CITY OF SURREY

the future lives here.

INITIAL PROJECT DESCRIPTION: MUD BAY NATURE-BASED FORESHORE ENHANCEMENTS PROJECT

November 2022

Prepared for:

BC Environmental Assessment Office
Victoria, British Columbia

Prepared by:

City of Surrey
Surrey, British Columbia

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Prepared for:

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EXECUTIVE SUMMARY

Project Overview

The City of Surrey (the City) is proposing the Mud Bay Nature-Based Foreshore Enhancements Project, Site S2 (the Project). The Project is a nature-based climate change adaptation project which would gradually increase the elevation of the salt marsh to help the natural marshes lining Boundary Bay adapt to sea level rise while enhancing biodiversity, reducing wave energy, and increasing coastal flood control.

Approximately 20% of the City's total land area is located within the coastal floodplain. The lands within the City's coastal areas are vulnerable to predicted consequences of climate change, including rising sea and groundwater levels, coastal squeeze of ecosystems (i.e., salt marshes), increased shoreline erosion, saltwater intrusion, higher levels and duration of floods, and increased risk of dyke breaching. These lands are also home to Semiahmoo First Nation since time immemorial and include important historical, cultural, and archaeological resources.

The Project is part of an innovative, nature-based approach to mitigate impacts associated with climate change in a way that enhances biodiversity and offsets the negative impacts of coastal squeeze (the loss of coastal habitats in front of sea defences as sea level rises), as well as protects important neighborhoods, farms, businesses, critical infrastructure, transportation corridors, and internationally recognized bird and wildlife habitats.

The Project involves placing sediment and planting native marsh species on the foreshore to increase the extent and elevation of the marshes over time. It will be supported by the design, construction, and adaptive management of nature-based salt marsh pilot studies in the City of Delta and the City of Surrey (the Pilot Studies), where the results and lessons learned from the Pilot Studies will be used to inform the design, construction, and adaptive management of the Project. The predicted area of shoreline modification for the Project is approximately 790 metres linear shoreline and may result in approximately 8.19 hectares of foreshore disturbance.

Due to the restorative nature of the Project and its' low likelihood of causing significant adverse effects, the City is seeking an Environmental Assessment Certificate (EAC) Exemption Order for the Project. An Exemption Order is a legal order under the *Environmental Assessment Act* that allows a reviewable project to proceed without an EAC provided the project is constructed, operated, and decommissioned in accordance with the conditions described in the Order.

Project Purpose and Benefits

The purpose of the Project, which will use the "Living Dyke" concept and Green Shores approach, is to adapt to sea level rise via nature-based foreshore enhancements. These enhancements are intended to emulate the natural unprotected shoreline rebuilding process, while maintaining the shoreline position.

Conventional coastal engineering (e.g., dykes) has been the traditional solution to combat flood risks. However, these defences require continual maintenance due to erosion at the base and the need to increase the width and height to keep up with sea level rise and storm surges. Coastal wetlands and marshes provide considerable protection against storm surges and related wave effects when severe

storms come ashore. Studies have also shown that salt marshes in front of coastal dykes can reduce the nearshore wave heights, protecting them from erosion, reducing the likelihood of dyke failure, and reducing the need to increase dyke heights, which exacerbates coastal squeeze (the loss of coastal habitats in front of sea defences as sea level rises).

Nature-based flood defences are a more sustainable approach that supports important marine ecosystem functions. Compared with conventional engineering approaches, nature-based flood defences have additional benefits including improved water quality, carbon sequestration, production of fisheries, nature conservation, and the creation of recreational space

The complex foreshore texture will simultaneously enhance biodiversity, reduce wave energy, increase the factor of safety for coastal flood control and offset the negative ecosystem impacts of coastal squeeze.

Engagement

The Project is within the core territory of Semiahmoo First Nation, the traditional territories of the Katzie, Kwantlen, Sto:lo, and Tsawwassen First Nations, and may be of interest to other Indigenous nations and organizations. For several years, the City has been working with the public, stakeholders, technical experts, and Indigenous nations to develop the Project as part of Surrey's Disaster Mitigation and Adaption Fund (DMAF) Program, which includes a total of 13 projects identified during the development of the City's 2019 Coastal Flood Adaptation Strategy (CFAS).

Recognizing the broader planning context under which CFAS was developed, the 20 Indigenous nations and organizations listed below (in alphabetical order) were identified and provided regular updates between 2016 and 2021 on the proposed CFAS and DMAF projects (which includes the Project).

1. Cowichan Tribes
2. Fraser Valley Métis Association
3. Halalt First Nation
4. Katzie First Nation
5. Kwantlen First Nation
6. Lake Cowichan First Nation
7. Lyackson First Nation
8. Musqueam Indian Band
9. Penelakut Tribe
10. Seabird Island Band
11. Semiahmoo First Nation
12. Shxw'ow'hamel First Nation
13. Skawahlook First Nation
14. Soowahlie First Nation
15. Stó:lō Nation
16. Stó:lō Tribal Council
17. Stó:lō Xwexwilmexw Treaty Association
18. Stz'uminus First Nation
19. Tsawwassen First Nation
20. Tsleil-Waututh Nation

Since the onset of the CFAS program in 2016, the City has undertaken a considerable amount of engagement with relevant stakeholders, Indigenous nations, regulators, land owners, and the public on the CFAS, including the Project. During this preliminary engagement, key interests, values, and concerns around the Project were identified, considered, and incorporated into the development of the Project.

The Project was further refined through a collaborative working group called the Boundary Bay Living Dike Roundtable (the Roundtable), which was created in 2018. The Roundtable consists of representatives from Indigenous nations, environmental regulators, coastal engineering experts, municipal staff, and researchers. Participation in the Roundtable is voluntary, and its objectives include information sharing, technical dialogue, and relationship building. Roundtable participants have held scheduled meetings since November 2018 and will continue to provide input through later Project phases including construction, monitoring, and evaluation.

Going forward, the City intends to build on the success of this preliminary engagement, through the implementation of the plans and principles described in the *Mud Bay Nature-Based Foreshore Enhancements Project, Site S2 – Engagement Plan (Sept 2022).* The City is committed to ongoing engagement, studies and adaptive management to ensure that potential adverse effects are avoided, minimized or mitigated to acceptable levels, and to address concerns, including those of Indigenous nations.

Effects Assessment

Considering the restorative nature of the Project, it offers the potential benefit of increased salt marsh habitat and biodiversity, improved water quality, and increased abundance and distribution of cultural resources. As a results, potential positive effects exist for wildlife and marine fauna that directly use the salt marsh, in addition to the potential to support the re-establishment of traditional cultural practices within Mud Bay. This innovative Project also provides a more sustainable approach to adapt to climate change and sea level rise that can be emulated by other coastal municipalities across BC and beyond.

While the Project does have the potential to adversely affect some Valued Components (i.e., marine resources), including water and sediment quality, terrestrial habitat, wildlife habitat, land use, archaeological and heritage resources, and Indigenous Interests, with the implementation of proposed mitigation measures and standard best management practices, adverse residual effects are expected to be eliminated or reduced to acceptable levels. As a result, no significant adverse residual or cumulative effects are anticipated for the Project, including no serious impacts to Indigenous interests.

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LIST OF ACRONYMS AND ABBREVIATIONS

AIA	Archaeological Impact Assessment
ALR	Agricultural Land Reserve
AM	Adaptive Management
BC	British Columbia
BC EAA	*British Columbia Environmental Assessment Act*
BCEAO	British Columbia Environmental Assessment Offices
Biofilm	Microphytobenthos
BMP	Best Management Practice
CDFmm	Moist Maritime Coastal Douglas-fir Subzone
CEMP	Construction Environmental Management Plan
CEPA	*Canadian Environmental Protection Act*
CFAS	Coastal Flood Adaptation Strategy
DAS	Disposal at Sea
DFO	Fisheries and Oceans Canada
DMAF	Disaster Mitigation and Adaptation Fund
DPD	Detailed Project Description
DSSRG	Delta South Surrey Regional Greenway
EA	Environmental Assessment
GHG	Greenhouse gas
HCA	*Heritage Conservation Act*
IBA	Important Bird Area
IPCC	Intergovernmental Panel on Climate Change
IPD	Initial Project Description
IR	Indian Reserve
KWL	Kerr Wood Leidal Associates Ltd.
MFLNRORD	Ministry of Forests, Lands, Natural Resources Operations and Rural Development
MOF	BC Ministry of Forests
MoTI	Ministry of Transportation and Infrastructure
MOU	Memorandum of Understanding
NRCan	Natural Resources Canada
SARA	*Species at Risk Act*
SEA	Strategic Engagement Agreement
Site D1 or D1	Nature-based Foreshore Enhancements Pilot Study in Delta
Site S1 or S1	Nature-based Foreshore Enhancements Pilot Study in Surrey
The City	The City of Surrey
The Project	The Full-Scale Mud Bay Nature-Based Foreshore Enhancements Project, Site S2
TLP	Thin Layer Placement
USA	United States of America

UTM	Universal Transverse Mercator
VC	Valued Component
WMA	Wildlife Management Area
WSA	*Water Sustainability Act*

1.0 GENERAL INFORMATION AND CONTACTS

The City of Surrey (the City) is proposing the Mud Bay Nature-Based Foreshore Enhancements Project, Site S2 (the Project). General information and the principal contact for the Project is described in Table 1.

Table 1 Project Information and Key Contacts.

Project Name	Mud Bay Nature-Based Foreshore Enhancements Project, Site S2
Project sector/type	Water Management Project, Shoreline Modification
Project location	Surrey, BC
Proponent Name	City of Surrey
Proponent address	Engineering Department, 4th Floor, 13450 104 Ave, Surrey, BC, Canada V3T 1V8 T 604.598.5830
Proponent website	www.surrey.ca; https://www.surrey.ca/city-services/19888.aspx
Principal contact for the Project and the EAC Exemption Order	Miriam Marshall, R.P. Bio. | Environmental Coordinator City of Surrey Miriam.Marshall@surrey.ca

1.1 PURPOSE, RATIONALE, AND BENEFITS

The Project is a nature-based climate change adaptation project which would increase the elevation of the salt marsh to help the natural marshes lining Boundary Bay adapt to sea level rise while enhancing biodiversity, reducing wave energy, and increasing coastal flood control. Approximately 20% of the City's total land area is located within the coastal floodplain, which is home to historic and important neighbourhoods, farms and businesses, critical infrastructure and transportation corridors, and internationally recognized bird and wildlife habitat. These lands are also home to Semiahmoo First Nation since time immemorial with important historical, cultural, and archaeological resources.

Predicted consequences of climate change in the City's coastal areas include rising sea and groundwater levels, coastal squeeze (the loss of coastal habitats in front of sea defences as sea level rises) of ecosystems (e.g., salt marshes), increased shoreline erosion, saltwater intrusion, higher levels and duration of floods, and increased risk of dyke breaching. Current coastal dykes are highly vulnerable, and by 2070, it is expected that all dykes will be overtopped multiple times per year, with overtopping likely resulting in dyke failure. At present, under 200-year flood conditions, a portion of Highway 99 would be inundated, including bridge decks at three locations (City of Surrey 2022c).

Conventional coastal engineering (e.g., dykes[1]) has been the traditional solution to combat flood risks. However, these defences require continual maintenance due to erosion at the base and the need to increase the width and height to keep up with sea level rise and storm surges. Coastal wetlands and

[1] Consistent with the City of Surrey's terminology, the term "Dyke" is used throughout this document to refer to structures constructed to prevent the flooding of land. Dykes are considered a "dike" as defined in the *Dike Maintenance Act* [RSBC 1996, c. 95], and may refer to a sea dyke or a river dyke. The term "Dike" is only used in this document when referring to the specific Provincial legislation and when referring to a committee/working group that has a name that includes "Dike" as opposed to "Dyke."

marshes provide considerable protection against storm surges and related wave effects when severe storms come ashore. Studies have also shown that salt marshes in front of coastal dykes can reduce the nearshore wave heights, protecting them from erosion and reducing the likelihood of dyke failure (Zhu et al. 2020).

The Project is an alternative to traditional engineering approaches and implements a nature-based approach to adapt to climate change and sea level rise. Nature-based flood defences are a more sustainable approach. Ecosystems such as salt marsh have the natural capacity to reduce storm waves and storm surges and can keep up with sea level rise by natural accretion of sediments (Gedan et al. 2011; Shepard et al. 2011; Fagherazzi et al. 2012). Compared with conventional engineering approaches, nature-based flood defences have additional benefits including improved water quality, carbon sequestration, production of fisheries, nature conservation, and the creation of recreational space (Temmerman 2013).

The purpose of the Project, which will use the "Living Dyke[2]" concept and Green Shores[3] approach, is to gradually increase the elevation of the salt marsh to adapt to sea level rise of up to one meter (m), via nature-based foreshore enhancements, as shown in Figure 1. These enhancements are intended to emulate the natural unprotected shoreline rebuilding process, while maintaining the shoreline position. The complex foreshore texture will simultaneously enhance biodiversity, reduce wave energy, increase the factor of safety for coastal flood control and offset the negative ecosystem impacts of coastal squeeze, which is key to the Project due to the existing dyke structure and Highway 99 that runs parallel to the Project. The Project consists of the design, construction, and adaptive management (AM) of a nature-based salt marsh. Pilot studies in the City of Delta (Site D1 or D1) and the City of Surrey (Site S1 or S1) are also planned, where the results and lessons learned from the D1 and S1 pilot studies will be used to inform the design, construction, and AM of the Project (Site S2). The Pilot Studies are anticipated to be constructed in 2023. If the Pilot Studies are not successful, the City may abandon plans to advance the construction of the Project, which is anticipated to be constructed in 2025.

The Project is part of the City's Coastal Flood Adaptation Strategy (CFAS) and Disaster Mitigation and Adaptation Fund (DMAF) Program. The DMAF program is a $187 million coastal flood protection program with $76.6 million of federal grant funding. The DMAF Program consists of 13 individual grey and green infrastructure improvements within the Boundary Bay Watershed, with the purpose of reducing vulnerability of the lowlands and infrastructure to coastal flooding and sea level rise. The federal funding expires on March 31, 2028; thus any delays to the Project could result in the City not receiving the full $76.6 million of federal funding and may have 'knock-on' effects on other aspects of the DMAF coastal flood protection program.

Further to the Project enhancing biodiversity and offsetting the negative impacts of coastal squeeze, there are potential benefits of the "Living Dyke" concept for future carbon capture and sequestration, as marshlands provide an important and effective sink for the storage of carbon (Ouyang and Lee 2014; SNC Lavalin 2018).

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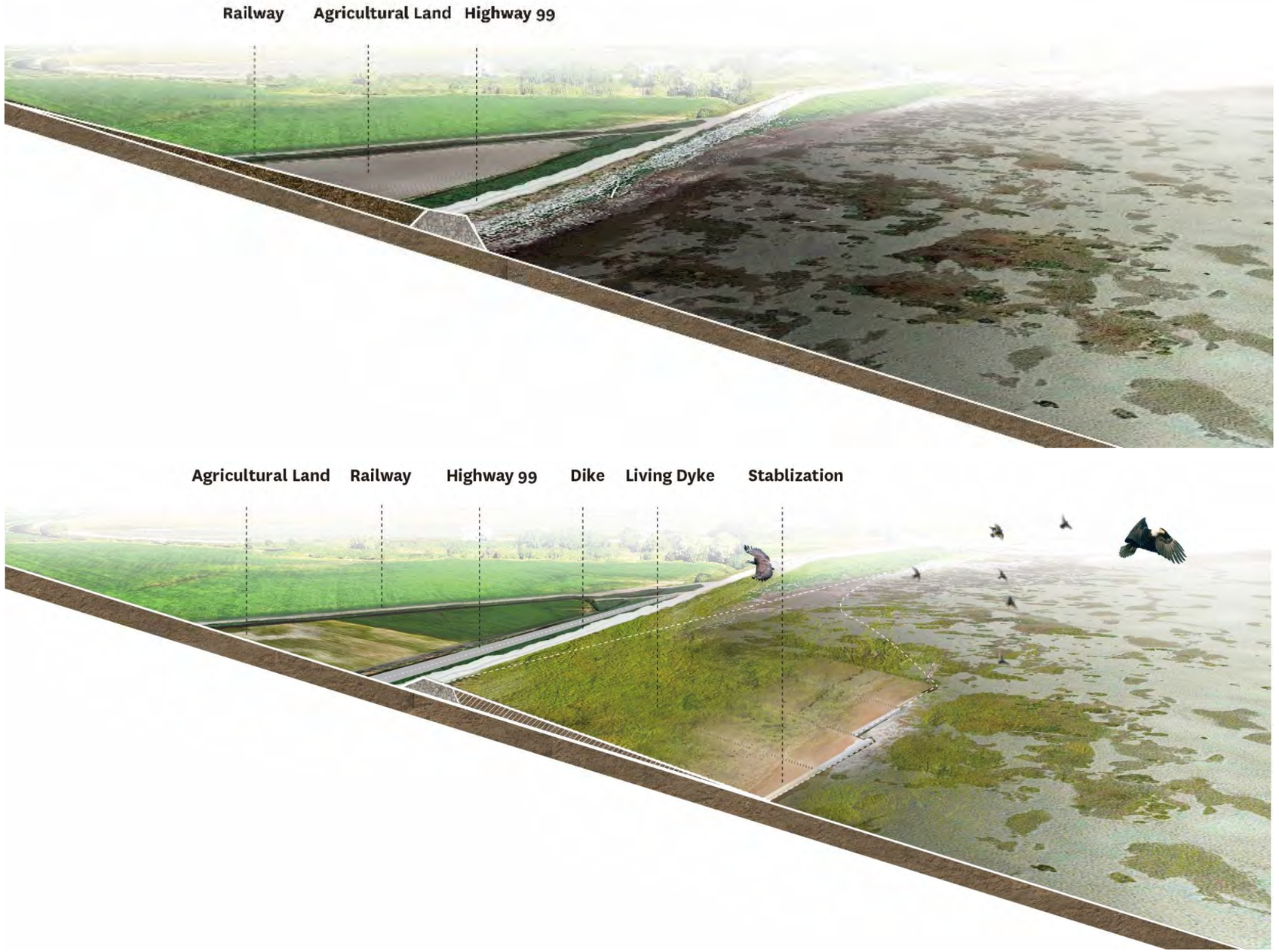
[2] Living Dyke: A coastal flood protection system that also protects and enhances existing and future coastal and aquatic ecosystems (SNC-Lavalin 2018). The Living Dyke concept is not considered a dike as defined in the *Dike Maintenance Act* [RSBC 1996, c. 95].

[3] Green Shores: A program developed by the Stewardship Centre of BC. Green Shores provides science-based tools and best practices to help people minimize the impacts of new developments, and restore shoreline ecosystem function of previously developed sites. A number of Green Shores workshop have been held throughout the CFAS program in an effort to engage community members, design professionals, regulators, and community groups in exploring Green Shore options for the CFAS Study Area.

Figure 1 **Before and after artistic rendering of the Mud Bay Nature-Based Foreshore Enhancements Project.**



Source: Artistic renderings provided by Yuxiang (Ethan) Liu, Masters of Landscape Architecture student at the University of British Columbia (supervised by Kees Lokman)

An additional benefit of the Project is to increase the understanding of viable coastal marsh adaptation approaches and their replicability at a larger scale and in other jurisdictions. In particular, the Project will improve understanding of techniques for salt marsh construction to preserve the salt marsh habitat and maintain the flood protection function of the salt marsh, including creating new salt marsh and raising existing salt marsh.

Summary of potential Project benefits:

- Enhance biodiversity, reduce wave energy, increase the factor of safety for coastal flood control, and offset the negative ecosystem impacts of "coastal squeeze";
- Create salt marsh to provide an important and effective sink for the storage of carbon;
- Improved water quality, production of fisheries, nature conservation, and the creation of recreational space;
- Protect historic and important neighbourhoods, farms and businesses, critical infrastructure and transportation corridors, and international recognized bird and wildlife habitats;
- Emulate the natural unprotected shoreline rebuilding process, while maintaining the shoreline position;
- A more sustainable solution to address climate change and sea level rise impacts compared to traditional dyking and maintenance techniques; and
- Improve understanding of techniques for marshland construction and the preservation of salt marsh habitat that can be replicated at a larger scale and in other jurisdictions.

1.2 LEGISLATIVE AND REGULATORY CONTEXT

1.2.1 Environmental Assessment Regulatory Requirements

Per the *Reviewable Projects Regulation* under the British Columbia *Environmental Assessment Act* (BC EAA) Reg. 243/2019; the Project, as presented in Figure 2 and Figure 3, is anticipated to trigger an assessment based on the following assumption:

- Site S2 – Nature-Based Foreshore Enhancements Project:
    - Per Part 5 (Water Management Projects – Shoreline Modification Projects), it is assumed that the Project, Site S2, would be reviewable, as it would likely result in a direct physical disturbance of over 2 hectares (ha) of foreshore or submerged land. The predicted area of shoreline modification for Site S2 is approximately 790 metres long and approximately 8.2 ha of foreshore disturbance.

The City is submitting this Initial Project Description (IPD) as required under the BC EAA, to seek an EAC Exemption Order for the Project. An EAC Exemption Order is a legal order under the *Environmental Assessment Act* that allows a reviewable project to proceed without an EAC provided the project is constructed, operated and decommissioned in accordance with the conditions described in the Order. Submission of the IPD is the first step in the process, after which the EAO will initiate formal engagement on the Project and seek feedback to document issues and concerns that the City will endeavour to address through the submission of a subsequent Detailed Project Description (DPD) prior to any decisions being made.

