment to and experience implementing long-term monitoring and adaptive management efforts to ensure habitat enhancement projects achieve desired outcomes. Offsetting effectiveness is confirmed through extensive and regular monitoring. In the Federal Review Panel Report, the review panel noted that the port authority is highly experienced in developing offsetting habitat in the Fraser River estuary, and has demonstrated successful remediation of offsetting habitat that did not function as originally intended. The port authority will apply its experience and these same monitoring and management efforts to the benefit of the offsetting projects advanced through the RBT2 offsetting plan.

Furthermore, most of these past port authority enhancement and offsetting projects involve intertidal marsh and eelgrass habitats, which are known to benefit a wide variety of fish and wildlife species and life stages (**Appendix**

[11] Any future development of the site would also require cooperation from YVR to ensure that the project is constructed in line with their wildlife management objectives.

IR2020-1.1-C), notably including estuarine-rearing juvenile salmon such as ocean-type Chinook populations of the Harrison and South Thompson rivers.

The RBT2 offsetting plan will integrate the lessons learned from these past projects to reduce the risk of deficiencies, and rapidly detect and address them in the unlikely event they occur.

7.1. Legacy habitat bank projects

With respect to the three legacy habitat bank projects, two are located on the Fraser River's north arm (Gladstone Park Tidal Marsh Project and Riverfront Park Tidal Marsh Project) with a third located on the south arm (Timberland Basin Habitat Project). All three were constructed in the late 1980s through mid-1990s, resulting in successful establishment of brackish and freshwater intertidal marsh habitats. Habitat creation measures involved installation of perimeter berms, followed by fill/growing medium placement and marsh plantings. As discussed in **Section 4** above, the Timberland Basin Habitat Project, Riverfront Park Tidal Marsh Project, and the Gladstone Park Tidal Marsh Project are proposed for inclusion in the RBT2 offsetting plan.

The Timberland Basin Habitat Project involved trial planting of Lyngbye's sedge. Although the site experienced heavy geese grazing pressure, it naturally transitioned into functioning low marsh habitat through a combination of additional transplanting and natural vegetation colonization, and was considered successful by DFO.

Each legacy project has contributed productive fish habitat values for more than two decades following a comparatively short period to become fully established. These projects were successfully carried out by the port authority and multi-disciplinary teams working on its behalf. Over the last few decades, an even more thorough understanding of intertidal marsh creation has been gained by the port authority and technical specialists working within the Fraser River estuary. This knowledge base and the lessons learned from past projects support a broad adaptive management approach, helping to inform the design and implementation of intertidal marsh projects within the regional setting.

Examples of lessons learned relating to intertidal marsh habitat creation include knowledge with respect to the approach to constructing the marsh bench itself (i.e., through infilling behind a rock containment berm); planting prescriptions and other measures to provide resilience in relation to erosion, herbivory, and sea-level rise; and site-specific understanding of the physical setting and processes influencing proposed offsetting locations, allowing the team to integrate this understanding into the design development process. Monitoring reports demonstrating the success of the legacy projects in providing effective and productive fish habitat, and remedial measures undertaken in the event that sites required intervention or adaptation, have been made available electronically to Indigenous groups and DFO.

7.2. Deltaport Third Berth Project

There were five components undertaken as part of habitat offsetting for the DP3 Project:

1. Offsite salt marsh construction (Third Party Payment):
    - Frenchies Island: A marsh island located in the south arm of the Fraser River and part of the South Arm Marsh Complex, a protected Wildlife Management Area (WMA). Fish access was provided through the creation of approximately 1,000 m of new channels and increasing the availability of open water at medium-tide levels over an approximately 1 ha area. Accumulated wood was removed from the intertidal marsh to increase habitat productivity and improve plant community diversity. Positive improvements in salt marsh habitat values (including vegetation coverage) were rapid.
    - Grauer Property: Enhancement work included the creation of tidal channels and pools for fish, and the removal of accumulated logs and undesirable vegetation, which resulted in dense native plant coverage and diversity.
2. Log removal from an area located within TFN lands: Involved removal of dense accumulations of logs and other woody debris that were suppressing salt marsh growth in an area of approximately 2.3 ha. Full recovery of salt marsh vegetation quickly followed (i.e., within three to five years).