The Pilot Studies are not reviewable under the Reviewable Projects Regulations, and they will not result in a direct physical disturbance of over 1,000 m of linear shoreline, or over 2 ha of foreshore or submerged land. The predicted area of shoreline modification for the D1 Pilot Study is approximately 210 metres in length and 1.38 ha. Similarly, the predicted area of shoreline modification for the S1 Pilot Study is approximately 320 m in length and 1.44 ha.

The City is targeting a Ministerial decision on the EAC exemption request by Aug 2023. This is to support the detailed Project design, planning, and construction in a timeframe that enables the Project to be fully complete by March 2028 in order to meet federal DMAF funding requirements. If it were determined that the Project is required to proceed to an EA, the City would have to cancel or rescope the Project given that the time to conduct an EA and fully execute the Project would not align with the DMAF funding deadline.

The Project will not require an Impact Assessment under the federal *Impact Assessment Act* [S.C., 2019] because the physical works associated with the Project are not described in the Regulations Designating Physical Activities, the Minister of Environment and Climate Change has not designated the Project, and the Project is not located on federal lands.

1.2.2 Permits and Authorizations

Federal and Provincial Legislation

The Project is within the Boundary Bay Wildlife Management Area (WMA). A WMA is an area of land designated under section 4(2) of the BC *Wildlife Act* for the benefit of regionally to internationally significant fish and wildlife species or their habitats. In June 1995, the Boundary Bay WMA was designated for the purpose of conserving critical, internationally significant habitat for year-round, migrating and wintering waterfowl populations, along with important fish and marine mammal habitat.

Within a WMA, conservation and management of fish, wildlife, and their habitats is the priority; therefore, other uses generally need to be compatible with this priority. New activities that involve use of land or resources in a WMA require written permission from the Regional Manager. A Memorandum of Understanding (MOU) for the Project has been prepared and signed by City of Delta, City of Surrey, and the Government of BC to facilitate the development of the Nature-Based Foreshore Enhancements Pilot Studies, and the Project, Site S2. The MOU lays out the process for securing the WMA permission and can be found in Appendix A2.

A 1977 Order in Council, regarding the *Environment and Land Use Act*, stated that "*the Fraser River Estuary and adjacent submerged lands, including Boundary and Semiahmoo Bays…[shall] be subject to a mandatory environmental impact assessment*". The BC Ministry of Forests (MOF) has confirmed that the WMA process under the *Wildlife Act* will be sufficient to satisfy the requirements under the Order in Council for the Mud Bay Foreshore Enhancements Project.

The Project is expected to require federal and provincial permits and authorizations, as outlined below in Table 2, and is compatible with existing government policies and bylaws, such as those described in Table 3.

Table 2 Other Federal and Provincial permitting requirements for the Mud Bay nature-based foreshore enhancements project, Site S2.

Applicable Legislation		Agency	Permit/Approval/Authorization	Information Regarding Permits
Federal	*Fisheries Act*	Fisheries and Oceans Canada (DFO)	Request for Review (RFR)	An RFR will be prepared to assess the potential impacts of the Project on fish and fish habitat. This will allow DFO to determine whether the Project will require a *Fisheries Act* Authorization, due to death of fish or Harmful Alteration, Disruption or Destruction (HADD) of fish habitat. Given the aim of the project is habitat restoration and the avoidance and mitigation measures proposed, as discussed in Section 6.3.1, an authorization is not expected to be required. If this is the case, DFO will still issue a letter to the City that recommends avoidance and mitigation measures that will be implemented during Project construction.
			Authorization [Section 35(2)]	An Authorization is not expected to be required under the *Fisheries Act*.
	Canadian Environmental Protection Act (CEPA)	Environment and Climate Change Canada (ECCC)	Disposal at Sea (DAS) Permit	The disposal of dredged or excavated material in the marine environment requires a permit under Part 7, Division 3 of the *CEPA*. Where a project can demonstrate that the placement is for another purpose (i.e., beneficial reuse) and that it meets the criteria for placement and is not contrary to the purposes of Division 3 of *CEPA* or the aims of the London Protocol or Convention, a DAS permit is not required. The Project is not anticipated to require a DAS permit, as the dredged material is being reused for beneficial purposes (salt marsh construction) and the imported salt marsh sediments will be confirmed to meet criteria defined within the Disposal at Sea Regulations (DAS criteria). This will be confirmed with ECCC. See Section 6.3.1 for further discussion on avoidance and mitigation measures related to imported sediment quality.
	Canadian Navigable Waters Act	Transport Canada	Approval or Notice	Navigation is protected under the *Canadian Navigable Waters Act* and the Project is within a Navigable Water. The potential for interference with navigation depends on the construction method selected. The placement of imported sediment from a marine dredging vessel has greater potential to interfere with navigation, than land-based construction options. If the Project does not interfere with Navigation, the City may submit a No Interference with Navigation notification, which includes a public notice. Alternatively, if the Project has the potential to interfere with navigation, an application for approval will be submitted to Transport Canada which may result in an approval being required.
	Species at Risk Act (SARA)	ECCC	SARA Permit	A SARA permit is required when a project may affect a listed wildlife species (or its critical habitat), that is federally managed (on federal lands, aquatic species or migratory birds) or where a critical habitat prohibition has been issued to extend the prohibition to provincial/private lands (i.e. an emergency protection order). If during construction, the salvage and relocation of SARA-listed migratory bird species during project construction is necessary (i.e., to remove species from harm's way), a SARA permit may be required. No SARA-listed aquatic species have been identified within the Mud Bay area. Critical habitat for the SARA-listed Audouin's night-stalking tiger beetle exists within the Mud Bay area; however, this species is not federally managed and, although a draft recovery strategy was proposed in 2021 and is under review, an emergency protection order has not been issued. As a result, a SARA permit would not be required. Given the aim of the Project is habitat restoration and the avoidance and mitigation measures proposed, as discussed in Section 6.3.1, adverse effects to critical habitat are not expected anyway.
Provincial	*Heritage Conservation Act*	Ministry of Forests	Heritage Inspection Permit	Archaeology sites may not be altered or changed without a permit. A Heritage Inspection Permit has been acquired to assess the archaeological significance of the Project footprint. Indigenous nations with interest in the Project may also issue Cultural Heritage Investigation Permits, in addition to the Heritage Inspection Permit. See Section 6.3.2 for further discussion on avoidance and mitigation measures related to archaeology and cultural heritage sites.
	Water Sustainability Act	Ministry of Forests	Water Use Approval [Section 10]	Water Use Approvals are required for the diversion, use or storage of surface water or groundwater for a number of purposes, including habitat conservation. Specifically, a Use Approval authorizes the temporary diversion and use of a stream or aquifer. A Water Use Approval is only required if the imported sediments are placed using the land-based pumping construction method and a local freshwater water source is used to support the pumping of sediments.
	Dike Maintenance Act	Ministry of Forests	Approval	The *Dike Maintenance Act* states that changes must not be made to a dike or the area adjacent to a dike without the prior written approval of the Inspector or a Deputy Inspector of Dikes. While changes listed in the *Dike Maintenance Act* are largely engineering-related, the Project may be considered an alteration of the foreshore that could increase flood levels or impact dike integrity; therefore, an Approval may be required.
	Wildlife Act	Ministry of Forests	Wildlife Management Area	The Project is located within the Boundary Bay WMA. Under the *Wildlife Act*, activities that involve the use of land or resources in a WMA require written permission from the Regional Manager. An MOU for the Project has been prepared and signed by the City of Delta, the City of Surrey, and the Government of BC to facilitate the development of the Nature-Based Foreshore Enhancements Project, including the Project, Site S2. The MOU lays out the process for securing the WMA permission.
			General Wildlife Permit	The *Wildlife Act* requires a permit for the management of wildlife; however, this pertains only to vertebrate species. The Project may require a general wildlife permit to allow for the capture or handling of amphibians, reptiles, and mammals if required for salvage. See Section 6.3.1 for further discussion on avoidance and mitigation measures related to wildlife.
	Agricultural Land Commission Act	Agricultural Land Commission	Approval	Approval must be sought for non-agricultural usage of Agricultural Land Reserve (ALR) Lands. Lands in the ALR include Mud Bay Park and lands north of the extent of the Colebrook Dyke, and may be used for access to the Project site. Access to the Project site via the Boundary Bay Dyke Trail will result in short-term non-agricultural land usage (construction access) for ALR lands currently approved for non-agricultural usage (flood protection and recreation); therefore, an Approval is not expected to be required under the *Agricultural Land Commission Act*. See Section 6.3.2 for further discussion on avoidance and mitigation measures related to land use.
	Land Act	Ministry of Forests	License or Lease	The foreshore is provincial crown land and within the WMA. The Project site is defined within the terms of reference for the Nature-Based Foreshore Enhancements Project and the MOU between the City of Surrey, the City of Delta, and the Government of BC; the MOU addresses that land tenure cannot be issued within the WMA and is not required for the Project.

Regional and Municipal Bylaws

In addition to the federal and provincial legislation, regional and municipal bylaws that the Project may need to adhere to when working within Metro Vancouver and the City were also identified, as summarized in Table 3.

Table 3 Relevant Regional and Municipal Bylaws.

Applicable Bylaw		Information Regarding Bylaw
Metro Vancouver (Regional)	Bylaw No. 1177, 2012: Regional Parks Regulation	The use of the dyke trail of the Boundary Bay Regional Park will be required for access to the Project site. Based on Bylaw No. 1177, a Park Permit will be required to close down the dyke walkway during active construction works within the Regional Park. A proposal must be submitted to Metro Vancouver describing the works to be completed and including effectiveness monitoring and AM plans. Following approval, a letter of authorization will be provided to the Project confirming access into the park
City of Surrey (Municipal)	By-law No. 16389: Soil Conservation and Protection	The Project construction will require the deposition of imported sediments[4] in the Project footprint within the Mud Bay foreshore. Per the Soil Conservation and Protection By-law, the Project is exempt from a Soil permit because the Project is necessary for the construction of City infrastructure, the work will be initiated by the City, and the sediment deposition will occur at the City Project site. The Project must be conducted in accordance with Schedule A, Performance Standards, of the By-law.
	By-law No. 16138: Erosion and Sediment Control	The Project construction area will exceed 2,000 m^2 of land. Per the Erosion and Sediment Control By-law, an Erosion and Sediment Control Permit application must be submitted to the City prior to construction, which will include an Erosion and Sediment Control Plan.
	By-law No. 7044: Noise Control	The Project is proposed to be constructed in February 2025. During this time of year, tides can often be at their lowest during the evening and at night. As construction needs to occur at low tide, night work is expected. Per the Noise Control Bylaw, any construction works outside of 7:00 am to 10:00 pm Monday to Saturday or at any time on Sunday will require written approval.
	By-law No. 17160: Pesticide Use Control	The destruction of a noxious or invasive weed by means of pesticide use is permitted within 1m of the high-water mark when application of the pesticide is carried out by a Certified Applicator and in accordance with the *Weed Control Act* and *Invasive Plant Regulation*.
	By-law No. 13007: Highways, Traffic and Parking Regulation	The Project construction will require obstruction or temporary closure of the Boundary Bay Dyke Trail in Mud Bay Park. Per the Highways, Traffic and Parking Regulation, a Traffic Obstruction Permit application will be submitted to the City prior to construction, which will include a Traffic Management Plan.

[4] Under the *Soil Conservation and Protection By-law* (No. 16389), "soil" is defined as "the entire mantle of natural material above bedrock, including, but not limited to, sand, gravel, rock, silt, clay, peat, or topsoil," which is interpreted to be inclusive of dredged sediments for salt marsh construction.

1.2.3 Indigenous Treaties, Agreements, and Protocols

The Government of BC has various agreements in place with several Indigenous nations; those listed below may be pertinent to the Project. Information was obtained from the Government of BC's publicly available information on First Nations Negotiations (Government of BC 2022a), BC Assembly of First Nations (BCAFN 2022), and the Government of Canada's First Nations portal (Government of Canada 2020).

Treaties and Land Claims

Final Agreements:

- Final Agreement between the Tsawwassen First Nation, Government of Canada, and Government of BC – 2009

Provincial Agreements

Reconciliation Agreements:

- Métis Nation Relationship Accord between the Métis Nation British Columbia and BC – 2021

Memoranda of Understanding:

- MOU between the Government of BC and the Union of BC Municipalities (UBCM) regarding Engagement with UBCM and local governments on Treaty Agreements, Non-treaty Agreements, and Indigenous Initiatives

Strategic Engagement Agreements (SEA):

- S'ólh Téméxw Stewardship Alliance SEA between the Stó:lō First Nations and BC – 2019

Protocols

- *Ancestral Remains and Burial Places Plan* developed by the City with input and feedback provided by Penelakut Tribe, Musqueam Indian Band, and Katzie, Semiahmoo, Tsawwassen, and Tsleil-Waututh Nations.
- Semiahmoo First Nation *Treatment of Human Remains Protocol.*
- Tsleil-Waututh Nation *Ancestral Remains Policy (August 2017).*
- Sto:lo *Heritage Policy Manual (May 2003)* regarding policies and procedures for the protection, preservation, and management of Stó:lō Heritage; includes information about ancestral remains.

Declaration on the Rights of Indigenous Peoples Act

The BC *Declaration on the Rights of Indigenous Peoples Act,* passed in November 2019, sets the United Nations Declaration on the Rights of Indigenous Peoples as the basis for reconciliation between BC and Indigenous Peoples in the Province. It supports transparent, cooperative, staged approaches through which BC works with Indigenous nations, businesses, and local governments on decisions affecting Indigenous Peoples and their rights (Government of BC, no date).

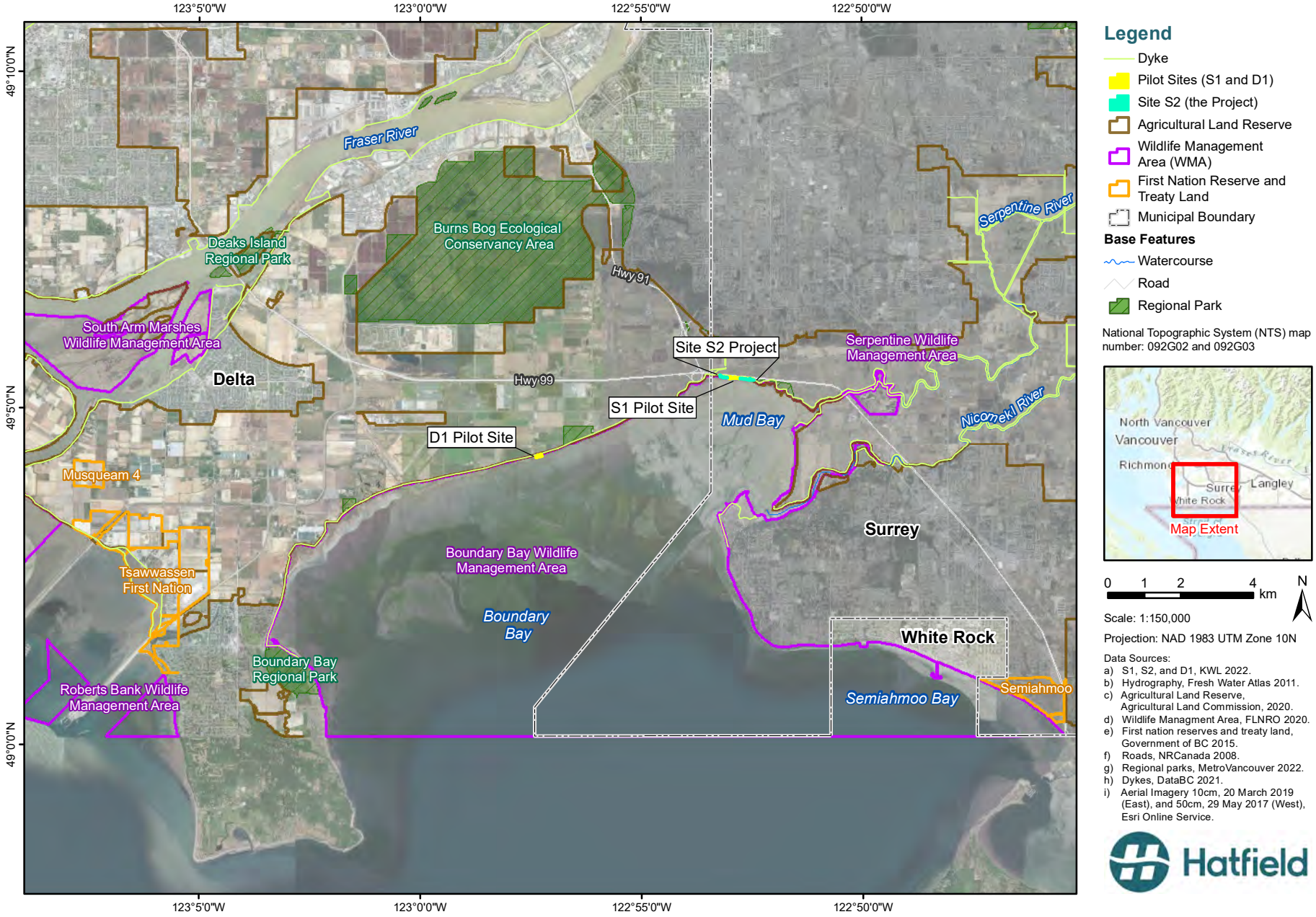
The BC *EAA* (B.C. Reg. 243/2019) enables reconciliation with Indigenous nations through meaningful participation in the BC EA process by enabling early awareness of key interests and identification of areas for collaboration and resolution. The Government of BC anticipates that Indigenous nations will choose to make a decision on whether a project should be approved through an expression of consent or by withholding consent. It is noted that the Ministers must take the Indigenous nations' decisions into consideration, however, the final decision-making authority remains with the Government of BC (Government of BC, no date). Section 7 of the BC EAA (2018) enables the requirement for Indigenous nation consent regarding projects in the EA process.

1.3 PROJECT STATUS AND HISTORY

The Project has not been previously proposed, and prior to the submission of this IPD, a great deal of time and effort has been put forward to engage others in the identification of issues related to the CFAS and DMAF projects, including the Project design, as described in sections 7.0 and 8.0. Over the course of several years, the Project design has evolved as a result of the identification of issues, and the City is confident that the current design will not result in significant adverse effects, or serious impacts to Indigenous Interests with the implementation of mitigation measures and adherence to other required regulatory processes.

The Project is located on the northern shore of Mud Bay, which is in the northeast of Boundary Bay, and located within the City of Surrey, as shown in Figure 2 and Figure 3.

Figure 2 Nature-Based Foreshore Enhancements, including D1, S1 and S2.



Legend

- Dyke
- Pilot Sites (S1 and D1)
- Site S2 (the Project)
- Agricultural Land Reserve
- Wildlife Management Area (WMA)
- First Nation Reserve and Treaty Land
- Municipal Boundary

Base Features

- Watercourse
- Road
- Regional Park

National Topographic System (NTS) map number: 092G02 and 092G03

0 1 2 4 km

N

Scale: 1:150,000

Projection: NAD 1983 UTM Zone 10N

Data Sources:
a) S1, S2, and D1, KWL 2022.
b) Hydrography, Fresh Water Atlas 2011.
c) Agricultural Land Reserve, Agricultural Land Commission, 2020.
d) Wildlife Managment Area, FLNRO 2020.
e) First nation reserves and treaty land, Government of BC 2015.
f) Roads, NRCanada 2008.
g) Regional parks, MetroVancouver 2022.
h) Dykes, DataBC 2021.
i) Aerial Imagery 10cm, 20 March 2019 (East), and 50cm, 29 May 2017 (West), Esri Online Service.

Hatfield

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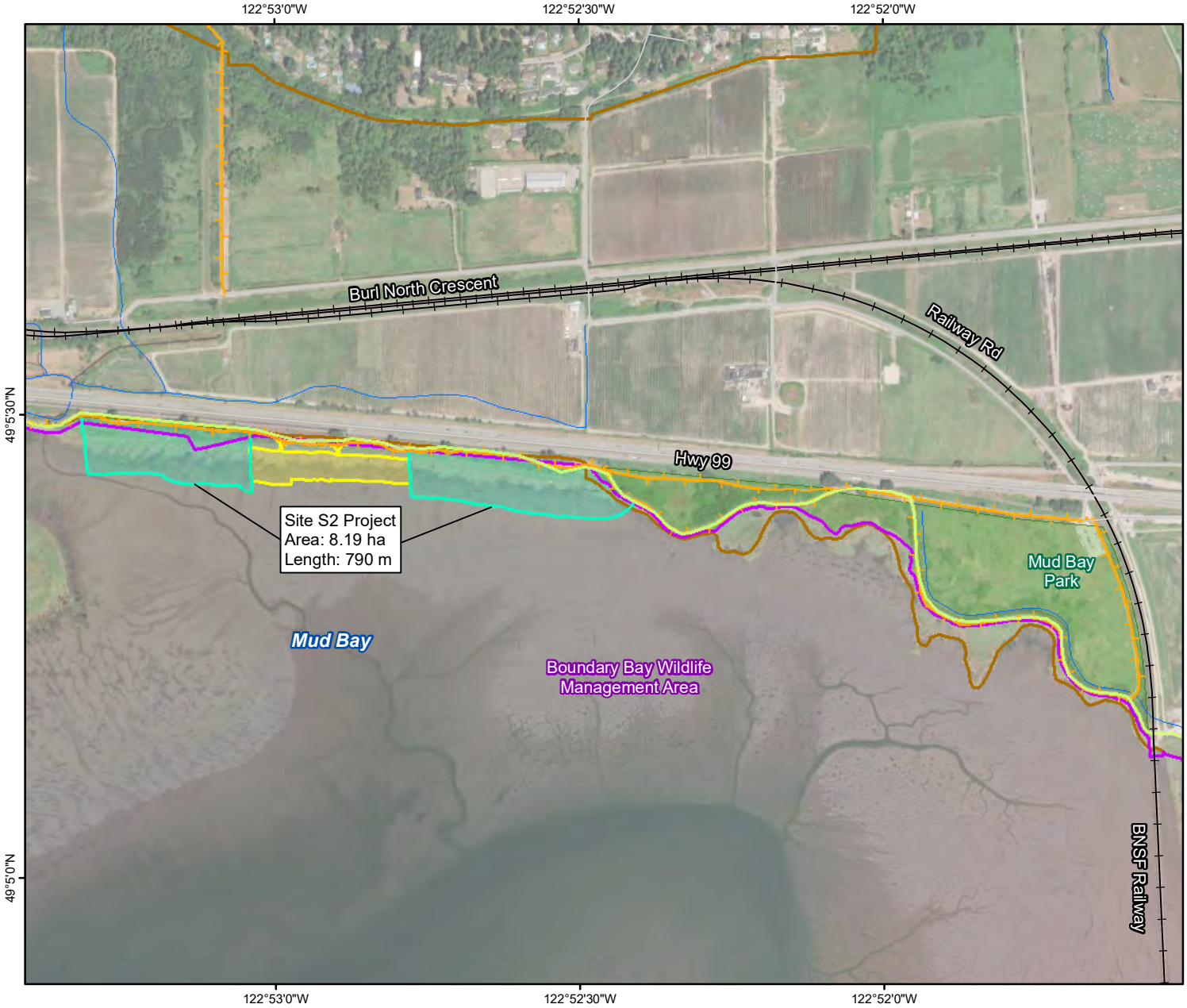
Figure 3 Mud Bay Nature-Based Foreshore Enhancements Full-Scale Project, Site S2.



Legend

- Existing Colebrook Dyke
- Recreational Trail
- S1 Pilot Site
- Site S2 (the Project)
- Wildlife Management Area (WMA)
- Agricultural Land Reserve

Base Features

- Watercourse
- Road
- Railway
- Parks

National Topographic System (NTS) map number: 092G02

0 100 200 300 m

N

Scale: 1:12,000

Projection: NAD 1983 UTM Zone 10N

Data Sources:

a) S2 site, created by Hatfield using buffers around KWL site data 2022.
b) S1 pilot site, KWL 2022.
c) Hydrography, Fresh Water Atlas 2011.
d) Roads, park, dyke, and trails, City of Surrey 2020-2022.
e) Wildlife Management Area, FLNRO 2020.
f) Aerial Imagery 10cm, 15 January, 2017, Esri Online Service.

Hatfield

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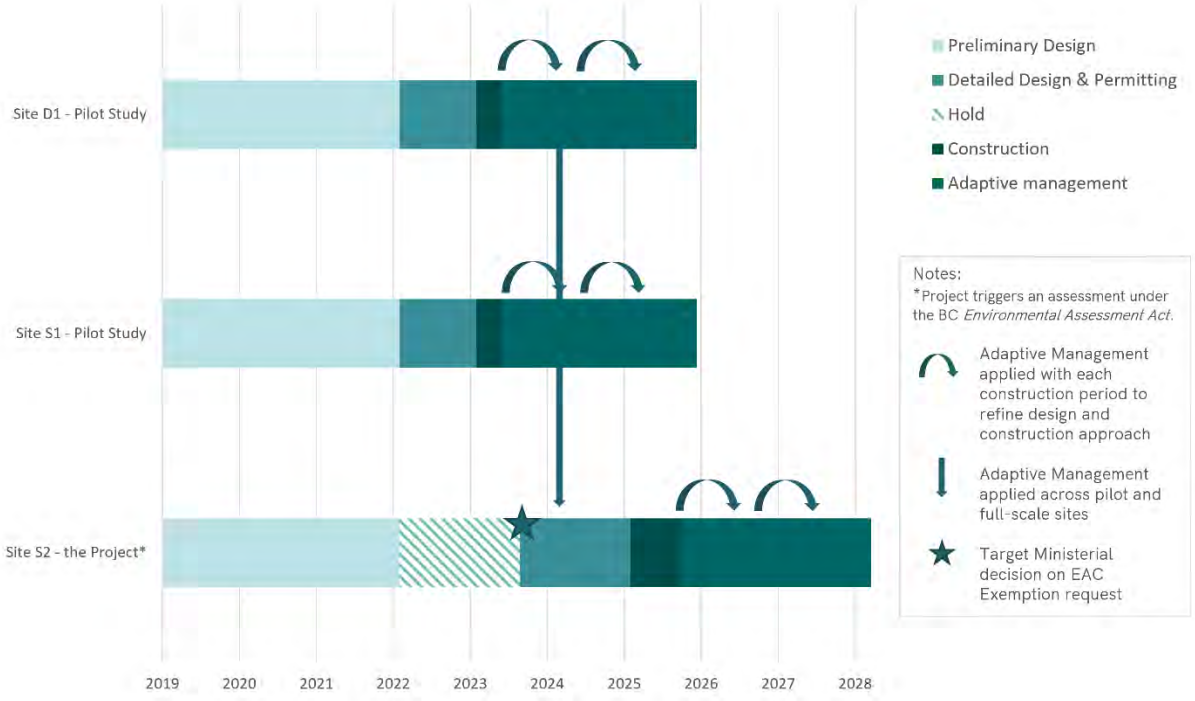
1.4 PROJECT TIMING

As further described in Section 3.2, the Project will employ a phased approach to construction, relying on Adaptive Management (AM) and lessons learned from the Pilot Studies before implementing the Project, Site S2. Assuming successful Pilot Studies and permit acquisition, initial construction of the Project aims to begin February 2025 through to October 2025, at which time the adaptive management phase of the Project would start and could extend until March 31, 2028. Figure 4 presents this phased approach to Project construction.

The Project would be a permanent environmental enhancement feature; therefore, the post-construction phase will consist of adaptive monitoring and management. No decommissioning is expected as part of the Project.

Figure 4 Schedule of Mud Bay Foreshore Enhancements Project Construction Phases.



1.4.1 Constructability and Timing Windows

The Project will be conducted in a sensitive coastal habitat. Although a more detailed construction schedule will be determined at a later date, through Project permitting and a Construction Environmental Management Plan (CEMP), the following timing windows and constructability will be considered when scheduling and planning Project activities:

- **Tides:** the Project site is inundated almost daily. Construction will be timed to work in the dry and additional measures may be required to contain the site each day to minimize erosion and sedimentation.

- **Season:** construction outside of the storm season is ideal to minimize the risk of the works being destroyed before vegetation has been established. Furthermore, depending on the month, the low tides may require night work (November to January most pronounced storm season; low tides in the region are at night from October to March). Night work may require work outside typical municipal construction hours and require prior approval. The least risk timing window for fish is between August 16 to February 28, while the least risk timing window for bird species is between mid–August and early April. Based on these considerations, construction should take place in February at the end of the least risk fish window and when there is generally a reduced number of storms. If constructed in February, low tides will be at night.
- **Sequence:** the placement of imported marsh sediment and construction of the sediment edge stabilization should occur during the least-risk timing window for wildlife, birds, and fish (see above). Marsh planting should occur according to the plant species growth cycle, from April for early growing species (e.g., rush and grass families), to May to mid-June for pickleweed (*Sarcocornia pacifica),* and other salt marsh species. Newly placed marsh sediments should be left for several weeks to months, depending on construction timing and plant growth window, to allow soils to settle and consolidate prior to marsh planting. Brushwood bundles may need to be tightened several months after construction, following settlement.

2.0 ENGAGEMENT SUMMARY

2.1 PRELIMINARY ENGAGEMENT WITH INDIGENOUS NATIONS

Proponents may be involved in the procedural aspects of consultation with Indigenous nations, however, the term “consultation” primarily refers to the legal obligations of the Crown (i.e. provincial and federal governments) when Aboriginal interests (rights and title) may be adversely affected by a Crown decision.

Engagement is different than consultation. Engagement aims to build relationships with Indigenous Nations by exchanging information in the absence of legal consultation obligations. The purpose of engagement is to build trust and create meaningful relationships. The following section summarizes the relevant preliminary engagement that occurred during the planning of CFAS and through which the Project concept was identified and developed.

The Project is within the core territory of Semiahmoo First Nation, lies within the traditional territories of the Katzie, Kwantlen, Sto:lo, and Tsawwassen First Nations, and may be of interest to other Indigenous nations and organizations. Recognizing the broad planning context under which CFAS was developed 20 Indigenous nations and organizations were identified from the federal and provincial consultation databases and subsequently confirmed with further guidance from the provincial Heritage Conservation Branch. The City engaged with the following Indigenous nations and organizations on the CFAS and DMAF programs (listed in alphabetical order):

1. Cowichan Tribes
2. Fraser Valley Métis Association
3. Halalt First Nation
4. Katzie First Nation
5. Kwantlen First Nation
6. Lake Cowichan First Nation
7. Lyackson First Nation
8. Musqueam Indian Band
9. Penelakut Tribe
10. Seabird Island Band
11. Semiahmoo First Nation
12. Shxw'ow'hamel First Nation
13. Skawahlook First Nation
14. Soowahlie First Nation
15. Stó:lō Nation
16. Stó:lō Tribal Council
17. Stó:lō Xwexwilmexw Treaty Association
18. Stz'uminus First Nation
19. Tsawwassen First Nation
20. Tsleil-Waututh Nation

These Indigenous nations were provided regular updates between 2016 and 2021 on the proposed CFAS and DMAF projects (which includes the Project). During preliminary engagement, the City received feedback related to the Project from the Katzie, Kwantlen, Semiahmoo, Tsawwassen First Nations, Tsleil-Waututh Nation, Musqueam Indian Band, and Penelakut Tribe (see Table 13). In July 2022 the City sent a letter to 13 mainland Indigenous nations providing notification of the City’s intent to seek an EAC amendment and invited feedback or questions. The City shared the IPD with the Semiahmoo First Nation and incorporated their feedback prior to submission to EAO.

As one of the outcomes of engagement, the Project the developed an innovative collaborative working group called the Boundary Bay Living Dike Roundtable (henceforth the Roundtable) that includes Indigenous nation membership established through a draft Terms of Reference. The Roundtable provides the opportunity for Indigenous nations and stakeholders to share their concerns and issues about the Project, as well as to speak to opportunities presented by the Project. The Roundtable consists of representatives from Indigenous governments and rightsholders, environmental regulators, municipal governments, coastal engineering experts, and researchers. It is chaired by staff from the Emergency Planning Secretariat and West Coast Environmental Law. The City acknowledges that Indigenous nations participation in the Roundtable and constituent groups does not constitute formal, statutory consultation. The Roundtable does, however, provide a venue for information sharing, technical dialogue, and relationship building with participating Indigenous nations.

Participants in the Roundtable are:

- Musqueam Indian Band
- Semiahmoo First Nation
- Tsawwassen First Nation
- Tsleil-Waututh Nation
- The First Nations Emergency Planning Secretariat
- City of Surrey
- City of Delta
- City of Richmond
- Ministry of Forests
- The South Coast Conservation Land Management Program
- Emergency Management BC
- DFO
- Natural Resources Canada (NRCan)
- West Coast Environmental Law

The Roundtable has held scheduled meetings since November 2018 and will continue to provide input through later project phases including construction, monitoring, and evaluation. The Roundtable has since evolved to include a Technical Working Group made up of members with specific technical expertise, a smaller Core Team made up of Semiahmoo First Nation, the City of Surrey, and the City of Delta to discuss logistics and strategy, and a Core Team Plus, which includes the Core Team and additional invitees (e.g., Project consultants and technical resource people) who have been involved in the process thus far and may provide additional insights going forward. Further detail on feedback received from Indigenous nations during this preliminary engagement and how this feedback has been addressed can be found in Section 7.1.

Each identified Indigenous nation or group described above has been notified of the City's intent to seek an EAC Exemption Order on the Project via a memo that was distributed on July 6, 2022. Indigenous nations will also have the opportunity to notify the BCEAO if they would like to be a participating Indigenous nation via the BCEAO's EAC Exemption Order review process. Engagement with Indigenous nations and organizations will continue along with broader outreach and engagement through established City of Surrey channels and the BCEAO.

The planned approach for future engagement with participating Indigenous nations is outlined in Section 7.3.

2.2 PRELIMINARY ENGAGEMENT WITH GOVERNMENT, PUBLIC AND STAKEHOLDERS

As a fundamentally participatory project, CFAS engaged with over 30 organizations, agencies, and governments, while over 2,000 residents and other stakeholders attended workshops, open houses, and focus groups, or participated through surveys and other engagement events. CFAS communications generated major national media coverage and over a quarter million social media impressions.

Indigenous engagement is an important component of CFAS and therefore the Project, where Indigenous nations have been engaged since 2016. This includes Semiahmoo First Nation, who actively participate as part of the Core Team, as discussed in Section 2.1.

Broader public engagement involved general outreach activities and events in both in-person and digital formats, project open houses, pop-up events in the study areas, a travelling community roadshow, and exhibits at community events and festivals throughout the City. Recognizing that younger generations will be significantly influenced by the CFAS decisions, a special emphasis was also placed on engaging with younger generations.

Further detail on public interests as they relate to the design and development of the Project and how interests have been addressed can be found in Section 8.0.

3.0 PROJECT LOCATION, ACTIVITIES AND COMPONENTS

3.1 PROJECT LOCATION

The Project is located on the northern shore of Mud Bay, which is in the northeast of Boundary Bay (Figure 2, Figure 3). The Project is located within the City of Surrey and the Serpentine River estuary, immediately south of Highway 99, and adjacent to recreational areas, such as Mud Bay Park and the Boundary Bay Dyke Trail. The Project also lies within or overlaps with multiple Indigenous nations and Indigenous organizations' traditional territories, as further discussed in Section 4.1.

Coordinates for the extent of the Project footprint are as follows:

- Degrees, minutes, and seconds (DMS):
    - Southeastern Extent: 49°5’23.19”, -122°52’24.6396”
    - Northwestern Extent: 49° 5' 30.138", - 122° 53' 19.0464"
- Latitude, longitude:
    - Southeastern Extent: 49.089775°, -122.873511°
    - Northwestern Extent: 49.091705°, -122.888624°
- Universal Transverse Mercator (UTM; NAD83) Zone 10:
    - Southeastern Extent: Easting 509235, Northing 5437443
    - Northwestern Extent: Easting 508131, Northing 5437656

3.1.1 Project Footprint

The Project will be constructed within the Mud Bay foreshore, on provincial Crown land, adjacent to City parkland, within the Boundary Bay WMA, as shown in Figure 2 and Figure 3. The Project footprint extends along the shoreline for a combined length of approximately 790 m of linear shoreline and approximately 105 m seawards of the Colebrook Dyke, and considers the area required for the constructed salt marsh and potential disturbance associated with construction activities within the foreshore (including access roads). The two sections of the Project footprint extend along the Mud Bay shoreline for a combined length of approximately 790 m of linear shoreline which equates to a total estimated Project footprint of 8.2 ha. The Project area includes the Mud Bay Park parking lot and access along the Colebrook Dyke to the Project location, in addition to the Project footprint.

Project footprint characteristics are summarized in Table 4 and Section 3.2, and presented in Figure 3. All elevations throughout the IPD are relative to mean sea-level (CGVD28) unless otherwise stated.

Table 4 Characteristics of the Project.

Characteristic	
Area of Disturbance	8.2 ha
Length of Disturbance	790 m
Salt Marsh Bench Target Elevation	+1.1 – +1.4 m elevation
Thin Layer Placement Target Elevation	+1.4 – +1.6 m elevation
Thin Layer Placement Depth	0.1 – 0.2 m

3.2 PROJECT COMPONENTS

Salt marshes naturally develop in river deltas or estuaries, coastal bays, or shoreline areas where fine-grained sediments accumulate to an elevation such that tidal inundation is sufficiently limited to allow salt marsh species to root and grow.

Using the “Living Dyke” concept and the Green Shores approach, the Project will gradually increase the elevation of the salt marsh to adapt to sea level rise of up to one metre (m). For this gradual increase to occur, the construction of a raised salt marsh will involve supplying sediment and vegetation on the foreshore to help enhance habitat and other ecological, cultural, and aesthetic values to the foreshore, provide natural flood regulation services to help protect communities from sea level rise, and minimize the loss of coastal ecosystems.

The Project is comprised of three components: (1) Sediment placement, (2) Sediment stabilization, and (3) Vegetation.

3.2.1 Sediment Placement

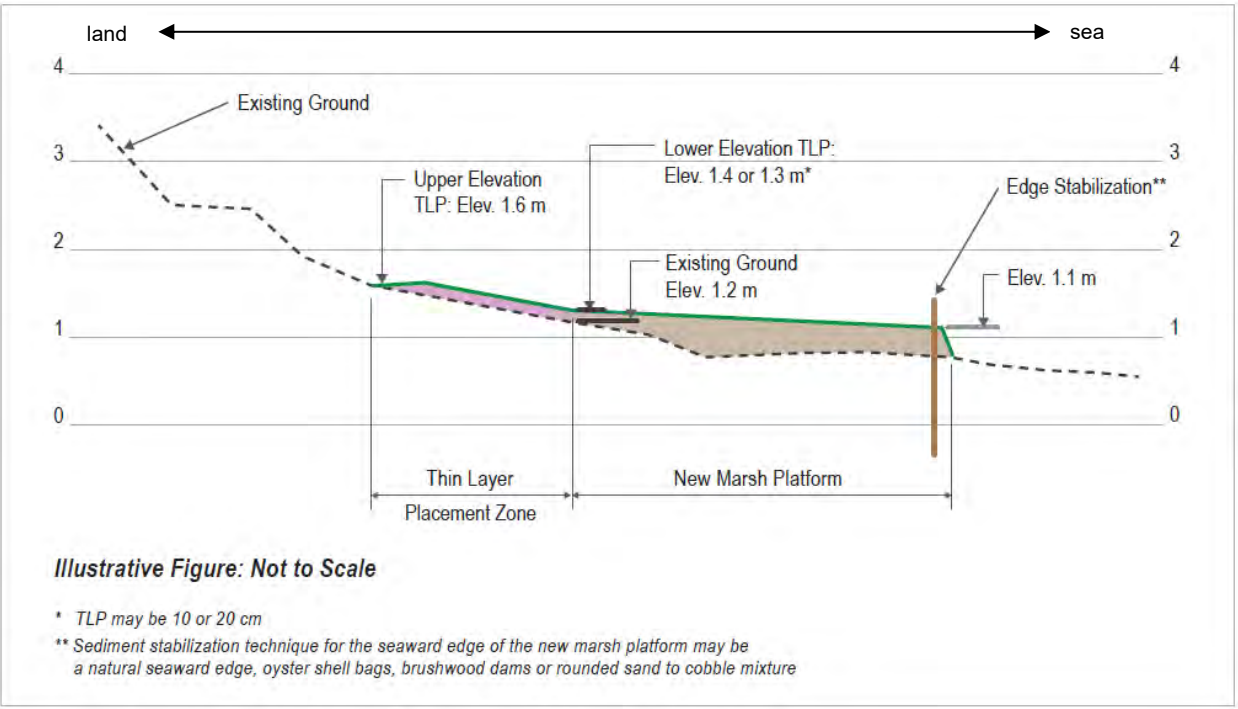
The Project will involve extending the existing salt marsh bench seaward from its current location to raise the existing lower marsh. The constructed salt marsh will tie into the existing high marsh and be built an estimated 40 to 50 m seawards of the current low marsh edge. It is anticipated that the seaward edge of the extended marsh will approximately follow the existing shape of the shoreline, with some areas more gently curved than the existing site. The target elevation for the constructed marsh bench is estimated to be a seaward edge of 1.1 m above mean sea level (CGVD28), where the edge stabilization treatments will start.

The landward elevation of the new marsh bench is dependent on the preferred TLP thickness over the existing marsh, which will be 0.1 – 0.2 m of sediment placed over existing vegetation. Thin Layer Placement (TLP) is a salt marsh construction technique where successive lifts of sediment are added on top of an existing marsh to maintain its elevation relative to the sea level (raising the marsh). The imported sediment is added at a rate such that the existing vegetation is not smothered and can grow through the material. The TLP technique has been successful for a range of lift depths, from 5 cm up to approximately 30 cm, with the greatest success in the 5 to 15 cm range. Regrowth through the sediment was found to take approximately 2 years (Raposa et al 2021). The landward elevation of the new marsh bench is dependent on the preferred TLP thickness over the existing marsh, which will be 0.1 – 0.2 m of sediment placed over

existing vegetation. The TLP technique will be a novel approach within with Mud Bay area, successful TLP will depend on the existing vegetation's capacity to grow through the sediment.

The targeted landward elevation of the marsh bench will be between 1.3 and 1.4 m depending on TLP thickness and will extend upwards following the existing slope to an elevation of 1.6 m, which is the upper elevation range for most marsh species. The total width of the proposed constructed salt marsh from the seaward edge to the upper edge of the TLP area may range from 60 – 90 m, depending on the preferred edge stabilization technique. The TLP area is expected to vary from 20 to 10 m wide (in the landward-seaward direction) depending on the existing marsh width, see Figure 5 for an illustrative cross-section with target elevations. The Project will extend along the Mud Bay shoreline for a combined length of up to 790 m of linear shoreline.