3. Caisson refugia: Fish refugia openings were installed to support the colonization of sessile subtidal marine communities.
4. Subtidal artificial reef habitat: Eight subtidal reefs were established seaward of the Deltaport facility to increase the diversity and productivity of fish habitat in the area (e.g., by providing attachment opportunities for macroalgae and encrusting marine life, and crevices for reef-associated fish species).

For the above-mentioned four components, DFO has confirmed that the port authority has met the offsite offsetting obligations under the DP3 FAA.

5. East causeway habitat enhancement (includes 10 offsetting elements): Through the port authority's long-term monitoring program, it was identified that the components of the east causeway habitat offsetting site were not fulfilling objectives. These sites have subsequently been adaptively managed. Remediation efforts have been undertaken (as described in **Section 7.2.1** below), and monitoring is currently underway.

In addition to the DP3 offsetting measures described above, the port authority restored a 450 m^2 area of native eelgrass habitat in the inter-causeway area, through transplantation of an area that was the location of a temporary barge ramp for the DP3 Project. Within one year, the transplanted eelgrass had multiplied and spread, resulting in cover exceeding 85% and the site resembling a well-established bed (Precision Identification 2016).

7.2.1. East causeway habitat offsetting remediation

The port authority constructed lagoon marshes and open marsh benches on the south shoreline of the Roberts Bank causeway in 2010 as part of the east causeway habitat offsetting for the DP3 Project. The original habitat offsetting concept proposed creation of an offshore barrier island with openings at regular intervals to allow tidal cycling and channel flushing, as well as tidal access for juvenile salmon and other organisms. Salt marsh transplants were proposed behind the barrier island in the tidal channel sheltered from storm waves and winds. Upon request by DFO and the Canadian Wildlife Service, this concept was modified to reduce footprint impacts on wetted habitats, with the offshore barrier island reduced in size and offsetting works limited to within the toe of the existing causeway.

Pre-construction monitoring was undertaken in 2008 and 2009, followed by post-construction monitoring in 2010, and effectiveness monitoring for five growing seasons between 2011 and 2015. Monitoring results revealed that the removal of the offshore barrier island from the original design led to exposure of open marsh benches to wind and waves and alongshore transport of sediment, which, in turn, resulted in erosion and lowering of elevation, increased periods of inundation, and hindered plant growth. Moreover, accumulation of debris and eelgrass wrack generated from the adjacent bed (which is approximately 850 ha in size) rendered lagoon marshes anoxic over time, restricting plant colonization and growth.

In 2017, the port authority undertook remedial action to enhance physical characteristics of the constructed lagoon marshes and created two new barrier beach/marsh units where open marsh benches were not successful (total of nine remediated salt marsh areas). Revegetation focused primarily on transplanting pickleweed and saltgrass, which naturally dominate the upper and lower marsh.

Three months after planting in May 2017, the port authority conducted a salt marsh assessment, which indicated favourable results for vegetation establishment in the salt marsh habitat features. Plug survival exceeded 80% at five out of eight remedial locations, while at the remaining three locations, plug survival ranged from 50% to 70%.

Although some eelgrass wrack and debris were noted within the constructed marsh, pickleweed and saltgrass were showing signs of growth and persistence under the wrack cover. In September 2018, the first year of a proposed five-year remediation monitoring program (biannual monitoring: 2018, 2020, and 2022) was carried out (Hemmera 2018b). Monitoring reports have been made available to Indigenous groups and DFO electronically. Results from Year 3 (2020) monitoring will be submitted to DFO when available, with preliminary results described further below.