Figure 5 Illustrative Cross-section Including Target Elevations.



Up to 6,400 m^3 of imported salt marsh sediment will be used.

The Pilot Studies will consider options that test the combination of different components and techniques for sediment amendments, sediment stabilization, natural recruitment of vegetation, and TLP on the existing salt marsh. The Pilot Study options are based on feedback obtained through the stakeholder engagement process on the CFAS and DMAF programs and through the Roundtable. The Pilot Studies have been designed to maximize pilot testing by subdividing the plots into experiments with different structural stabilization techniques, planting techniques, sediment sources, and TLP thickness. The preliminary design for the Project (Appendix A3) is based on the design of pilot Site S1. The experiments undertaken in the Pilot Studies will ultimately inform the detailed design for the Project. Changes have been made to the selected Pilot Studies options based on design development, costing, and feedback.

3.2.2 Sediment Stabilization

Four stabilization techniques will be tested as part of the Pilot Studies: natural seaward edge, oyster shell bags, brushwood dams and rounded sand to cobble mixture. Stabilization techniques were discussed with the Roundtable and more natural approaches were preferred by participants. Therefore, the use of non-natural materials or rip-rap is not being considered for sediment stabilization. NRCan (part of the Roundtable) is currently testing the four sediment stabilization techniques in a laboratory by creating small-scale versions and subjecting them to oceanic forces. Results are expected in late 2022 and will help inform the selection of a preferred technique. The Pilot Studies will experiment with the sediment stabilization techniques summarized below and the Project will implement the most successful option.

Natural Seaward Edge

The natural seaward edge is a shallow sloped sand face, comprised of imported sediment that might provide a suitable substrate for biofilm to colonize. This experimental approach would rely on the natural establishment of biofilm for stabilization. Biofilm is composed of extracellular secretions and filaments that help bind sediments and increase sediment resistance to erosion, thereby providing a stable condition for marsh plants to establish. Biofilm can be considered an “ecosystem engineer” and provides ecosystem services including sediment stabilization, nutrient cycling, and food chain support. Biofilm is renewable and re-establishes on deposited sediments from winter storms in the following spring. This process was suggested by Kellerhauls and Murray (1969).

Biofilm has been observed in the Project footprint (KWL 2022b) however, manipulating biofilm to stabilize sediments has not been previously attempted, and, based on observations supporting the biophysical assessment, the biofilm abundance in the area is believed to be relatively low (see Section 6.3.1.2). Therefore, it is expected that active sediment stabilization will be required.

Oyster Shell Bags

This method uses oyster shells contained within a natural bag or wide mesh. The bags are stacked to provide a permeable and somewhat flexible seaward edge, that would contain the placed sediments and provide some energy dissipation from waves, which may promote sedimentation on the marsh bench. Stacked oyster shell bags have been used throughout the eastern United States of America (USA) as a method to foster oyster reef growth, reduce erosion, and retain marshes and sediment. Oyster shell bags have also been used by Project Watershed on Vancouver Island for marsh construction.

Stability is provided by the weight and interlocking of the oyster shell bags. Oyster shells are less dense than rock, and the reduced weight relative to rock would result in lower stability. Bags made of a biodegradable fabric (such as jute or coconut fibre) would be filled with oyster shells and stacked to provide a permeable edge that will contain sediment.

A thin layer of granular filter material would be placed along the landward side of the oyster shell bags to help retain newly placed salt marsh sediment while it dewaters (if placed as a slurry). The dimensions of the oyster shell bags and the resulting berm are dependent on the material selected for the bags, which will be further refined in later stages of design.

The oyster shell bags are expected to break down in approximately 2 to 5 years, depending on the material chosen to contain the oyster shells. When the biodegradable bags break down, the shells will disperse along the shoreline. The intention is for the oyster shell bags to act as a temporary measure to stabilize the edge while marsh vegetation establishes. Once the bags biodegrade, the effect on the constructed salt marsh should continue to be monitored to understand the potential need for long-term stabilization.

Rounded Sand or Cobble

This stabilization technique consists of placing well-graded small rocks, in the sand to cobble range, at the seaward edge of the constructed salt marsh bench. This would create a “hard” edge at the seaward side of the constructed salt marsh to contain the placed sediment and provide some energy dissipation for waves, which may promote sedimentation on the marsh bench. This method has been used in many marsh construction projects in the lower mainland.

A sufficient volume of material would be placed such that the material can move with wave motion without exposing underlying sands and mud. It is expected that the material will be shaped by the waves to an “equilibrium profile”, which is stable over long periods. Depending on the gradation selected, it may be necessary to place a “filter layer” of finer material between the rounded sand to cobble and the finer-grained imported sediment.

Maintenance requirements for this option would vary depending on the mobility of the rock. Larger “stable” rock sizes would require little maintenance; a smaller rock size may require periodic repair or supplementation.

Brushwood Dam

This technique uses wooden vertical supports and brushwood woven between the vertical supports to create a permeable structure along the seaward edge of the sediment addition, to contain the placed material and provide some energy dissipation for waves, which may promote sedimentation on the marsh bench. Brushwood typically is comprised of the branches of local bushes, shrubs, and small trees such as willow, hardhack, or vineyard grapevine pruning waste wood.

Stability is provided by the lateral resistance of the wooden vertical supports. The landward side of the brushwood dams may include straw bales embedded into the placed salt marsh material to improve sediment retention during sediment placement and allow for dewatering of the placed sediment through a straw bale “filter”.

Dams would be constructed of wooden vertical supports with brushwood bundles woven between the vertical supports to create a permeable structure. Brushwood bundles would be fastened to vertical supports using wire that is typically non-biodegradable, to be sufficiently strong to counteract the buoyancy forces on the brushwood during high tide. The bundles of brushwood will be approximately 0.3 m in diameter and can be stacked or embedded to achieve the required design elevations.

The finished pole height above ground would vary depending on the height of the marsh being constructed above the existing mudflat. The poles typically extend approximately two-thirds of their total length below ground. Brushwood dam heights are expected to be in the order of 0.4 m to 0.7 m above ground; therefore, 1.0 to 1.5 m below existing ground. Brushwood dams would extend above the placed sediment to reduce

wave-induced scour and encourage sediment recruitment behind them. Drainage outlets (low points in the brushwood dams) may be included in the design to better facilitate drainage and reduce the potential for fish stranding behind the dams.

The landward side of the brushwood dams would include straw bales embedded into the placed salt marsh material to improve sediment retention during sediment placement and allow for dewatering of the placed sediment through a straw bale "filter". No digging or excavation into native material would be required for the straw bale placement. The straw bales are intended to be temporary and will naturally break down over time.

The brush component of the brushwood dams is expected to break down in 2 to 5 years, depending on the material chosen as the woven brushwood. The wooden poles are expected to persist for longer but would eventually degrade. The length of time for poles to degrade is dependent on the diameter of the poles and the type of wood used, as some materials are generally more rot-resistant. Based on experience with wood in riverine restoration projects, Western Red Cedar, Douglas Fir, and Western Hemlock are generally the preferred species (in order) for greater longevity (MELP 1997). The marine environment, and intertidal area in particular, is subject to more rapid decay than freshwater systems, and in general, poles are expected to degrade within approximately 5 to 10 years in a marine environment (Western Wood Preservers Institute 2012, Younie 2015). For the Project, the brushwood dams could be maintained over the long term or left to naturally decay.

The brushwood dam design would be based on designs from the Netherlands, which have been proven to work in similar conditions. A unique feature of the BC coast, relative to the Netherlands, is the prevalence of large driftwood from the logging industry. How the brushwood dams interact with driftwood driven by waves is unknown; therefore, collecting data on their structural integrity and performance will be an important component of the AM plan.

3.2.3 Vegetation

In salt marshes and coastal processes, the vegetation provide several ecological services (e.g., fish and wildlife habitat), sediment stabilization, and wave attenuation. Nursery-grown salt marsh species, ideally propagated from plant material (seeds, plant fragments or cuttings) sourced in and around the Project, will be used for creating marsh for the Project. The species for planting are dependent on the elevation and the location within the marsh bench.

The intention is to take the planting techniques that are most successful during the Pilot Studies and apply them to the Project.

Planting Zones

The constructed marsh bench for the Project will have three zones of planting.

1. Marsh Edge: 12 m wide band at the seaward edge in the lower elevation zone;
2. Transition Marsh: 4 m wide band landward of the marsh edge in the transitional elevation zone; and,
3. Marsh Platform: the remainder of the marsh bench (excluding the TLP area) in the upper elevation zone.

The zones have been developed by considering the elevation range of each band, the species of vegetation that prefer that elevation range, and the density of plants that will provide sediment stabilization. Different planting densities and strategies will be used in each zone.

Planting Species

Using plant material (seeds, plant fragments, or cuttings) from Boundary Bay for propagation will ensure that the native, genetic constitution will be maintained, and transplanting will result in the best-adapted stock for in situ vegetation establishment. The species selected for nursery propagation have evolved under site conditions and developed disease resistance and other attributes, termed local provenance, to encourage successful establishment. Natural colonization by annuals and other perennials will also occur and improve plant coverage, diversity, and productivity.

Table 5 summarizes the proposed planting species and the estimated plant quantities. Proposed plant species were discussed with the Roundtable, including options to incorporate plants that are of interest to Indigenous nations. Estimated quantities are for the construction phase of the Project, additional stock for supplemental planting may be required during the AM phase.

Table 5 Plant species and estimated quantities.

Scientific Name	Common Name	Estimated Total Plugs
Triglochin maritima	Arrowgrass	23,700
Sarcocornia pacifica	Pickleweed	17,700
Bolboschoenus maritima	seacoast bulrush	6,700
Distichlis spicata	Saltgrass	10,200
Hordeum jubatum	foxtail barley	1,400
Deschampsia cespitosa	tufted-hairgrass	2,100
Juncus balticus	Baltic rush	1,400
Plantago maritima	seaside plantain	2,100

3.2.4 Laydown Areas and Access

Laydown areas for material stockpiles will be required but the location has not yet been determined. The contractor will determine the best locations for material laydown areas and equipment storage to facilitate construction subject to constraints included in the construction contract. Laydown areas and access will be chosen to minimize footprints and impacts on undisturbed marsh areas.

The main access to the Project site will be from the Colebrook Dyke/Boundary Bay Trail, which will be accessed from nearby Mud Bay Park. Some improvements may be needed along the Dyke to facilitate construction access and/or equipment pullouts and turnarounds. Regardless of the preferred construction option, it is expected that access routes/ramps from the Dyke to the Project site will be required. Depending on the preferred construction methodology, the footprint of the temporary roads may vary.

Temporary access roads and ramps may be required depending on the preferred construction method and will be constructed with sediment and/or standard road construction materials, as required, the use of temporary construction mats may also be considered. Equipment traffic will travel along the access routes and depending on the preferred construction option and sediment stabilization technique, equipment may also be required to travel along the perimeter of the constructed salt marsh. The Project footprint reflects consideration of these potential disturbances.

The existing Mud Bay Park parking lot may be a suitable laydown area, if some parking is to be maintained for the duration of construction, an extension of the Mud Bay Park parking lot may be required.

Materials placed to enable temporary construction access will be removed after construction and the access routes/ramps outside of the Boundary Bay Dyke footprint will be reclaimed.

3.3 PROJECT ACTIVITIES

The Project consists of earthworks and restoration activities in the marine environment. Construction of the Project will require the import and placement of up to 6,400 m^3 of sediment around and on the existing salt marsh. The marsh plants and substrates are vulnerable to crushing, abrasion, and compaction. Low-impact construction methods that minimize the operation of heavy machinery in areas of the foreshore with established salt marsh vegetation are required. Onsite equipment will be limited to equipment required during the construction phase of the Project and involve the import of sediments for marsh construction via land-based vehicles, offshore vessels, or a combination of both.

Salt marsh construction activities on the Mud Bay foreshore involve several key activities related to sediment:

1. Sediment Source – The sediment chosen for the salt marsh will be matched as closely as possible to the existing sediment at the site, depending on the local availability of material. Salt marsh sediment amended with additional fine sediment will be considered as part of the pilot sites (if necessary) and may be incorporated into the Project design based on the outcome of the pilot studies.
2. Sediment Quality – Sediment will be analyzed to meet appropriate environmental standards.
3. Sediment Placement and Stabilization – Three potential methods of sediment placement are being considered. Results from the Pilot Studies will help inform the preferred method, as further discussed in Section 3.3.3:
    a. Conventional material placement;
    b. Land-based pumping; and,
    c. Marine dredging vessel.
4. Vegetation Planting

3.3.1 Sourcing Sediment

The proposed salt marsh sediment will be matched to the existing sediment as closely as possible, depending on the availability of material. The sediment source for Project construction is expected to be Fraser River dredged sediment (main channel or secondary channels and harbours). Dredged sediment may be procured directly through the Port of Vancouver or other local dredging authorities projects (such as harbours). Alternatively, dredged sediment may be purchased through Mainland Sand and Gravel, which stockpiles Fraser River sand at its Timberland and No. 5 Road depots.

Dredging work on the Fraser River main channel takes place year-round with typical volumes of 3 million m^3 of sediment per year, though available volumes are dependent on timing and other groups that have agreements for the reuse of dredged material.

Alternative sources may be identified and considered, such as pre-load sediment and upland sediment sources from nearby projects.

The use of dredged material may either require stockpiling at a suitable site, or construction being timed to coincide with dredging.

3.3.2 Environmental Quality

For use of sediment in the intertidal area, sediment will be sampled to confirm that it meets appropriate environmental standards. The disposal of dredged material, from any source, into the marine environment requires a permit under Part 7, Division 3 of *CEPA*. Where a project can demonstrate the placement is for another purpose (i.e., beneficial reuse) and is not contrary to the purposes of Division 3 of *CEPA* or the aims of the London Protocol or Convention, a DAS permit is not required; however, the imported marsh sediments will be required to meet the DAS criteria.

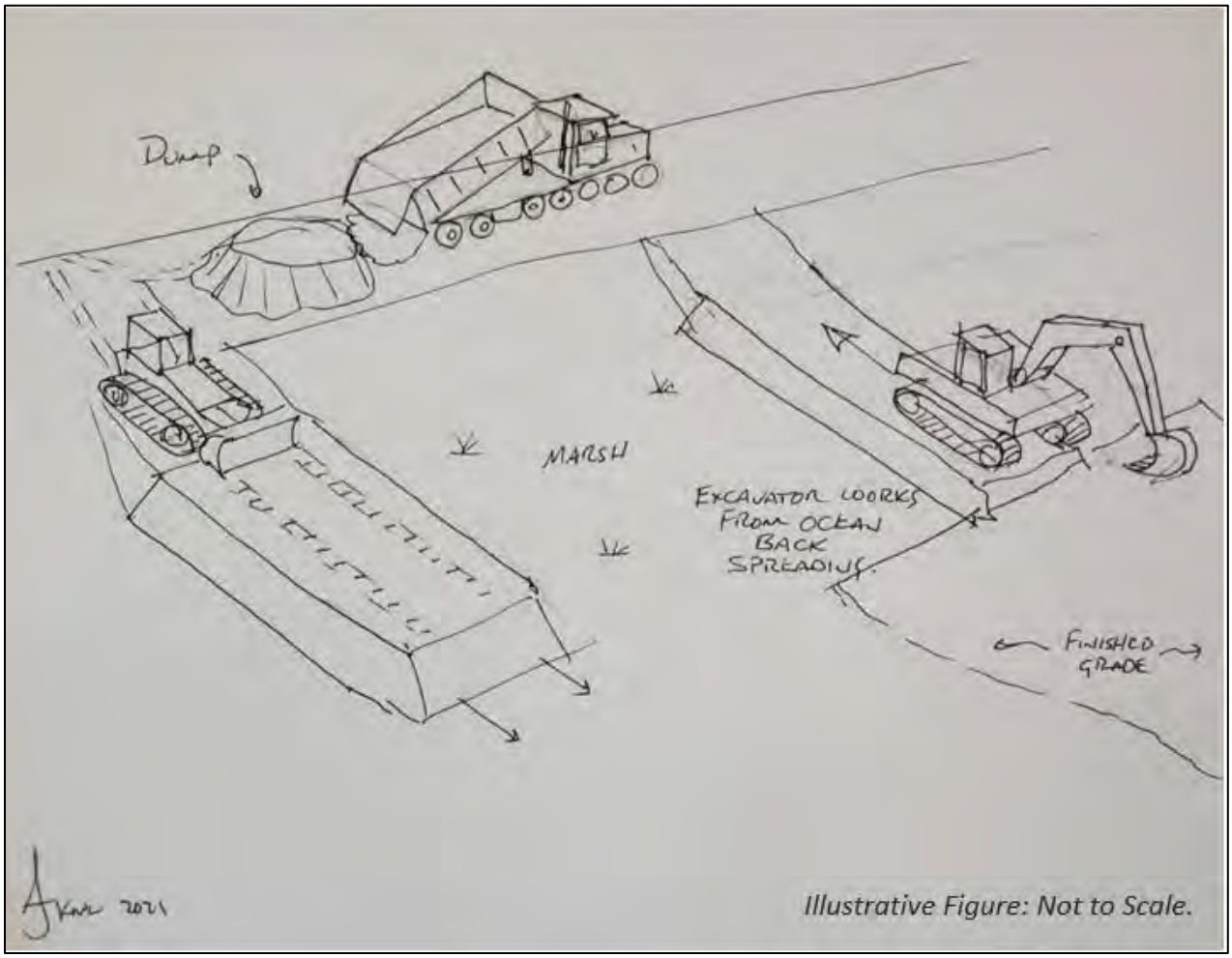
Environmental sampling is routinely conducted on dredged sediment for disposal and will be conducted on all sediment used for the Project. Procurement of the imported salt marsh sediment will include stipulation of environmental quality standards, that are consistent with DAS criteria, for acceptance of the imported marsh sediment.

3.3.3 Sediment Placement Methods

Option 1: Conventional Material Placement

The conventional material placement method would see the placement of dry imported marsh sediment in trucks for transport to the Project site. The sediments may either be placed directly onto the Project footprint via temporary access roads as discussed in Section 3.2.4, or dumped on top of the Colebrook Dyke where tracked loaders could use the imported marsh sediment to build temporary roads seaward from Colebrook Dyke to the seaward edge of the Project. Once the temporary road is built, an excavator could then work from the seaward edge back towards the Dyke, spreading the imported sediment material off the temporary road to the finished grades. Timber matting may be used at the Dyke edge to provide additional stability and protection. See Figure 6 for a conceptual sketch, showing potential material placement using conventional machinery.

Figure 6 Conventional material placement sketch.



Source: Kerr Wood Leidal (2022). Technical Memorandum #6 Pilot Project Preliminary Design (50%) – Draft Rev. 1

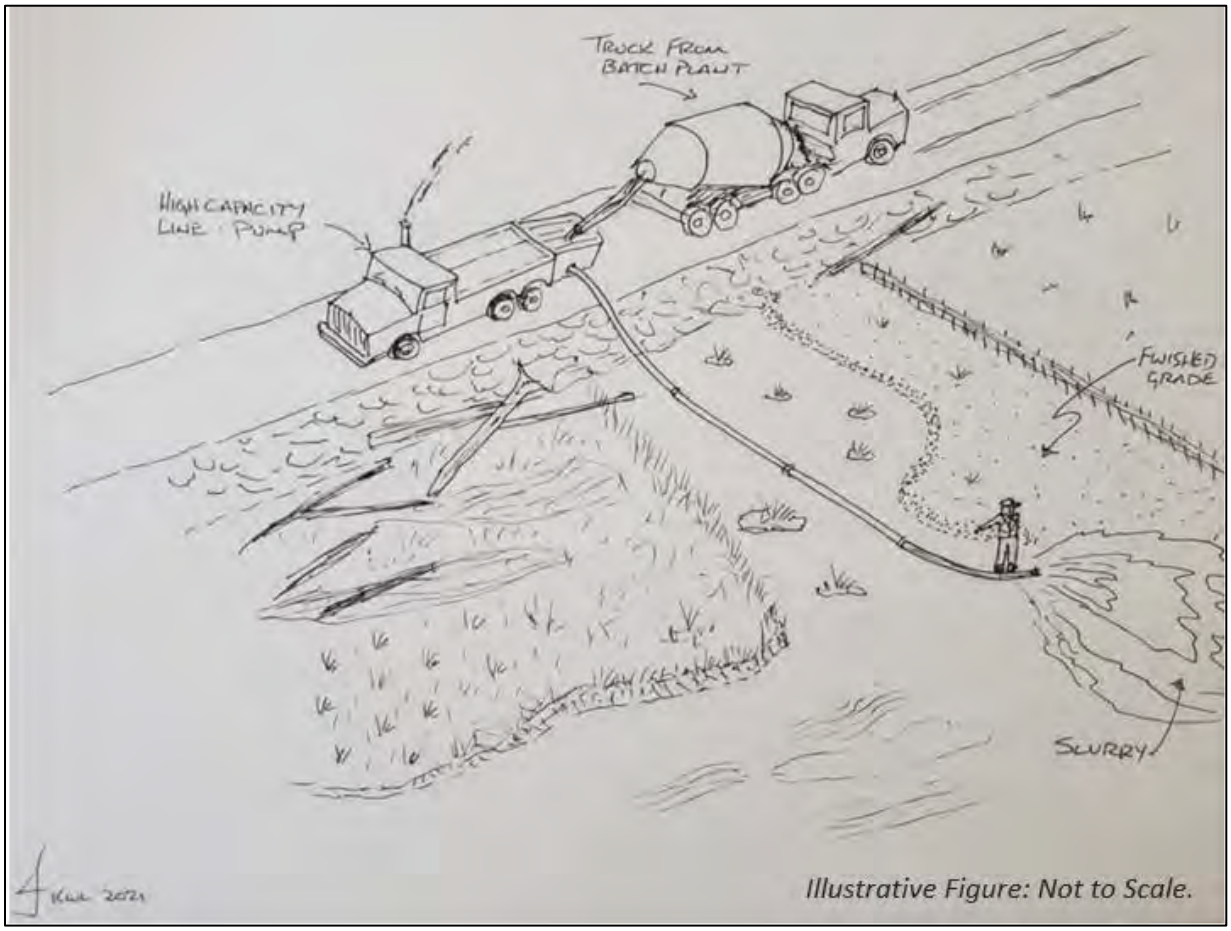
Option 2: Land-Based Pumping

The land-based pumping method of material placement would see sediment spread onto the foreshore using clean concrete pumps or other appropriate pumps for slurries, originating from the Colebrook Dyke. This is shown conceptually in Figure 7. Land-based pumping could be accomplished by transporting dry imported salt marsh sediment to the site, adding water, and then pumping; or by, transporting a sediment slurry to the site and pumping the material onto the foreshore.

If transporting dry sediments to the site and mixing into a slurry, up to 5.6 m^3 of water would be required per m^3 of sediment to be placed. This method may be effective if water is supplied locally, either from the City or from a water withdrawal from a nearby watercourse or Mud Bay. This method may require fluidizers and/or plasticizers to support mixing.

Sediments would be placed as a slurry, requiring temporary containment barriers to retain the slurry. Sufficient time would be required for the sediment to naturally dewater prior to the removal of the temporary containment barriers. This method of construction is typically used in TLP applications in the USA, though more typically pumped as a natural slurry directly from a dredging ship vessel or barge.

Figure 7 Land-based pumping sketch.



Source: Kerr Wood Leidal (2022). Technical Memorandum #6 Pilot Project Preliminary Design (50%) – Draft Rev. 1

Option 3: Marine Dredging Vessel

The marine dredging vessel method of material placement would involve material spread onto the foreshore using pumped slurry from a marine dredging vessel or barge moored in Boundary Bay. The vessel would need to be moored in sufficient water depth to safely navigate and to avoid grounding on the seabed. The intertidal mudflats extend 3-4 km between the Project and navigable waters.

The dredging vessel would be moored in suitably deep waters, the closest location to the Project is the crescent beach channel, which is located approximately 3-4 km from the Project site. A pipeline would be assembled from the mooring location to the Project site, this would likely be a pipeline that would be floated in (installed) during high tide and would need to stretch the full distance to the Project site. In previous projects, dredged material has been pumped up to approximately 2 km (personal communication from Fraser River Pile and Dredge to KWL). Pumping dredged material up to 3-4 km would be a relatively novel approach. Learning opportunities around pumping dredged slurry beyond 2 km may exist from work being conducted by Fraser River Pile and Dredge for the Sturgeon Bank Sediment Enhancement Project. This is a Project that is being led by Ducks Unlimited, Raincoast Conservation Foundation, Tsawwassen First Nation, and Lower Fraser Fisheries Alliance, which may also require the pumping of dredged sediments beyond 2 km.

Sediments would be placed as a slurry, requiring temporary containment barriers to retain the slurry as described under Option 2. Sufficient time would be required for the sediment to naturally dewater prior to the removal of the temporary containment barriers. Additional considerations would be required around extending a (part-time) floating pipeline through 3-4 km of tidal flats, which due to the shallow nature of Mud Bay, would likely only be floating during for part of the high tide. During low tide, the floating pipeline would be sitting on top of the exposed mud flats.

3.3.4 Sediment Stabilization

Stabilization materials will be sourced locally. Potential sources of brushwood include material from local municipality vegetation clearing operations, woody debris brought to Metro Vancouver composting facilities, vineyard pruning material, and pine seedling material. The oyster shells could be sourced from restaurants or shellfish processing facilities and would need to be cleaned beforehand. Cobble would be sourced from a local aggregate supplier.

Maintenance of piled oyster shell bags would depend on the bag size selected and its' stability. A key constraint on the design of oyster shell bags will be related to handling them during construction. Because the bags will be made of biodegradable material, they may be limited in size due to the tensile capacity of the bag material.

The vertical wooden supports that make up the Brushwood Dam would be approximately 0.14 m in diameter, with a pointed end that would be driven into the ground. Within the first few months after construction brushwood bundles typically settle and would require tightening of the bundles. The structures are maintained, as needed, by replacing brushwood and poles over the years and may be maintained as permanent structures. Although the posts for the brushwood dams could conceivably be installed by hand in the same manner as fence posts using a "post driver", it is considered to be more practical to install them using a small excavator equipped with a vibratory hammer.

Sediment stabilization materials will be clean and free of fines prior to use.

3.3.5 Vegetation Planting

Local sourcing of plant materials for propagation will involve selecting sites with abundant seed and material to harvest, under the guidance of Qualified Professionals, to collect enough material for propagation. It is anticipated that one or two years of lead time is required to obtain viable plant material. For large plant volumes, transplanting from the nursery may require more than one year to successfully vegetate the Project.

The planting strategy will be to plant higher densities in the marsh edge and transition marsh, with lower density (wider spacing) in the marsh platform. Closer to the seaward edge, a higher planting density has been selected in consideration of the expected importance of stabilizing the edge; landwards, the marsh platform zone will be planted with wider spacing. The potential methods for planting may be planting evenly spaced single plugs, or planting in grouped plugs in all marsh zones.

Marsh planting will occur according to the plant species growth cycle; April for early growing species (e.g., rush and grasses), and May to mid-June for pickleweed and other salt marsh species. Vegetation for marsh planting should be delivered immediately prior to placement (i.e., plants should not be kept on site unplanted for an extended period).

During construction of the salt marsh, plants will be planted during low tide when marsh sediment is exposed, and during the driest conditions possible.

3.3.6 Design Criteria and Constraints

The design criteria and constraints are summarized in Table 6. An indication of where there may be flexibility, or a lack of flexibility due to engineering, environmental or other constraints is provided.

Table 6 Nature-based foreshore enhancement project design criteria and constraints summary.

Key Issue	Criteria/Constraint
Project Siting	The Project location for Site S2 is within the Colebrook Dyke foreshore, from the City of Delta boundary eastwards for approximately 880 m of combined linear shoreline. The Project site must remain in the Colebrook Dyke foreshore to achieve Project objectives, and is constrained by the outflow of Eugene Creek to the west, the Colebrook Dyke to the north, and Mud Bay Park to the west.
Land Jurisdiction	The site is situated on and adjacent to lands within multiple (and overlapping) jurisdictions. Land jurisdiction is important because it informs relevant approval and permitting requirements. The Project will be constrained to working on the seaward side of the existing fence along Highway 99.
Performance Risk	The Project is to be informed by the experimental Pilot Studies D1 and S1, some techniques may not produce intended results during pilot testing or full-scale construction. Performance targets will be defined as part of the AM plan. The experimental Pilot Studies are necessary to inform the optimal design of Project and may define further constraints on the design of the Project. Techniques implemented during the Pilot Studies may be adjusted as more information is gained and there is flexibility.
Environmental Permitting and Authorizations	There are numerous constraints related to environmental permitting. Environmental permits and approvals must be obtained prior to Project construction, as discussed in Section 1.2.
Archaeological	Archaeological investigations will be conducted to identify potential archaeological sites; investigation and alteration permits will be sought as required. Construction techniques will be selected to avoid digging to minimize the possibility of archaeological site disturbance.
Met-Ocean Conditions	Met-ocean design criteria have been developed to define water levels, wind, and wave conditions to inform Project design and determine preferred construction strategies.
Driftwood and Debris	Preference to avoid salt marsh construction in the upper high tide range where significant driftwood and debris deposit (approximately 1.5 to 2.5 m elevation), which could smother and damage planting.
Salt Marsh Elevation and Slope	Existing vegetation is located from 0.5 to 1.8 m, with greatest species diversity and benches between 0.9 and 1.6 m. Construction of the salt marsh bench will target an elevation of 1.1 to 1.6 m. The elevation has some flexibility and will be refined based on the results of the Pilot Studies.
Sediment Composition	Imported sediment will be constrained by the composition of available material and the need to pilot test sediment compositions that can be feasibly created in large volumes for construction. Imported sediment will target a similar composition to the existing salt marsh that includes a mixture of sand, silt, and clay. There is some flexibility in the sediment composition within the range that will be defined.

Table 6 (Cont'd.)

Key Issue	Criteria/Constraint
Sediment Placement Depth	Target placement depth for TLP at 10 – 20 cm, based on learnings from the D1 and S1 Pilot Studies. There is some flexibility in the sediment depth placement.
Drainage	Drainage is required for salt marsh growth. Drainage will be provided within the constructed salt marsh by grading to encourage positive drainage and avoid areas of pooling water.
Construction Materials	Preference to use only natural and biodegradable, "nature-based" materials. Construction approach will avoid establishing hard infrastructure.
Vegetation Stock	Nursery-grown salt marsh species, propagated from plant material sourced in and around the Project, will be the target vegetation stock for the Project. Available vegetation stock will be constrained by the success of seed collection and propagation. Based on work to date this is the preferred method but there may be flexibility in the approach.
Construction Methods	The preferred construction methods will minimize the operation of heavy machinery in areas of the foreshore with established salt marsh vegetation, stay within the Project footprint, and avoid soft soils where machinery could get stuck. Construction planning is ongoing and there is some flexibility in the approach that will be refined through engagement and engineering design.
Bird Herbivory	Bird consumption of salt marsh plantings is a frequent occurrence based on past experience from projects in the Lower Mainland. Success of the constructed salt marsh vegetation may be constrained by bird herbivory, a "wait and see" approach is proposed to determine the actual extent of grazing and then determine what level of or adaptive management may be required.

3.4 ALTERNATIVE MEANS OF CARRYING OUT THE PROJECT

The Project is an alternative to traditional engineering approaches and implements a nature-based approach to adapt to climate change and sea level rise. Nature-based flood defences are a more sustainable approach, and have additional benefits including improved water quality, carbon sequestration, production of fisheries, nature conservation, and the creation of recreational space.

The design and construction of the Project will follow site specific AM practices to ensure that the enhancements are successful. Before arriving at the experimental design for the pilot sites, significant information sharing and technical dialogue was completed during the Living Dyke Roundtable meetings. Changes have been made to the Project components and techniques based on design development, costing, and stakeholder feedback. These changes include the following:

1. TLP experimentation was expanded to investigate variation in TLP placement conditions (i.e., placement on salt marsh hummocks and to the existing salt marsh bench).
2. The selected "amended dredge" sediment will be river sand supplemented with or sourced from areas with higher fines content than typical dredged sediment, which is predominantly sand.
3. The Project location has been adjusted to enable experimentation with the variation in salt marsh morphology and conditions seen within Mud Bay, and to enable a reduction in the length of access routes and amount of disturbance required to access the Project site.

4. Planting techniques and patterns were adjusted to include performance evaluation of single plugs versus grouped plugs.

5. The edge stabilization technique, rounded sand to cobble, was added to the sediment stabilization options being carried forward.

Additional options were considered for the Project components: (1) Sediment Placement, (2) Sediment stabilization, and (3) Vegetation. This included alternative techniques to construct a component and alternative options of the component itself (i.e., additional sediment stabilization options). The following subsections provide an overview of alternative options considered during Project design. These options were eliminated from the Project design based on feedback from the Living Dyke Roundtable and Living Dyke Technical Working Group; as well as, consideration of Project economics and scalability of the options from pilot-scale to full-scale implementation. The selected options considered for the Project are intended to support minimizing impacts to the existing marsh, minimizing potential impacts to potential archaeological sites, maximizing the experimental design of the Pilot Studies (D1 and S1), and maximizing the use of natural materials.

Sediment Placement

An existing unknown is whether sediment from the Fraser River dredging program is suitable for marsh establishment, or whether further amendments are required (or beneficial). If a sediment amendment is required, this will have logistical and financial repercussions for the Project. Different sediment amendments were considered in addition to the options discussed in Section 3.3.1. Other possible amendments to the dredged sediments that were considered include:

- Adding peat or sawdust to the sediment to change the characteristics of the material and increase sediment cohesion. This option would require testing before use to assess potential sawdust acidity (which would depend on the tree species) and buoyancy under tidal conditions; and,

- Adding eelgrass detritus that has washed up on shore to improve the sediment organic component.

An additional unknown is the capacity of the existing vegetation to grow through the imported salt marsh sediments. The TLP technique has been successful for a range of lift depths from 5 cm up to approximately 30 cm, with the greatest success in the 5 to 15 cm range. Regrowth through the sediment was found to take approximately 2 years (Raposa et al 2021). As discussed in Section 3.2.2. TLP thicknesses of 10 and 20 cm will be placed, based on the outcomes of the Pilot Studies (D1 and S1).

Sediment Stabilization

The necessary level of stabilization required to keep the imported salt marsh sediment relatively stable and facilitate establishment of the constructed salt marsh is an existing unknown. A range of sediment stabilization techniques were considered in addition to those discussed in Section 3.3.4. Other possible sediment stabilization techniques considered included the following:

- Polysaccharide amendment: imported marsh sediment placed along the seaward edge would be amended with a natural, food-grade polysaccharide (e.g., guar gum) to increase soil cohesion, and provide increased stabilization along the edge. The polysaccharide is a similar chemical to what

biofilm produces to stabilize sediments; this technique is intended to mimic that natural process until the biofilm can develop over the summer growing season.

  - Pro: natural material, minimal intervention, easy to construct.
  - Con: novel technique, may not perform as intended, sacrificial and intended to be a short-term bridge until the natural biofilm can establish. Optimal concentrations of amendment not known.

- Sand berm: construction of a sacrificial continuous or intermittent sand berm along the seaward edge of the constructed salt marsh to act as an energy dissipation structure and sediment nourishment source for the salt marsh bench and bay while it lasts. Given that the sand berm would be expected to be a temporary feature, no maintenance would be expected unless a decision was made to "renew" it to provide further sediment supplementation.
  - Pro: natural material, easy to construct.
  - Con: sacrificial and intended to be a short-term bridge until the natural biofilm can establish.
- Soil wraps: construction of a continuous seaward edge out of natural fabrics (such as coconut coir matting) folded around soil to create a continuous seaward edge to contain the imported salt marsh sediment and provide some energy dissipation for waves. Soil wraps would be held in place with stakes and the fabric material would biodegrade over time. Stability would be provided by the weight of the wrapped soil, and the friction between soil wraps and the staking. Required maintenance for soil wraps is expected to be limited, as long as, they maintain their structural integrity.
  - Pro: natural material, permeable, used extensively in the general bioengineering context, but not in the salt marsh construction context.
  - Con: requires stakes or embedment to make it stable. May have archaeological impacts. Cost may be excessive and availability of coir may be a challenge. Also, if the wrap material fails it may completely destabilize the soil wraps.

Vegetation

A key question about vegetation that has significant implications for scaling up the Pilot Studies to the Project, is whether the constructed salt marsh will establish through natural recruitment (allowing the existing vegetation to colonize the placed sediment naturally) or if the area needs to be planted with nursery stock to promote vegetation establishment.

Different planting strategies were considered prior to the options discussed in Section 3.3.5. In consideration of allowing opportunity for natural recruitments, consideration was given to only plant the seaward edge of the constructed marsh and alternate planted and non-planted areas within the marsh platform.

4.0 LAND AND WATER USE

The Project is situated on and adjacent to lands within multiple (and overlapping) jurisdictions, as shown in Figure 2. Key jurisdictional information is as follows:

- The Project site is within the City of Surrey. The City's municipal boundary extends seawards of Mud Bay Park to include a section of Mud Bay. The nearest residential community is Panorama Ridge, located approximately 0.7 km directly north of the Project.
- 20 Indigenous Nations and organizations were identified as potentially having an interest in the Project. The Project is within the core territory of Semiahmoo First Nation.
- Portions of the Project are under the jurisdiction of the Government, where lands seaward of the natural boundary and the WMA are managed by MOF.
- The Boundary Bay Dyke Trail, which is part of Boundary Bay Regional Park, is located on top of the Colebrook Dyke. The Dyke is classified as a low consequence, non-standard dyke with City of Surrey as the maintenance authority. The Boundary Bay Dyke Trail and Boundary Bay Regional Park are operated by Metro Vancouver.

The Project will be implemented within the Mud Bay foreshore, on provincial Crown land, adjacent to City parkland (Mud Bay Park), within the Boundary Bay WMA, and adjacent to the ALR. The land is zoned A-1. The City does not anticipate that there are any rezoning or changes in land designations required for the Project

Project footprint characteristics are summarized above in Section 3.1, and presented in Figure 3.

4.1 INDIGENOUS NATIONS AND RESERVE LANDS

The Project aims to emulate the natural unprotected shoreline rebuilding process in a manner that simultaneously enhances biodiversity and offsets the negative ecosystem impacts of coastal squeeze, related to sea level rise. This nature-based approach aligns well with an Indigenous ethos where land base is deeply connected to identity. For Semiahmoo, as with many other Indigenous nations, the land and sea is seen as provider of raw materials, and a sacred place having spiritual power (Semiahmoo First Nation 2014).

Based on search results from the provincial and federal consultation area database, 20 Indigenous nations and organizations were identified as potentially having an interest in the Project. These Nations and organizations are presented in Table 7 (in alphabetical order) and where relevant, information on the location of their traditional territories and reserves in relation to the Project is provided.

The City will continue to work with Indigenous nations and their organizations and regulatory agencies, through review of the IPD and Engagement Plan, to confirm the Nations and Indigenous organizations that are interested in participating in the BCEAO's EAC Exemption Order review process. A summary of the engagement that took place between 2016 and 2021 and the Nations that were engaged during this period, is provided in Section 2.1. Further detail on feedback received from Indigenous nations during this preliminary engagement and how this feedback has been addressed can be found in Sections 7.1 and 7.2.

Table 7 Indigenous Nation traditional territory and reserve location in proximity to the Project.

Indigenous Nation	Traditional Territory and Reserve Location	Approximate Distance from Reserve to the Project
Cowichan Tribes	The traditional territory of Cowichan Tribes includes the southern half of Vancouver Island, the Gulf Islands, as far south as Sumas and Nooksak in Washington State, as well as Lulu Island and the Fraser River through to Yale. (Cowichan Tribes 2021a). Cowichan Tribes is made up of seven traditional villages and nine reserves totaling approximately 2400 ha on southeast Vancouver Island (Cowichan Tribes 2021b). **Reserves include:** ▪ Cowichan Indian Reserve (IR) 1 (2291.3 ha), located in the Cowichan and Quamichan districts; ▪ Cowichan IR 9 (17.9 ha), located near the mouth of Koksilah River at the head of Cowichan Bay; ▪ Est-patrolas IR 4 (27.8 ha), located to the south of Cowichan Bay;Kil-Pah-Las IR 3 (20.6 ha); ▪ Theik IR 2 (30.3 ha), located on the south shore of Cowichan Bay; ▪ Kakalatza IR 6 (8 ha) and Tzartlam IR 5 (6.5 ha), located on the Cowichan River; ▪ Skutz IR 7 (7.3 ha), located on the Cowichan River at Skutz Canyon; and ▪ Skutz IR 8 (14.9 ha), located at the head of Skutz Canyon (Government of Canada 2020).Kil-Pah-Las IR 3 (20.6 ha) ▪ Theik IR 2 (30.3 ha), located on the south shore of Cowichan Bay ▪ Kakalatza IR 6 (8 ha) and Tzartlam IR 5 (6.5 ha), located on the Cowichan River ▪ Skutz IR 7 (7.3 ha), located on the Cowichan River at Skutz Canyon ▪ Skutz IR 8 (14.9 ha), located at the head of Skutz Canyon (Government of Canada 2020)	67 – 86 km
Fraser Valley Metis Association (FVMA)	The FVMA serves and represents the Métis people and provides opportunities to strengthen and revitalize their communities. The FVMA doesn't have asserted traditional territories in the vicinity of the project but do have a head office located in Abbotsford (Fraser Valley Metis Association 2022).	NA

Table 7 (Cont'd.)