Year 1 (2018) monitoring results indicated that most of the remediated salt marshes were in early succession stages, with some additional measures required at two of nine salt marshes to address vegetation survivorship and further promote establishment of these marshes (e.g., further modification of bench elevations, installation of eelgrass wrack and wood exclusion structures, and additional marsh planting). Monitoring recently conducted in 2020 provides evidence of successful performance of the exclusion structures, increases in plant diversity, and the ongoing establishment of salt marshes but the continued presence of eelgrass wrack (potentially limiting salt marsh growth) and spread of invasive species in the upland riparian habitat is impacting performance. The port authority will be implementing the required remedial actions of invasive species removal and additional planting through this adaptive management approach.

The challenges associated with the east causeway marsh habitats are not expected to occur at proposed RBT2 marsh offsetting habitat projects, as the potential influence of wind and wave conditions has been considered and reflected in the design development process. Lessons that continue to be learned through ongoing remediation and monitoring of the east causeway marsh habitats will be integrated into the future planning and design of proposed RBT2 marsh offsetting habitat projects.

7.3. Habitat Enhancement Program

7.3.1. Salt Marsh Restoration Projects

As part of the port authority's Habitat Enhancement Program, and in addition to the similar work conducted as part of DP3 offsetting (**Section 7.2**), the port authority established five tidal salt marsh restoration sites along the Tsawwassen foreshore of Roberts Bank and in Boundary Bay. One site is located on TFN lands. Restoration activities involved removal of dense accumulations of logs and other woody debris to provide for natural salt marsh vegetation recovery. Restoration work was undertaken in late 2013 through early 2014 by TFN's Joint Venture partnership, resulting in removal of woody debris from a total salt marsh habitat area of approximately 6.3 ha. As of the late summer of 2019, six years of a monitoring program have been carried out (GL Williams & Associates Ltd. and Hemmera 2014, GL Williams & Associates Ltd. 2015a, 2016, 2017, GL Williams Associates Ltd. and Moffatt & Nichol 2019a, 2019b). Monitoring reports have been made available to Indigenous groups and DFO electronically.

Salt marsh recovery through natural recruitment was rapid, with dense salt marsh coverage becoming established within most areas (especially high marsh habitats) within three years and complete vegetation coverage within most heavily disturbed areas (e.g., low marsh habitats and/or areas previously covered with the densest log accumulations) within five years. This is consistent with similar salt marsh restoration works completed by the port authority for the DP3 Project, and by the B.C. Ministry of Transportation and Infrastructure as offsetting for the South Fraser Perimeter Road project.

Due to the high energy marine conditions, the Boundary Bay site has been affected by physical changes over the past five years, primarily ongoing accumulation of logs. However, marsh vegetation has re-established and the log removal conducted in 2014 has improved the overall productivity and value to fish and wildlife. The port authority continues to regularly monitor log accumulation at the salt marsh sites and these considerations will be evaluated during confirmatory monitoring to establish the habitat credit values at withdrawal, consistent with any of the other habitat bank sites. Furthermore, findings will be considered in the context of RBT2 offsetting projects that involve log removal (i.e., the Westham Island Canoe Pass Tidal Marsh Project and the Finn Slough Enhancement Project). This salt marsh restoration work demonstrates the resilience of salt marshes and ability of salt marsh vegetation to quickly recover following removal of log debris.

7.3.2. Glenrose Tidal Marsh Project

The Glenrose Tidal Marsh Project involved construction of intertidal marsh habitat at three sites on the southern shore of the Fraser River's south arm, just upstream of the Alex Fraser Bridge.

The area was identified as an important opportunity by Musqueam to protect important cultural heritage sites from further desecration. With physical construction undertaken in the spring/summer of 2014, marsh vegetation transplanting occurred in the late summer of 2014. As of 2019, five years of monitoring had been completed (GL

Williams & Associates Ltd. 2015b, GL Williams Associates Ltd. and Moffatt & Nichol 2016, 2017, 2018, 2019c). Monitoring reports have been made available to Indigenous groups and DFO electronically and the results are summarized below.