Indigenous Nation	Traditional Territory and Reserve Location	Approximate Distance from Reserve to the Project
Halalt First Nation	Halalt First Nation is located near Crofton on Vancouver Island. The asserted traditional territory of Halalt First Nation is in the lower Chemainus Valley, at the southeastern edge of the City of Duncan, and Willy Island, off the mouth of the Chemainus River (Halalt First Nation 2019). **Reserves include:** ▪ Halalt IR 2 (109.20 ha), located on the right bank of the Chemainus River; and ▪ Halalt Island IR 1 (56.60 ha), located on Willy Island in Stuart Channel at the mouth of the Chemainus River) (Halalt First Nation 2019 and Government of Canada 2020).	62 – 65 km
Katzie First Nation	Katzie First Nation is located in the Fraser Valley. At the centre of Katzie territory is sḳəýċəyaʔɬ x̌acaʔ (the lake of the Katzie), also known as Pitt Lake. The Project falls within Katzie First Nation traditional territory, which encompasses the present-day municipalities of Pitt Meadows, Maple Ridge, Surrey, Langley, and Delta (Katzie First Nation, 2022). **Reserves include:** ▪ Barnston Island IR 3 (54.6 ha), the main community of the Katzie; ▪ Graveyard IR 5 (0.4 ha); ▪ Katzie 1 (43.1 ha); ▪ Katzie 2 (23.1 ha); and ▪ Pitt Lake 4 (214 ha) (Government of Canada 2020).	17 – 36 km
Kwantlen First Nation	Kwantlen First Nation is located primarily on McMillan Island near Fort Langley. The Project falls within Kwantlen First Nation traditional territory, which extends from Richmond and New Westminster in the west to Surrey and Langley in the south, east to Mission, and to the northernmost reaches of Stave Lake (Kwantlen 2020). Kwantlen has seven reserves with a total reserve land base of 568.9 ha **Reserves include:** ▪ Langley 2 (58.3 ha); ▪ Langley 3 (40.9 ha); ▪ Langley 4 (93.4 ha); ▪ Langley 5 (140.6 ha); ▪ McMillan Island 6 (191 ha); ▪ Pekw'xe:yles (10.3 ha), this is a shared reserve ; and ▪ Whonnock 1 (34.4 ha) at the confluence of the Stave and Fraser Rivers (Government of Canada 2020).	25 – 44 km

Table 7 (Cont'd.)

Indigenous Nation	Traditional Territory and Reserve Location	Approximate Distance from Reserve to the Project
Lake Cowichan First Nation (Ts'uubaa-asatx Nation)	Lake Cowichan First Nation (Ts'uubaa-asatx Nation) have always made their primary home on Cowichan Lake. The English translation of the name Ts'uubaa-asatx is "People of the Lake" (Ts'uubaa-asatx Nation 2021). The asserted traditional lands of Lake Cowichan First Nation encompass the Lake Cowichan Watershed including lands surrounding Cowichan Lake, its shoreline, and the adjacent streams and forest inland, the small lakes in the vicinity, and the uppermost portion of Cowichan River (Ts'uubaa-asatx Nation 2021). **Reserves include:** ▪ Lake Cowichan First Nation has one reserve on Vancouver Island (39 ha) along the north shore of Cowichan Lake (Ts'uubaa-asatx Nation 2020).	92 km
Lyackson First Nation	Lyackson First Nation is located in Chemainus, BC. Core traditional territory includes a portion of southern Vancouver Island from north of Ladysmith, west to Lake Cowichan, east to the Gulf Islands, especially Valdes Island (where Lyackson manages three land reserves which comprise a third of the island), and across the Strait of Georgia to include a narrow corridor on the lower Fraser River (Lyackson First Nation 2020 and BC Treaty Commission 2022). **Reserves include:** ▪ Lyackson IR 3 (710.60 ha), near the north end of Valdes Island); ▪ IR 5 (2 ha), situated at the south tip of Valdes Island; and ▪ Shingle Point IR 4 (32 ha), located on the west shore of Valdes Island (Lyackson First Nation 2020 and Government of Canada 2020).	53 – 59 km
Musqueam Indian Band	Musqueam Indian Band is located in the municipalities of Delta and Richmond. Musqueam traditional territory includes Vancouver, North Vancouver, South Vancouver, Burrard Inlet, New Westminster, Burnaby, and Richmond (Musqueam Indian Band 2022). The Project is located outside of the southern boundary of Musqueam traditional territory but is within the Nation's Consultation, Accommodation, and Resource Access boundary. **Reserves include:** ▪ Musqueam IR1 (former); ▪ Musqueam IR2, the main village site; ▪ Sea Island IR3, which is unoccupied; and ▪ Musqueam IR4 (57.2 ha), which is located in the farmlands of Delta (Government of Canada 2020).	18 – 29 km

Table 7 (Cont'd.)

Indigenous Nation	Traditional Territory and Reserve Location	Approximate Distance from Reserve to the Project
Penelakut Tribe	Penelakut Tribe is located on Penelakut Island in the southern Gulf Islands with traditional territory on southern Vancouver Island that encompasses Ladysmith to the north, Lake Cowichan to the west, and the Gulf Islands to the east. The Nation's traditional marine territory extends across the Strait of Georgia and includes a corridor along the lower Fraser River. The four reserves of Penelakut Tribe comprise 635.70 ha of land on Galiano Island, Penelakut Island, Tent Island, and Chemainus (Penelakut Tribe 2022). **Reserves include:** ▪ IR 9 (29.10 ha), located on Galiano Island; ▪ IR 7 (556.70 ha), located on Penelakut Island; ▪ IR (34.40 ha), located on Tent Island; and ▪ Tussie IR (15.50 ha), located in Chemainus (Government of Canada 2020).	53 – 58 km
Seabird Island Band	Seabird Island Band is a band government of the Sto:lo people and is located in the upper Fraser Valley region, 3 km east of Agassiz (Seabird Island Band 2020). The main community is Seabird Island, located in the District of Kent on the Fraser River near Agassiz. The Nation's traditional territory is in close proximity to the Project. **Reserves include:** ▪ Pekw'xe:yles (10.3 ha), which is a shared reserve; and ▪ Seabird Island (2179 ha), located on the Fraser River near Agassiz (Seabird Island Band 2020 and Government of Canada 2020).	43 – 89 km
Semiahmoo First Nation	Semiahmoo First Nation is primarily located on the 129 - acre Semiahmoo IR between the boundary of White Rock and the Canada–US border. The Project falls within the traditional territory of Semiahmoo First Nation, which encompasses portions of the Salish Sea, Lower Mainland BC, and extends into Washington (Semiahmoo First Nation 2020). **Reserves include:** ▪ Semiahmoo First Nation reserve (129 ha), located between the boundary of White Rock and the Canada–US border (Government of Canada 2020).	12 km

Table 7 (Cont'd.)

Indigenous Nation	Traditional Territory and Reserve Location	Approximate Distance from Reserve to the Project
Shxw'ow'hamel First Nation	Shxw'ow'hamel First Nation is a band government of the Sto:lo people located in the Upper Fraser Valley region near Hope. Shxw'ow'hamel is a member of the Stó:lō Tribal Council and is part of the Tiyt Tribe of the Stólō Nation. The total reserve land is 372.1 ha (BC Assembly of First Nations 2022). **Reserves include:** ▪ Shxw'ōwhámél (Ohamil) IR 1, located 13 kilometres west of Hope along the Trans-Canada Highway; ▪ Wahleach IR 2, located along the Lougheed Highway; ▪ Xelhálh (kuth-lath) IR 3, located north of Yale BC along Highway #1 (Shxw'ōwhámél First Nation 2020); and ▪ Pekw'xe:yles, shared reserve (Government of Canada 2020).	42 – 118 km
Sq'ewá:lxw (Skawahlook) First Nation	Skawahlook First Nation is located on three IRs situated near Provincial Highway #7, between the towns of Hope and Agassiz (First Nations Land Management Resource Centre 2022). The Nation is a member of the Stó:lō Xwexwilmexw Treaty Association. **Reserves include:** ▪ Skawahlook IR 1; ▪ Ruby Creek IR 2; and ▪ Pekw'xe:Yles.	96 – 97 km
Soowahlie First Nation	Soowahlie First Nation is a band government of the Sto:lo people located in the Upper Fraser Valley region at Cultus Lake (First Nations Land Management Resource Centre ND). **Reserves include:** ▪ Grass 15 reserve (64.8 ha), which is located 0.5 miles south of Chilliwack; ▪ Pekw'xe:yles reserve (10.3 ha), which is a shared reserve; and ▪ Soowahlie 14 reserve (458.30 ha), located 1 mile south of Vedder Crossing on the left bank of the Chilliwack River (Government of Canada 2020). Currently 170 members live on reserve.	42 – 71 km

Table 7 (Cont'd.)

Indigenous Nation	Traditional Territory and Reserve Location	Approximate Distance from Reserve to the Project
Sto:lo Nation	Stó:lō Nation is the political amalgamation of eleven Stó:lō communities: Aitchelitz, Leq'á:mel, Matsqui, Shxwha:y, Skowkale, Squiala, Sumas, Tzeachten, Yakweakwioose, Popkum, and Skawahlook First Nation. As of 2021, there are 2,841 Band members living throughout the 11 communities. The Sto:lo Nation Service Agency is located in Chilliwack, north of Cultus Lake. The Nation's traditional territory extends from Yale to Langley (Stó:lō Nation 2018).	67 km
Sto:lo Tribal Council	Sto:lo Tribal Council helps negotiate land and resources agreements outside of the BC treaty process. The Sto:lo Tribal Council represents Chawathil First Nation, Cheam First Nation, Kwaw-Kwaw-Apilt First Nation, Scowlitz First Nation, Skawahlook First Nation, Skwah First Nation, Sumas First Nation, Yale First Nation, each on their own behalf, and Aitchelitz Band, Shxwhá:y Village, Skowkale First Nation, Soowahlie First Nation, Squiala First Nation, Tzeachten, and Yakweakwioose First Nation, as represented by Ts'elxwéyeqw Tribe Limited Partnership (Stó:lō Nation 2018). Locations of the Nations identified as being relevant to this project can be found within this table.	NA
Sto:lo Xwexwilmexw Treaty Association	The Sto:lo Xwexwilmexw Treaty Association is the official negotiating body for the Treaty Process. The Treaty Association represents and creates opportunities for their six member Nations through self-governance: Aitchelitz First Nation, Leq'á:mel First Nation, Skowkale First Nation, Skawahlook First Nation, Tzeachten First Nation, and Yakweakwioose First Nation (Sto:lo Xwexwilmexw Treaty Association nd). Locations of the Nations identified as being relevant to this project can be found within this table.	NA
Stz'uminus First Nation	The main Stz'uminus First Nation community is located near Ladysmith. The traditional territory is located on east Vancouver Island and includes four reserves located on Vancouver Island comprising more than 1,200 ha. Most of the land borders the Strait of Georgia and Ladysmith Harbour (Stz'uminus First Nation 2022). **Reserves include:** ▪ Chemainus IR 13 (1,082.30 ha); ▪ Oyster Bay IR 12 (106.90 ha), located near Ladysmith Harbour; ▪ Squaw-Hay-One IR 11 (31 ha), located southeast of the community of Chemainus; and ▪ Say-La-Quas IR 10 (6 ha), located on the Chemainus River (Government of Canada 2020).	63 – 72 km

Table 7 (Cont'd.)

Indigenous Nation	Traditional Territory and Reserve Location	Approximate Distance from Reserve to the Project
Tsawwassen First Nation	Tsawwassen First Nation is located in Tsawwassen and the Nation owns approximately 724 ha of land between Point Roberts and the South Arm of the Fraser River. The Project falls within the Tsawwassen First Nation's traditional territory which extends from the watersheds that feed into Pitt Lake, the Pitt River, and portions of the municipality of Pitt Meadow, encompasses much of the land south and east of the South Arm of the Fraser River including the watersheds of the Serpentine and Nicomeckl rivers. The traditional territory also extends across the Salish Sea to encompass Galiano, Salt Spring, North and South Pender and Saturna Islands (Tsawwassen First Nation 2009). **Tsawwassen First Nation treaty lands include:** ▪ Tsawwassen First Nation Lands located in southwest Delta.	17 km
Tsleil-Waututh Nation	The traditional territory of Tsleil-Waututh Nation encompasses an area of approximately 190,000 ha reaching from the Fraser River in the south to Mamquam Lake (east of Whistler) in the north. The heart of the community is centred on the Burrard Inlet, between Maplewood Flats and Deep Cove in North Vancouver. The Project falls within the consultative boundaries of the Tsleil-Waututh Nation.(Tsleil-Waututh Nation 2021). **Reserves include:** ▪ Burrard Inlet 3 (108 Ha); ▪ Inlailawatash 4 (1 Ha); and ▪ Inlailawatash 4a (2 Ha).	25 – 43 km

4.1.1 Summary of Indigenous Nations Rights, Title, Interests and Land Subject to a Land Claim Agreement or Self-government Agreement

The full list of Indigenous nations whose traditional territories overlap with the Project area or who may have an interest in the Project due to direct or indirect effects are identified in Table 7. The City will continue to work with groups through the early engagement phase, to identify specific interests, and further understand and characterize each group's rights or other interests. This information will be updated in the Detailed Project Description (DPD).

Cowichan Tribes

Cowichan Tribes is represented by the Hul'qumi'num Treaty Group, currently in Stage 5 of the BC Treaty Process (Final Agreement) (Government of BC 2020). Cowichan Tribes is also a part of the Quw'utsun Nation, a group of Indigenous nations who represent their members in rights and title negotiations.

In 2019, Cowichan Tribes signed a framework agreement under the *First Nation Land Management Act* and voted to adopt a new land code (Quw'utsun Tumuhw) (Cowichan Tribes 2020).

Halalt First Nation

Halalt First Nation is represented by the Hul'qumi'num Treaty Group, currently in Stage 5 of the BC Treaty Process (Final Agreement) (Government of BC 2020). Halalt is also a part of the Quw'utsun Nation, a group of Indigenous nations who represent their members in rights and title negotiations.

Halalt First Nation has not signed a framework agreement under the *First Nation Land Management Act* (Indigenous and Northern Affairs Canada 2014).

Katzie First Nation

Katzie First Nation is negotiating its land treaty independently and is not part of either Sto:lo tribal councils (the Stó:lo Nation and the Stó:lō Tribal Council). Katzie is in Stage 4 of the BC Treaty Process (negotiating an Agreement in Principle with Canada and the Government of BC; Government of BC 2020).

Katzie First Nation recently signed a framework agreement under the *First Nation Land Management Act* (First Nations Land Management Resource Centre 2022).

Kwantlen First Nation

Until 2018, Kwantlen First Nation was part of the Stó:lō Tribal Council. Kwantlen is not currently involved in treaty negotiations with the Government of BC and the Government of Canada (Government of BC 2020). Stó:lō Tribal Council is working on land and resource agreements with BC outside of the treaty process.

Kwantlen First Nation has signed a framework agreement under the *First Nation Land Management Act* (First Nations Land Management Resource Centre 2022).

Lake Cowichan First Nation (Ts'uubaa-asatx Nation)

Lake Cowichan First Nation is represented by the Hul'qumi'num Treaty Group. The Hul'qumi'num Treaty Group is involved in treaty negotiations on behalf of its members and has transitioned into Stage 5 of the BC Treaty Process (Final Agreement) (Government of BC 2020).

Lake Cowichan First Nation has signed a framework agreement under the *First Nation Land Management Act* (First Nations Land Management Resource Centre 2022).

Lyackson First Nation

Lyackson First Nation is represented by the Hul'qumi'num Treaty Group, currently in Stage 5 of the BC Treaty Process (Final Agreement) (Government of BC 2020). Lyackson is also a part of the Quw'utsun Nation, a group of Indigenous nations who represent their members in rights and title negotiations.

Lyackson First Nation has not signed a framework agreement under the *First Nation Land Management Act* (Indigenous and Northern Affairs Canada 2014).

Musqueam Indian Band

Musqueam Indian Band have established aboriginal rights, as affirmed by the Supreme Court of Canada in R. v. Sparrow, [1990] 1 S.C.R. 1075.

Musqueam Indian Band has signed a Collaborative Management Agreement for the management of Crown tenures in the Fraser River Transition Area and are currently in Stage 4 of the Treaty Process. Musqueam is negotiating independently with BC and Canada; however, negotiations are currently on hiatus.

Musqueam Indian Band has signed a framework agreement under the *First Nation Land Management Act* (First Nations Land Management Resource Centre 2020).

Penelakut Tribe

Penelakut Tribe is represented by the Hul'qumi'num Treaty Group, currently in Stage 5 of the BC Treaty Process (Final Agreement). The Statement of Intent of the Hul'qumi'num Treaty Group includes both its core territory and a marine territory (Government of BC 2020). Penelakut Tribe is also part of the Quw'utsun Nation, a group of Indigenous nations that represents their members in rights and title negotiations.

Penelakut Tribe recently signed a framework agreement in 2020 under the *First Nation Land Management Act* (First Nations Land Management Resource Centre 2020).

Seabird Island Band

Seabird Island First Nation is not participating in the BC Treaty Process (Government of BC 2020).

Seabird Island Band has recently signed a framework agreement in 2020 under the *First Nation Land Management Act* (First Nations Land Management Resource Centre 2020).

Semiahmoo First Nation

Semiahmoo First Nation is not currently involved in treaty negotiations and has not signed a framework agreement under the *First Nation Land Management Act* (Indigenous and Northern Affairs Canada 2014).

Shxw'ow'hamel First Nation

Shxw'ow'hamel First Nation is a member of the Stó:lō Tribal Council and is working with the Government of BC on land and resource issues outside of the BC treaty process.

Shxw'ōwhámel First Nation was a signatory member of the SEA between Stó:Lō First Nations and the Government of BC (Stó:lō SEA) from April 1, 2014, to March 31, 2019. As of April 1, 2019, they are no longer members. Stó:lō SEA is managed by the People of the River Referral Office.

Shxw'ow'hamel First Nation signed a framework agreement in 2020 under the *First Nation Land Management Act* (First Nations Land Management Resource Centre 2020).

Skawahlook First Nation

Skawahlook First Nation is a member of the Stó:lō Xwexwilmexw Treaty Association and is in stage 5 of Treaty negotiations. The Nation has signed an operational framework agreement under the *First Nation Land Management Act* (Indigenous and Northern Affairs Canada 2014).

Soowahlie First Nation

Soowahlie is a member of Sto:lo Tribal Council and is involved in a SEA with the Government of BC.

Soowahlie First Nation has signed an operational framework agreement under the *First Nation Land Management Act* (Indigenous and Northern Affairs Canada 2014).

Sto:lo Nation

Stó:lō Nation is the political amalgamation of eleven Stó:lō communities: Aitchelitz, Leq'á:mel, Matsqui, Shxwha:y, Skowkale, Squiala, Sumas, Tzeachten, Yakweakwioose, Popkum, and Skawahlook. The Stó:lō Service Agency aims to ensure social and economic development within the Stó:lō community through various services and programs.

Stó:lō Nation is not directly involved in treaty negotiations (see Sto:Lo Xwexwilmexw Treaty Association) and has not signed a framework agreement under the *First Nation Land Management Act* (Indigenous and Northern Affairs Canada 2014).

Sto:lo Tribal Council

There is a SEA between the members of the Sto:lo Tribal Council and the Government of BC. The Sto:lo Tribal Council consists of Chawathil, Cheam, Kwantlen, Kwaw-kwaw-Apilt, Scowlitz, Seabird Island, Shxw'ow'hamel and Soowahlie First Nations.

The Sto:lo Tribal Council is negotiating land and resource agreements outside the BC treaty process. Sto:lo Tribal Council signed a SEA in 2014 (Government of BC 2022a).

Sto:Lo Xwexwilmexw Treaty Association

Sto:Lo Xwexwilmexw Treaty Association is negotiating in the BC treaty process on behalf of six of 11 bands in the Sto:lo Nation. Negotiations began in 1995 and are currently in stage 5.

Sto:Lo Xwexwilmexw Treaty Association signed a SEA in 2014 (Government of BC 2022a).

Stz'uminus First Nation

Stz'uminus First Nation has engaged in the Treaty Process both as a member of the Quw'utsun Nation and with the Hul'qumi'num Treaty Group. The Hul'qumi'num Treaty Group has transitioned into Stage 5 of the BC Treaty Process (Final Agreement) (Government of BC 2020).

Stz'uminus First Nation has signed a framework agreement under the *First Nations Land Management Act* (First Nations Land Management Resource Centre 2020).

Tsawwassen First Nation

Tsawwassen First Nation signed a modern treaty with Canada in 2007. The treaty came into effect on April 3, 2009.

Tsawwassen First Nation is the only treaty Nation with direct interests in the Project. The Project falls within or adjacent to water bodies considered for traditional and economic use by Tsawwassen First Nation in the Tsawwassen First Nation Harvest Agreement, which forms part of the final agreement.

Tsawwassen First Nation has not signed a framework agreement under the *First Nation Land Management Act*.

Tsleil-Waututh Nation

Tsleil-Waututh Nation is in Stage 4 of the BC Treaty Process (Government of BC 2020).

Tsleil-Waututh Nation recently signed a framework agreement in 2019 under the *First Nation Land Management Act* (First Nations Land Management Resource Centre 2020).

4.2 LAND OWNERSHIP AND TENURE

The Project is located on the northern shore of Mud Bay, which is in the northeast of Boundary Bay (Figure 2) in the City of Surrey. There is no federal land, although the Project site is situated on and adjacent to lands within multiple (and overlapping) jurisdictions, including the following;

Indigenous Nations

Recognizing a broader planning context under which CFAS was developed, a list of 20 Indigenous Nations and organizations were identified as potentially having an interest in the Project, as described in Section 4.1.1.

Provincial

The Project is located on provincial Crown land designated for conservation and recreation under the jurisdiction of the Government of BC (Government of BC 2021). Aquatic Crown land seaward of the natural boundary in Boundary Bay; as well as, all lands that comprise the Boundary Bay WMA are managed by the MOF (Government of BC 2022c).

The Project is within provincial Crown land, seaward of the Highway 99 corridor. Portions of the Colebrook Dyke lie within this corridor and access to the Project on the foreshore may require access from the Highway 99 corridor, these lands are managed by the MoTI.

Municipal

The Project is located in the City of Surrey. The Boundary Bay Dyke Trail, which is part of Boundary Bay Regional Park, is located on top of the Colebrook Dyke. The Boundary Bay Dyke Trail and Boundary Bay Regional Park are operated by Metro Vancouver (Metro Vancouver 2022).

The Colebrook Dyke is classified as a low consequence, non-standard dyke with City of Surrey as the maintenance authority.

Site access for the Project is anticipated along the existing Boundary Bay Dyke Trail, which is operated by Metro Vancouver.

Tenure

The Project is located in Mud Bay, on Crown land designated for conservation and recreation. It lies adjacent to a commercial crab fishing tenure, Boundary Bay Crab, encompassing a marine area of approximately 118 km^2.

Tenure cannot be issued in the WMA; the Project site was defined in the terms of reference for the Nature-Based Foreshore Enhancements Project and the MOU between the City of Surrey, the City of Delta, and the Government of BC. Authorization for the City to use Crown land within the WMA to construct the Project will be subject to review and approval by the Government of BC.

4.3 LAND AND WATER USE PLANS

Municipal

Access points for the Project are through designated Agricultural lands, per the City's Official Community Plan (City of Surrey, 2014).

There are no ongoing or approved Land Use or marine plans directly in the Project area at the Municipal level.

Regional

The Project is located within designated conservation and recreation lands under the 2040 Metro Vancouver regional Land Use plan (Metro Vancouver 2020).

The City of Surrey and Metro Vancouver are working together to develop a management plan for the Delta South Surrey Regional Greenway (DSSRG), which would overlap with potential access points for the Project.

The City's drinking water is supplied by the Greater Vancouver Water District (GVWD), per the Water Quality Monitoring and Reporting Plan for Metro Vancouver and Local Government members. Metro Vancouver is responsible for the monitoring, treatment, and delivery of water to the GVWD member municipalities. As of 2020, the number of water service connections within the City was 95,067. The City maintains eight water fill stations for use by construction companies to meet their water needs (City of Surrey 2021), the Panorama water fill station is closest to the Project site, located approximately 8 km away, and may be considered as a water source for construction activities.

Provincial

The Project is within the Fraser Valley South Landscape Unit on land covered by the Lower Fraser Sustainable Resource Management Plan (Chilliwack District Staff 2013).

A Management Plan was drafted for the Boundary Bay WMA in 1993 (Quadra Planning Consultants, 1993) that includes issues/concerns, goals and objectives for the WMA. It has not been updated since that time.

Indigenous Nations

The Fraser River Estuary includes Boundary Bay, which is covered by the Blueprint for Restoring Ecological Governance to the Lower Fraser River (Lower Fraser Fisheries Alliance 2020). Neighbouring Indigenous nations have developed Land Use plans for land in the vicinity of the Project area; however, these do not apply directly to the Project area.

4.4 PARKS AND PROTECTED AREAS

The Project is adjacent to Mud Bay Park, which is City owned parkland and part of the proposed DSSRG (see Figure 2). There are several designated and protected areas in the vicinity of the Project, the largest is Boundary Bay Regional Park (Metro Vancouver 2022), which connects to Mud Bay Park via the 20 km Boundary Bay Dyke Trail. The Project is also within Boundary Bay. This is shown in Figure 2.

Mud Bay Park parking lot is the only designated parking that provides vehicle access to DSSRG (Metro Vancouver 2021). Mud Bay Park is accessible via walking and mountain bike trails connecting to Boundary Bay Regional Park and the surrounding community. Mud Bay Park is bound on the east by the Burlington Northern Railway Line.

Mud Bay Park and Boundary Bay Regional Park offer walking, biking, bird watching, day use, and equestrian activities. Mud Bay Park offers a loop trail (2.5 km) and the Serpentine Greenway trail, which provides connection to the Boundary Bay Dyke Trail.

The Project is also within the Boundary Bay WMA and the Fraser River Estuary Important Bird Area (IBA). The Boundary Bay WMA was designated for the purpose of conserving critical, internationally significant habitat for year-round, migrating and wintering waterfowl populations, along with important fish and marine mammal habitat. Similarly, the Fraser River Estuary IBA was designated to recognize its importance as a stopover route on the extensive Pacific Flyway migration route and to conserve its critical, internationally significant habitat. Additionally, the Fraser River Estuary is also considered of hemispheric importance by the Western Hemisphere Shorebird Reserve Network.

5.0 EXISTING ENVIRONMENT

5.1 NATURAL SETTING AND DEVELOPMENT HISTORY

The Fraser River delta and floodplains, including the low elevation floodplains in the City, were formed over the last 10,000 years through fluvial processes with fine sediments from the Fraser River being deposited throughout the delta, creating an additional 625 km^2 of land (Groulx and Mustard 2004). These lands support a variety of habitats such as highly productive farmlands, wetlands, grass and shrublands, young forests, rivers, and intertidal flats. This variety of habitats houses a rich diversity of wildlife and is a permanent or temporary home to numerous terrestrial and marine invertebrates, fish, birds, and terrestrial and marine mammals (see Section 5.3 for details).

Boundary Bay is an important component in supporting vegetation and wildlife diversity, as it is an interface between terrestrial, freshwater, and marine habitats. The Nicomekl, Serpentine, and Little Campbell Rivers provide freshwater and sediment input to Boundary Bay, which mixes with marine waters from the Strait of Georgia. This provides the physical conditions needed for extensive salt marshes, mudflats, and eelgrass beds (Friends of Semiahmoo Bay Society 2018; Ducks Unlimited Canada and Smart Shores Inc. 2019). These intertidal habitats are of interest, as they provide important shelter and food for fish, particularly salmon, and migrating birds (Schaefer 2004; Jardine et al 2015). Together, Boundary Bay, Roberts Bank, and Sturgeon Bank are listed as an Important Bird Area (IBA), as they are crucial rest stops in the Pacific Flyway that supports millions of birds in their seasonal migration (Harrison and Dunn 2004).

The intertidal areas of Boundary Bay, including Mud Bay, provide valuable ecological services, including forage fish habitat and important biofilm resources over the mudflats. Additionally, both the subtidal and low intertidal eelgrass meadows, and the upper intertidal salt marshes, provide valuable physical coastal engineering services such as, wave attenuation and sediment retention (see review by Ducks Unlimited Canada 2018, Ducks Unlimited Canada and Smart Shores Inc. 2019, James et al. 2021).

The salt marshes in Mud Bay are believed to have formed when a former Fraser River channel discharged into Boundary Bay (Kellerhals and Murray 1969; Groulx and Mustard 2004). The present-day salt marsh areas occur along the coastline, with the greatest coverage of salt marsh occurring in the southeastern and northeastern portions of Mud Bay, near the mouths of the Nicomekl River and the Serpentine River respectively. The Mud Bay area has been physically altered since the 1860s, when significant infrastructure around Mud Bay and the lower Serpentine and Nicomekl Rivers was constructed, including dykes, sea dams, railways, and highways began. A series of dykes were built along Mud Bay and the lower reaches of the Serpentine and Nicomekl Rivers to mitigate flooding and support agricultural development. Manual diking of the rivers began in the 1860s and the first machine-made dykes were built in 1898, with expansions and upgrades occurring as needed (KPA Engineering Ltd. 1994). The Colebrook Dyke borders the northern shore of Mud Bay, just south of Highway 99, from the Surrey-Delta border to Mud Bay Park and along the northern bank of the Serpentine River to the sea dam. The Mud Bay North Dyke follows the southern bank of the Serpentine River, from the Railway Dyke well into the Surrey Dyking District (Government of BC). The Railway Dyke runs south from the Serpentine River until it joins the Mud Bay North Dyke, which follows the northern bank of the Nicomekl River to another sea dam.

The sea dams were constructed in the Serpentine and Nicomekl Rivers in 1913 to support agricultural development (KPA Engineering Ltd. 1994). The Serpentine sea dam is located approximately 4.2 km upstream from the mouth of the Serpentine River, at King George Blvd and the Nicomekl sea dam is located approximately 4.8 km upstream of the mouth of the Nicomekl River, at Elgin Road. These sea dams have gates that open and close to allow fresh water from the rivers to enter Mud Bay during low tide and prevent brackish water from travelling upriver during high tide. Additional stormwater management infrastructure exists within the Serpentine and Nicomekl lowland area and includes more than 100 km of ditches, 30 pump stations, 10 spillways, and 170 flood boxes (NHC 2016).

The Great Northern Railway, which extends along the eastern shoreline of Mud Bay, was constructed between 1909 and 1913 (Roberts 2018). The railway aligns with the contemporary eastern shoreline, except where it crosses the embayments formed at the mouths of the Nicomekl and Serpentine Rivers. The railway is built on a raised embankment along the eastern shoreline; however, it is not considered to be a dyke. The railway runs east-west to the north of Mud Bay but on the other side of Highway 99 from the Project.

A stretch of Highway 99 was constructed along the northern edge of Mud bay in the early 1960s. This stretch of highway lies immediately north of the Colebrook Dyke. At the northwestern corner of Mud Bay, the highway continues westward, past the westernmost extent of the Colebrook Dyke, and west of the Surrey-Delta border. At the northeastern corner of Mud Bay, the highway intersects the aforementioned railway by Mud Bay Park, just north of the Serpentine River embayment. Highway 99 continues to run in the eastward direction, past the railway-Highway 99 intersection for approximately 1.2 km, after which it turns southeastward and crosses the Serpentine River. The construction of Highway 99 involved extensive dredging and changes to the northern shoreline of Mud Bay.

In addition to the dredging associated with the construction of Highway 99, dredging has also taken place in southern Mud Bay. In 1963, 1970, and 1978, dredged material consisting of sand and fine silt was placed onto former marshes of Blackie Spit, north of Sullivan Point, resulting in substantial infilling of the area (Summers 2001).

5.2 PAST AND PRESENT ENVIRONMENTAL STUDIES AND PROGRAMS

Although the “Living Dike” concept is relatively new, in 2018 West Coast Environmental Law led an initiative in Boundary Bay to provide an initial technical feasibility assessment to define how this type of coastal adaptation might be applied in practice (SNC-Lavalin 2018).

Additionally, the Fraser River estuary and surrounding region have been the subject of numerous environmental studies during the past few decades and are described within a large body of contemporary information that is used to describe the environmental setting and Project effects assessment. Most notably, the City commissioned a series of studies for the CFAS and published them in three reports, titled PIER: Prioritizing Infrastructure and Ecosystem Risk from Coastal Processes in Mud Bay. These reports include desktop reviews; baseline surveys and mapping; risk assessments, modelling, and mitigation approaches. A summary of some of these PIER reports and other environmental studies is provided in Table 8:

Table 8 Past and Present Environmental Studies and Programs.

Year	Author	Study Name	Project/Program	Summary
2018	Golder	Mud Bay Shoreline Erosion Assessment Mapping Study	CFAS Reports: PIER: Phase 1	Shoreline erosion mapping study. The objective was to classify areas of coastal dyke in Mud Bay.
2018	Ducks Unlimited Canada	Mud Bay: Ecosystem Services Potential for Coastal Flood Protection	CFAS Reports: PIER: Phase 1	This report provides a review of literature on the ecosystem components of Mud Bay and their potential role in the City's CFSA.
2018	Northwest Hydraulics Consultants Ltd.	Mud Bay Coastal Geomorphology Study	CFAS Reports: PIER: Phase 1	High-level coastal geomorphology assessment to investigate the sedimentary conditions of Mud Bay and understand the implications of this condition on sea level rise and coastal flood mitigation options. Background information and available data was reviewed, data were analyzed to assess changes in historical to present conditions, and implications for sea level rise and mitigation were evaluated with respect to the sedimentological condition of Mud Bay.
2018	Friends of Semiahmoo Bay Society	Shoreline Assessment Mud Bay – Field Verification Report	CFAS Reports: PIER: Phase 1	The primary objective of this project is to complete a field verification of a desktop shoreline mapping exercise conducted by Golder and to report on field observations. Field observations were supplemented with relevant background documents and data available for the study area.
2018	Ducks Unlimited Canada	Monitoring Phase 1 Memo	CFAS Reports: PIER: Phase 1	Interim project update memo to report on the status of monitoring equipment installed and the next steps.
2018	Diamond Head	Regulators and Stewards Workshop Notes, Exit surveys	CFAS Reports: PIER: Phase 1	An informal meeting was held with science staff from the Department of Fisheries and Oceans (DFO) to discuss the Surrey CFAS.
2018	University of BC and Friends of Semiahmoo Bay Society	Preliminary Report on Mud Bay Nutrients Loading Effects on Eelgrass Bed Health	CFAS Reports: PIER: Phase 2	Eelgrass monitoring and experiments to fill known data gaps on biodiversity within eelgrass beds in Boundary Bay. In part, this project will inform the City's CFAS by informing ecosystem risk prioritization in Mud Bay.

Table 8 (Cont'd.)

Year	Author	Study Name	Project/Program	Summary
2018	Friends of Semiahmoo Bay Society	Mud Bay Eelgrass Mapping and Monitoring Report	CFAS Reports: PIER: Phase 2	This project builds on eelgrass mapping efforts to date. Boat-based eelgrass mapping was completed using an underwater camera and mapping software to interpolate data points, informing the total extent and relative abundance of eelgrass in Mud Bay and Boundary Bay. Foot-based sampling was conducted to quantify abundance and eelgrass bed health.
2018	Ducks Unlimited Canada	Monitoring Phase 2 Memo	CFAS Reports: PIER: Phase 2	Interim project update memo to report on the status of monitoring equipment installed and the next steps.
2019	Diamond Head	Framework for Environmental Vulnerability	CFAS Reports: PIER: Phase 2	This strategy focuses on both the current and future impacts of flooding within Surrey's coastal floodplain. As part of this project, Diamond Head Consulting evaluated potential impacts to habitats found in and east of Mud Bay that are likely to be impacted by Sea Level Rise and potential adaptation strategies.
2019	Ducks Unlimited Canada and Diamond Head	Ecosystem Vulnerability Workshop Summary and Notes	CFAS Reports: PIER: Phase 2	To identify greatest environmental vulnerabilities within the study area, ecosystem experts, environmental partners, and agency representatives were convened in a workshop setting.
2019	Northwest Hydraulic Consultants Ltd.	Wave and Wind Monitoring Plan	CFAS Reports: PIER: Phase 2	Summary of the OceanMet Monitoring reconnaissance, review of sites and instrumentation, and presentation of options. Various instrument options have been evaluated regarding the collection of wave and wind (velocity and direction) data, with consideration for the development of meaningful statistics and time series.
2019	Northwest Hydraulics Consultants Ltd.	Wave and Wind Monitoring RFQ	CFAS Reports: PIER: Phase 2	Summary of the proposed enhancements to the OceanMet monitoring program configuration, including adjustments to the originally proposed scope and budget.

Table 8 (Cont'd.)

Year	Author	Study Name	Project/Program	Summary
2019	City of Surrey	CFAS Reports: PIER ((Prioritizing Infrastructure and Ecosystem Risk) from Coastal Processes in Mud Bay)	CFAS Reports: PIER: Phase 3/Final	The final phase of the Project includes a summary of findings from all previous studies; final field monitoring report on Mud Bay environmental conditions; a final field monitoring report on the effects of nutrient loads on eelgrass bed health; Summary of wind monitoring and wave reduction modelling; coastal flood mitigation; and hydrological analyses.
2020	Diamond Head	Summary of Environmental Reports	CFAS Reports: PIER: Phase 3/Final	A summary of some of the key findings, options, and opportunities for mitigation from the previously conducted reports.
2019	Ducks Unlimited Canada and Smart Shores Inc.	Mud Bay Monitoring Report	CFAS Reports: PIER: Phase 3/Final	As a part of this partnership project DUC is leading Estuary Monitoring in Mud Bay which includes monitoring near-shore sediment and the collection of water quality, habitat, and wildlife data. DUC has partnered with Smart Shores Inc. to develop and implement Unmanned Aerial Vehicle data collection to detect and quantify different habitat types in the study area.
2019	UBC and FOSBS	Mud Bay Nutrient Loading Effects on Eelgrass Bed Health	CFAS Reports: PIER: Phase 3/Final	FOSBS and UBC carried out eelgrass monitoring and a nutrient loading experiment to fill known data gaps on biodiversity within eelgrass beds in Boundary Bay.
2019	Northwest Hydraulics Consultants Ltd.	Summary of Wind Monitoring Component to Date	CFAS Reports: PIER: Phase 3/Final	This letter summarizes work completed for the wind monitoring component of this program to date, reviews wind data collected to date, provides an overview of planned wind monitoring work, and makes recommendations for future wind monitoring.
2019	Northwest Hydraulics Consultants Ltd.	Green Infrastructure Recommendations – Reducing Wave Model Uncertainty	CFAS Reports: PIER: Phase 3/Final	This letter summarizes recommendations to reduce data uncertainty related to planning and design for green infrastructure projects in Mud Bay area. Specifically, recommendations to improve coastal wave model input data and to improve coastal wave model methodologies for establishment of dike construction elevations and corresponding flood construction levels are given.

Table 8 (Cont'd.)

Year	Author	Study Name	Project/Program	Summary
2019	Northwest Hydraulics Consultants Ltd.	Coastal Flood Mitigation DEM Workshop	CFAS Reports: PIER: Phase 3/Final	This memo provides a summary of the material covered at the workshop and recommendations on how to improve the coastal DEM for Boundary Bay.
2019	Northwest Hydraulics Consultants Ltd.	Conceptual Fish Passage for Serpentine River Sea Dam	CFAS Reports: PIER: Phase 3/Final	Preliminary Draft Report
2020	City of Surrey	Mud Bay – Ecosystem at Risk in Surrey, BC	CFAS Reports: PIER: Phase 3/Final	An interactive webpage allowing users to explore the City's unique coastal ecosystem, understand the challenges it faces, and to consider how collaborative solutions to build a resilient future for the City's residents and wildlife. Accessible at: Mud Bay – Surrey, BC (arcgis.com)
2020	Hatfield Consultants LLP.	Mud Bay Shorebird Survey	City of Surrey DMAF Project Baseline Studies Report	A monitoring report assessing the use of Mud Bay mudflats by shorebirds and how their usage relates to biofilm abundance.
2021	Hatfield Consultants LLP.	Final Baseline Studies Report	City of Surrey DMAF Project Final Baseline Studies Report	A series of baseline studies to asses vulnerabilities to climate change-derived sea level rise and coastal flooding, and includes mitigation projects to reduce the impact of sea level rise.
2004	Groulx and Mustard	Fraser River delta, BC: Issues of an urban estuary	Geological Survey of Canada Bulletin 567	Compilation of studies assessing the impact of urbanization on the Fraser River delta including impacts on or from geology and geography; wildlife habitats; pollution and contaminants; climate change; trade and commerce; and management and sustainability.
2004	Harrison and Dunn	Fraser River delta seagrass ecosystems, their distributions and importance to migratory birds	Geological Survey of Canada Bulletin 567	A study on the eelgrass beds from Brunswick Flats to Boundary Bay, BC, and their importance to shorebirds and ecosystem services.
2004	Schaefer	Ecological Setting of the Fraser River Delta and its Urban Estuary	Geological Survey of Canada Bulletin 567	An overview of the habitats of the Fraser River estuaries and an evaluation of their health with suggestions for restoration and management.

Table 8 (Cont'd.)

Year	Author	Study Name	Project/Program	Summary
2015	Jardine et al.	Biofilm consumption and variable diet composition of Western Sandpipers (*Calidirs mauri*) during migratory stopover	PLOS One	A study into the diet of Western Sandpipers during their migratory stopover in the Fraser River delta. It highlights the importance of biofilm and a variable diet for shorebirds.
2015	Port of Vancouver	Roberts Bank Terminal 2 Statement: Social and Economic Setting	Baseline Report	This assessment contains a social and economic baseline report detailing the human environment surrounding the Project area (Delta, Tsawwassen First Nation, Metro Vancouver).
2005	City of Delta	Corporation of Delta Official Community Plan	Official Community Plan	The Official Community Plan for the corporation of Delta outlines Delta's long-term vision for growth and development and provides an overview of Land Use designations, community infrastructure, and community profiles.
2009	AECOM	Tsawwassen First Nation Land Use Plan	Land Use Plan	The plan provides a long-term vision for Tsawwassen First Nation lands and provides certainty for the development of the community. Provides community overview and Land Uses.
2020	Metro Vancouver	Metro Vancouver 2040: Shaping our Future	Regional Growth Strategy	This regional growth strategy provides an overview of current community settings, Land Uses, and current challenges throughout Metro Vancouver.
2010	Government of Canada	Tsawwassen First Nation Final Agreement	Final Agreement	This Agreement is a treaty and a land claims agreement within the meaning of sections 25 and 35 of the *Constitution Act*, 1982.
2021	Metro Vancouver	Delta Nature Reserve + Delta South Surrey Greenway	Regional Background Report	Report used to inform park planning for Delta Nature Reserve, the DSSRG (connects to Mud Bay Park), and portions of the Burns Bog Ecological Conservancy Area. Includes information on visitation, park access, and cultural heritage.
2022	Natural Resources Canada	Boundary Bay Wave and Current Monitoring in support of Nature-Based Infrastructure for Coastal Resilience and Risk Reduction (Draft)	In support of the Project	Report describing oceanographic data (e.g., wave heights, water level, current velocity). Results will facilitate the hydrodynamic modelling efforts performed by project partners. The findings from these studies will inform the design and implementation of the Project.