The Glenrose Tidal Marsh Project is a good example of lessons learned from past enhancement projects and how they have been applied to RBT2 offsetting projects. The Glenrose Tidal Marsh Project consists of three separate marsh enhancement components: Glenrose Downstream, Glenrose Cannery, and Gunderson Mudflat. Each component was associated with a different design approach to creating a marsh bench, to fit the specific site conditions and promote intertidal marsh habitat establishment in the given areas. The Glenrose Downstream component involved construction of an intertidal marsh bench behind a rock riprap containment berm; the Glenrose Cannery component involved overlaying an intertidal rock riprap apron with soil; and the Gunderson Slough component involved placement of soil between rock groynes.

At the Glenrose Downstream site, and following the first full growing season of 2015, Year 1 monitoring carried out in late July showed rapid vegetation coverage with over 60% of sampled quadrats having vegetation coverage of up to 25%. At this same site, Year 2 (2016) monitoring showed 55% of sampled quadrats were characterized by vegetation coverage of greater than 50% and dense coverage in all quadrats by Year 3 (2017).

Marsh vegetation establishment has been slower at the other two sites (Glenrose Cannery and Gunderson Mudflat), especially at the latter and largest site as a result of herbivory impacts from Canada geese. Experimental “enclosures” and supplemental planting efforts have been successfully tested and used at this site to manage herbivory and promote marsh growth, with both sites continuing to show positive trends towards full vegetation coverage. RBT2 marsh offsetting projects are being designed to reduce the risk of geese herbivory affecting their establishment. An example of this is the placement of plant species like Baltic rush at the leading edges of the proposed marsh benches. Baltic rush is a mat-forming species and is, therefore, considered more challenging for geese to traverse and graze on. The success of the experimental herbivore enclosures provides a reliable technique to manage herbivory if needed, and additional confidence in the likelihood of the RBT2 marsh offsetting projects becoming established and functional.

Marsh vegetation at the Glenrose Cannery site, which involved a more novel design with planting medium placed within the interstices of rock protection, is occurring at an anticipated slower rate than would be expected to apply for more conventional intertidal marsh designs—like the kind used at the Glenrose Downstream site. The more conventional design involving the construction of a containment berm and fill placement behind it is being proposed for RBT2 marsh offsetting projects (e.g., the onsite marsh complex, the South Arm Jetty Tidal Marsh Project, the Westham Island Canoe Pass Tidal Marsh Project, and the Tilbury Island Peninsula Enhancement Project).

7.3.3. New Brighton Park Shoreline Restoration Project

The New Brighton Park Shoreline Restoration Project is located on the southern shoreline of Burrard Inlet, just west of the Second Narrows Bridge. This Habitat Enhancement Program project converted previously infilled marine habitats into a tidal basin with adjacent mudflat and salt marsh habitats. The project design was developed collaboratively with Musqueam, Tsleil-Waututh Nation, and Squamish Nation. Project construction began in September 2016 and ended with completion of an extensive planting program in June 2017. The planting program included salt marsh plugs, dune grass, shrubs, and trees, including species of Indigenous cultural and ecological value selected by Indigenous groups. In recognition of potential herbivory by Canada geese, fencing with horizontal roping was installed within the salt marsh soon after planting efforts, to deter Canada geese and promote establishment of the salt marsh. As of 2019, two years of monitoring had been completed (GL Williams Associates Ltd. and Moffatt & Nichol 2019d, 2019e). Monitoring reports have been made available to Indigenous groups and DFO electronically.

As anticipated, juvenile Pacific salmon were observed within the tidal basin immediately upon establishment of an unimpeded hydraulic connection between it and the wider Burrard Inlet. With respect to salt marsh habitat creation, monitoring in Year 1 (2018) indicated that salt marsh transplanting was thorough with plugs recorded in every quadrat, and vegetation coverage ranging from sparse to dense. In Year 2 (2019), sparse vegetation coverage was noted in the high marsh area between 1.5 m GD and 2.0 m GD, and that some supplemental

planting should be pursued. Salt marsh vegetation in the high marsh may be exposed to goose grazing during high tides, which is extremely challenging to fully address with fencing/ropes.

In response to these monitoring results, supplemental planting was carried out in the summer of 2020, demonstrating the port authority's commitment to identifying deficiencies early and taking remedial actions quickly. It is anticipated that Year 3 monitoring will show that additional planting has been successful.

7.3.4. Maplewood Marine Restoration Project

In collaboration with Tsleil-Waututh Nation (and with the involvement of Musqueam and Squamish Nation), the port authority's Habitat Enhancement Program recently completed implementation of the Maplewood Marine Restoration Project (Maplewood Project) on the north shore of Burrard Inlet, in a marine site that was identified as a restoration priority by Tsleil-Waututh Nation (https://www.portvancouver.com/projects/habitat-restoration/maplewood/). The Maplewood Project involved transforming approximately 5 ha of low diversity marine habitat into higher diversity marine habitat for fish, birds, and other wildlife. The final stage of implementation involved the transplantation of approximately 125,000 eelgrass shoots to create an approximately 1.5 ha eelgrass bed (the largest eelgrass transplant performed in Burrard Inlet), which was completed in August 2021. A major portion of the marine habitat created at the Maplewood Project site will be used to fulfil the fish habitat offsetting requirements for the Centerm Expansion Project, as determined by DFO.

Eelgrass transplantation for the Maplewood Project, as well as for proposed RBT2 eelgrass offsetting projects, will build on lessons learned from past eelgrass habitat projects conducted in the region. In particular, the Maplewood Project adopted the SAFE[12] eelgrass transplantation technique developed in B.C. by Cynthia Durance, which has been successfully used to transplant eelgrass at over one hundred sites in B.C.

As part of a November 2020 pilot project, the port authority transplanted approximately 5% of the total Maplewood Project eelgrass bed. This pilot work, which the port authority collaborated on with interested Indigenous groups and regional experts like Cynthia Durance, increased the overall understanding of eelgrass transplanting for the Maplewood Project and will inform transplant prescriptions, methods, and logistical planning for future eelgrass enhancement opportunities like those being proposed for RBT2 offsetting. Specifically, the pilot project involved the transplantation of approximately 7,000 eelgrass shoots and was designed to determine the success of a variety of scenarios relating to: provenance (three harvest locations, or donor sites, were used); density (transplant densities of 8 shoots per m^2 and 10 shoots per m^2 were used); shoot preparation techniques (both regular and trimmed shoots were planted, to see if the latter benefitted shoot welfare or transplantation efficiency); and ecotype (two different ecotypes of eelgrass were transplanted at varying elevations).

Divers involved in the pilot project and the full transplantation reported immediate fish and invertebrate use of planted areas. In due course, the Maplewood Project eelgrass transplant area will be monitored to determine success. The Roberts Bank and Burrard Inlet harvest (or donor) areas will also be monitored to assess their recovery. A recent joint press release by the port authority and Tsleil-Waututh Nation describing the Maplewood Project eelgrass transplantation is available here: https://www.portvancouver.com/news-and-media/news/eelgrass-transplanting-work-underway-at-maplewood-marine-restoration-project/.

Appendices

Appendix IR2020-1.1-A Supporting Documents

Appendix IR2020-1.1-B RBT2 Offsetting Project Summary Table

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[12] SAFE is an acronym for **S**ite selected, **A**nchored with **F**e (iron), using the appropriate **E**cotype. Eelgrass shoots are attached to plain steel washers (anchors). An ecotype is a population (or subspecies or race) that is adapted to local environmental conditions.

Appendix IR2020-1.1-C Key Offsetting Habitat Types

Appendix IR2020-1.1-D Ministry of Forests, Lands, Natural Resource Operations, and Rural Development Letter Regarding Status of Land Tenure Applications

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