5.3 BIOPHYSICAL ENVIRONMENT

5.3.1 Marine Habitat

Mud Bay is largely comprised of intertidal flats, which fall into three main habitats. Unvegetated mudflats cover approximately 351 hectares, salt marsh covers approximately 28 hectares (Figure 8, Ducks Unlimited Canada and Smart Shores Inc. 2019), and 49 ha are covered in native and non-native eelgrass (Figure 9, Friends of Semiahmoo Bay Society 2018). Salt marshes are an important component of coastal protection, as they attenuate wave action, stabilize shoreline sediments, and store flood water (see review by Ducks Unlimited Canada 2018). Additionally, salt marshes provide important habitat for a wide variety of invertebrates, which are a key food source for various birds and fish (Schaefer 2004). Eelgrass beds are also important for wave attenuation, as the vegetation can reduce wave forces (James et al. 2021). Eelgrass beds sequester carbon and house a rich diversity and high biomass of invertebrates that support and feed waterbirds and fish (Kellerhals and Murray 1969; Baldwin and Lovvorn 1992; 1994). Mudflats can host biofilm matrices, which form a mat-like structure on top of the sediment, which can help stabilize fine sediments and provides lipid-rich food for migrating shorebirds (see review by Kuwae et al. 2021).

Figure 8 Salt marsh and unvegetated mudflat habitat distribution in Eastern Mud Bay.

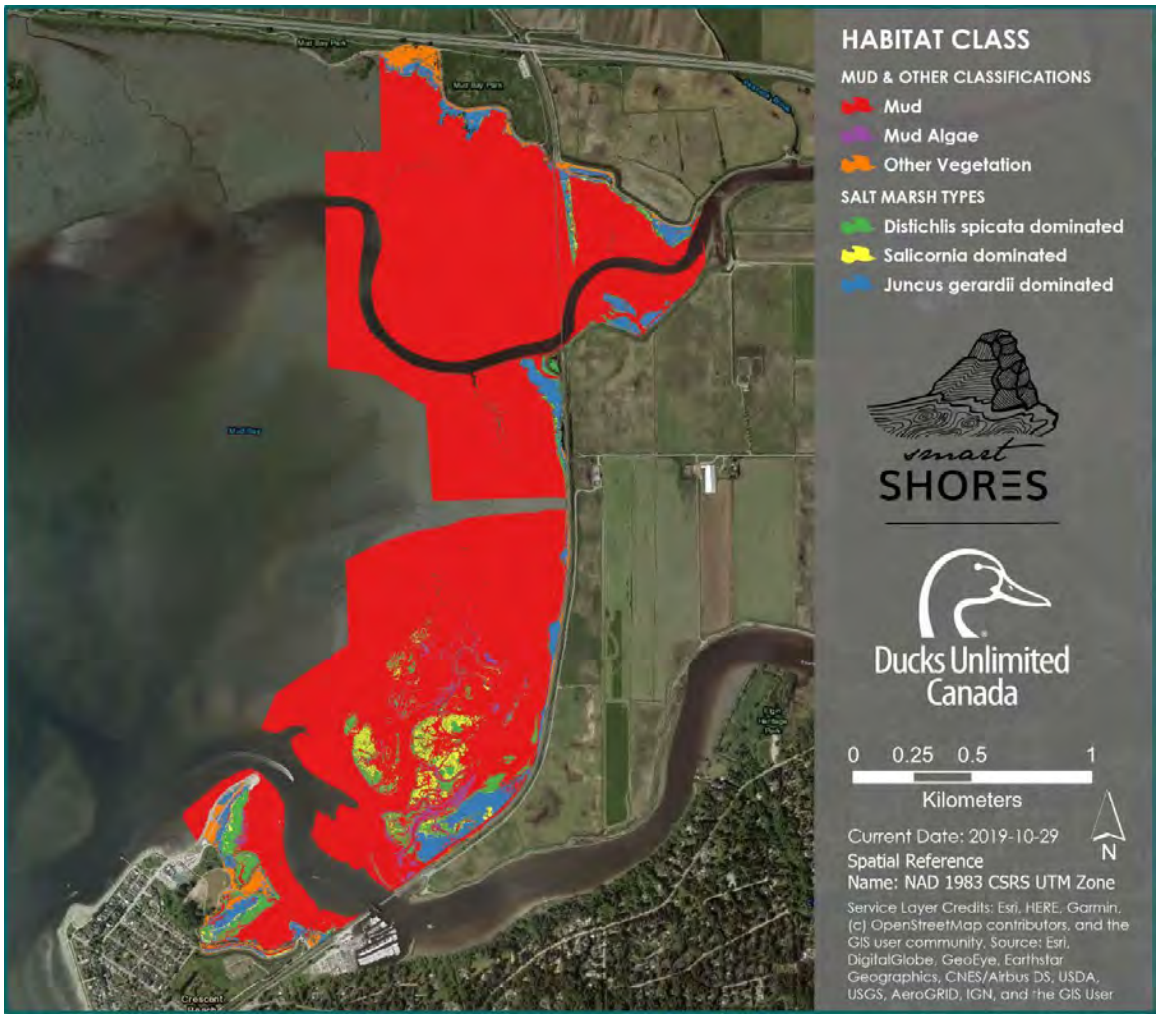


Figure first published in Ducks Unlimited Canada and Smart Shores Inc. 2019.

Figure 9 Eelgrass bed type and distribution.

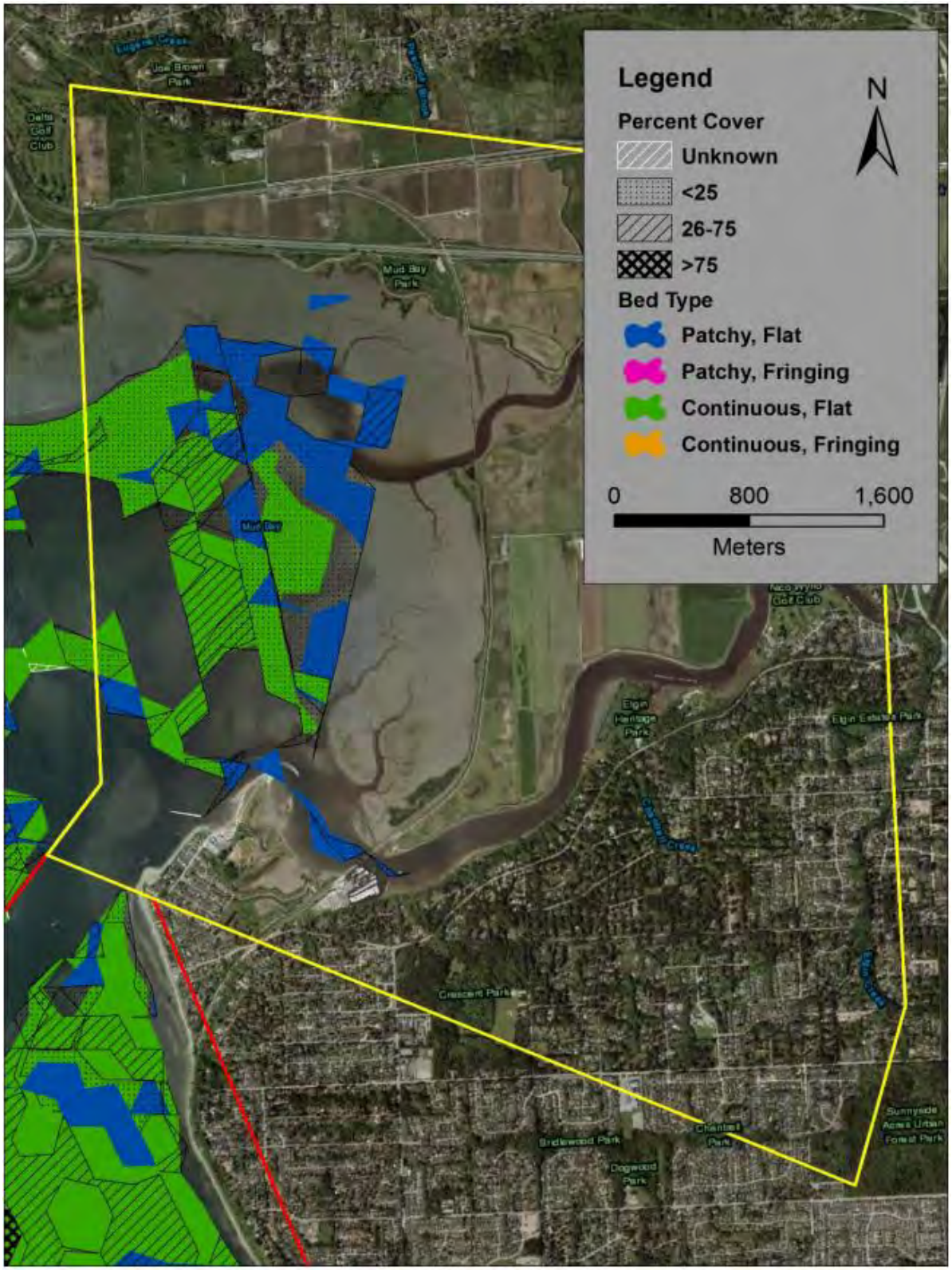


Figure first published in Friends of Semiahmoo Bay Society 2018.

5.3.1.1 Salt Marsh

The Project area includes salt marsh. Along the north shore of Mud Bay, the salt marsh is limited to a narrow strip along the toe of the Colebrook Dyke and as islands seaward of the dyke, which includes tidal channels and pools throughout these salt marsh areas (Friends of Semiahmoo Bay Society 2018). The extent of salt marsh in Mud Bay, as of 2018, was consistent with the description provided by Kellerhals and Murray (1969), demonstrating the stability of the salt marsh. It is described as dense and up to 15 centimetres (cm) in height, with a perpendicular extent from the dyke as low as 10 m (Friends of Semiahmoo Bay Society 2018). The results from an air photo analysis also indicate stable conditions in the Project area with respect to salt marsh extent, drainage channel planform, and shoreline location over the past 66 years (NHC 2018). Observed changes in salt marsh extent and shoreline morphology during this time were concentrated along the northern edge of Mud Bay and are largely attributed to the construction of Highway 99 and the opening of the discharge from Eugene Creek. The City has an ongoing survey of surface elevation within the salt marsh that commenced in 2018. The results indicate that there is some evidence to support the accretion of sediments in the Mud Bay salt marshes (Ducks Unlimited Canada and Smart Shores Inc. 2019).

The vegetation consists of a limited number of salt-tolerant species (most commonly grasses, sedges, or rushes) that have been recorded consistently through the last century, although some have been lost from dyking (Ducks Unlimited Canada and Smart Shores Inc. 2019). Key drivers of salt marsh dynamics include sediment supply and transport, salinity, nutrients, elevation and sea level, and storm events (Goals Project 2015). Shepard et al. (2011) conclude that salt marsh vegetation has a significant positive effect on wave attenuation and shoreline stabilization, particularly for more frequent, lower intensity storm events, and that these habitats also provide some benefits in terms of flood water storage.

A baseline survey conducted by Hatfield in 2020 found the following prominent species: a rush species (*Juncus gerardii*, 27% cover), seaside arrow-grass (*Triglochin maritima*, 27% cover), and seashore salt grass (*Distichlis spicata*, 21% cover). The latter two are also common native species in BC. The average percent vegetation cover was 66% over all plots. A complete list of species found at Site S2 from two separate surveys (Hatfield 2021; KWL 2021) can be found in Table 9. The distribution and abundance of salt marsh plant species varied within the Project area, but there was distinct and large coverage of certain species within plots and areas, including large coverage of the rush species east of Site S2, within the foreshore of Mud Bay Park, and fairly evenly spaced coverage for the three other main intertidal vegetation species throughout the entire Study. The invasive species *Spartina anglica* was present at two of the sampling locations fronting Mud Bay Park (Hatfield 2021).

McGregor (2021) noted the upper salt marsh area below the Dyke at Boundary Bay contained vegetation aligning with red-listed ecological communities: seashore saltgrass site association (Em03), tufted hairgrass-douglas aster (Ed02), and Arctic rush-Alaska plantain (Ed03).

Table 9 Salt marsh species in Mud Bay.

Common Name	Scientific Name
American glasswort/pickleweed	*Sarcocornia pacifica*
Baltic rush	*Juncus balticus*
Canadian sandsurry	*Spergularia canadensis*
Cordgrass species	*Spartina* species
Douglas aster	*Symphotrichum subspicatum*
Eelgrass species	*Zostera* spp.
Foxtail barley	*Hordeum jubatum*
Orache	*Atriplex patula*
Salt marsh rush	*Juncus gerardii*
Salt marsh sand spurry	*Spergularia salina*
Seacoast bulrush	*Bolboschoenus maritimus*
Seaside arrow-grass	*Triglochin maritima*
Sea milkwort	*Glaux maritima*
Sea plantain	*Plantago maritima*
Sea shore salt grass	*Distichlis spicata*
Three-square bulrush	*Schoenoplectus pungens*

5.3.1.2 Eelgrass

Eelgrass beds are abundant in Mud Bay (Friends of Semiahmoo Bay Society 2018) and have been noted as the richest habitats in terms of biomass and invertebrates in the area (Dr. Bittick, personal communication), providing important feeding grounds for many waterbirds (Kellerhals and Murray 1969; Baldwin and Lovvorn 1992; 1994). Eelgrass beds in Mud Bay are composed of two species; the native *Zostera marina* and the non-native *Z. japonica* (Harrison and Dunn 2004). *Z. japonica* may have mixed effects in the Bay, it grows higher on shore than native eelgrass, so it may have limited effects on *Z. marina* abundance. Overall, the addition of *Z. japonica* increases the total cover of eelgrass habitat, which is beneficial for many fish and birds, although some shorebirds (e.g., sandpipers) prefer feeding in unvegetated areas (Harrison and Dunn 2004). Both eelgrass species can host biofilm (bacteria, diatoms and algae) that are grazed by other organisms. The breakdown of eelgrass tissues by these microbes creates an abundance of detritus that can further host life, this case is especially true when the eelgrass forms large meadows. Eelgrass health relies on many physical factors, but one of the most important is light availability, which is influenced by suspended particles in the water (e.g., turbidity) and depth. Both species prefer depths of -2 m to +2 m from mean lower low water (MLLW), though *Z. japonica* is found higher on shore (1 to 2 m) when *Z. marina* is also present (Ruesink et al. 2010).

Eelgrass grows at lower elevations than the expected footprint, and the eelgrass beds are hundreds of meters seaward of the Project area in Mud Bay due to the shallow sloping shoreline. The eelgrass beds can be avoided as detailed maps have been constructed of eelgrass in Mud Bay (Friends of Semiahmoo Bay Society 2018).

5.3.1.3 Mudflats

Intertidal mudflats are comprised of fine sediment and generally have an anoxic layer directly below the surface, limiting the plants that can grow in them. However, a biofilm matrix comprised of a thin layer of organic detritus, algae, microbes, meiofauna and sediments grows on top of many mudflats in southern BC (Jardine et al. 2015). Of the microbes present in biofilm, the majority are made up of diatoms. Biofilm abundance and composition are influenced by numerous factors such as light, sediment, temperature, salinity, tide, rain, nutrient availability, and grazing (Jimenez Reyes 2013). Biofilm is an important component of mudflat habitat because it is a substantial food source for the invertebrate community (meiofauna and macroinvertebrates) and certain species of birds, including calidrid sandpipers at several migratory stopover sites in BC (Jardine et al. 2015). In Mud Bay, up to 52% of Western Sandpiper droppings were composed of biofilm, the highest proportion of any study site along the Fraser Estuary-Boundary Bay migratory stopover (Jardine et al. 2015). Furthermore, Mud Bay also contained the highest proportion of Western Sandpipers out of all the study sites, suggesting that Western Sandpipers target biofilm in Mud Bay as an important food source during their migration (Jardine et al. 2015). However, the study sites were well outside of the Project footprint, located close to the mouth of the Nicomekl River (Jardine et al. 2015).

While biofilm has been observed within the Project footprint (KWL 2022b, Hatfield staff – personal observation 2022), its abundance is low. Observations of shorebirds also suggests that biofilm abundance is relatively low within the Project area compared to other areas of Mud Bay (Hatfield 2020). There is potentially more biofilm in the Serpentine River mouth, east of the train bridge, and around the Nicomekl River mouth (Hatfield 2020). Based on the abundance and distribution of shorebirds observed in flight and on the mudflats of Mud Bay, their association with biofilm, and in comparison to other areas of the Fraser River estuary (e.g., Brunswick Point), the Project area does not appear to be a critical source of biofilm and core foraging or roosting areas (Hatfield 2020).

5.3.2 Terrestrial Habitat

The Project area is located within the Moist Maritime Coastal Douglas-fir (CDFmm) biogeoclimatic subzone, where estuarine salt marsh transitions into terrestrial vegetation at higher elevations (Green and Klinka 1994). Occurring predominantly on the landward side of the constructed dykes, the terrestrial habitat is characterized by a well-developed, shrub-herbaceous layer that is dominated by reed canarygrass (*Phalaris arundinacea*) and Himalayan blackberry (*Rubus armeniacus*; Hatfield 2021; KWL 2021). Native shrub and tree species occur to a lesser extent throughout the Project area and include salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa*), western red cedar (*Thuja plicata*), and sitka spruce (*Picea sitchensis*; Hatfield 2021).

The CDFmm ecosystems are rare on the landscape and they have been exposed to significant amounts of loss and alteration from natural and anthropogenic disturbances (Madrone 2008). Although the terrestrial plant communities in the Project area are red- or blue-listed (CDC 2022), the at-risk designation of these rare ecosystems is restricted to the mature and old forest stages (structural stage 6 and 7; McLennan and Ronalds 1999). There is no mature or old forest present in the Project area; therefore, ecosystems at risk are not considered to be present and will not be considered in the effects assessment.

Terrestrial habitat in the Project area is limited and dominated by non-native and invasive plant species (Hatfield 2021). Occurrences of at-risk plant species have not been identified (Hatfield 2021).

Comprehensive surveys for at-risk vascular plants have not been conducted in the Project area but are proposed ahead of construction.

5.3.3 Wildlife

The Project area at Mud Bay is part of the Boundary Bay WMA and provides important staging grounds for as many as one million waterbirds migrating along the Pacific Flyway, and the overwintering grounds of a large number of waterfowl, shorebirds, gulls, hawks, and the great blue heron (*Ardea herodias fannini*). Boundary Bay supports the largest wintering waterfowl concentrations in Canada (> 100,000 individuals; McPhee et al. 1993). Its value and importance are recognized internationally as an IBA by Bird Life International and a site of hemispheric importance by the Western Hemisphere Shorebird Reserve Network.

Extensive information has been obtained on Mud Bay in recent years, driven primarily by the City's need to understand the nature of proactive coastal floodplain management in response to climate change (Bitick and Christensen 2018; Christensen 2018 a,b). Bird abundance and distribution across seasons have been summarized using eBird (Christensen 2018b) and the local habitat associations of each, broad wildlife group described (Diamond Head 2019). In addition, Hatfield (2020, 2021) conducted baseline shorebird surveys and reported on baseline wildlife and vegetation conditions in the Project area. A comprehensive list of species at risk observed from Mud Bay is provided in Table A4.1.

5.3.3.1 Invertebrates

Two insect species at risk have been reported in Mud Bay (Table A4.1). The blue dasher dragonfly (*Pachydiplax longipennis*) is not expected to occur in the Project footprint, due to the lack of ponds. However, the Project area overlaps with proposed critical habitat for Audouin's night-stalking tiger beetle (*Omus audouini*; ECCC 2022). Recent surveys have revealed adult beetles of this species in four sampling points seaward of the Dyke at Mud Bay and other areas in Boundary Bay (R. McGregor, personal communication to C. Wood, Nov 23, 2021). Adults are flightless, but active ground-runners from April to August (Pearson et al. 2015; Maynard 2006). Due to their lack of flight ability, this species is expected to be relatively poor at dispersal (ECCC 2022). Larval habitat is unknown for the subpopulation at Mud Bay (R. McGregor, personal communication to C. Wood, Nov 23, 2021).

5.3.3.2 Amphibians and Reptiles

Potential freshwater habitat for pond-breeding amphibians exists adjacent to the Project (e.g., at Eugene Creek and on the landward side of the dyke at Mud Bay Park). Baseline visual encounter surveys of these wetland habitats did not detect any species of reptile or amphibian within the Project area (Hatfield 2021). Subsequent to the baseline report, two northwestern garter snakes (*Thamnophis ordinoides*), one common garter snake (*T. sirtalis*), and northern Pacific tree frog (*Pseudacris regilla*) were observed in Mud Bay Park, east of the Project (GBIF 2022). There is also a potential for western terrestrial garter snakes(*T. elegans*) to forage at the site. No amphibian or reptile species at risk are expected in the Project area (GBIF 2022).

5.3.3.3 Songbirds and Allies

The upper portions of the shore at Mud Bay may provide foraging opportunities for migrating songbirds and nesting habitat for species that prefer shrubs and open sites. Several records of species at risk have been reported from Mud Bay (Table A4.1). Hatfield (2021) conducted a review of bird observational records and point

count surveys along the Project area and detected one species at risk in the area: barn swallow (*Hirundo rustica*). Several records of black swift (*Cypseloides niger*) are reported from Mud Bay as recent as 2020. Nesting habitat for this species does not exist within the Project area as they nest in cliff habitats, often near waterfalls (COSEWIC 2015). This species is likely using Mud Bay and adjacent areas as foraging habitat, specializing on flying insects. Recent population declines are believed to be related to changes in food supply (COSEWIC 2015). Common nighthawk (*Chordeiles minor*) is yellow-listed in BC and threatened under Schedule 1 of SARA (CDC 2022). This species uses open and semi-open habitats, feeds on flying insects, and nests on the ground in bare sites (CDC 2022). This species has been noted nesting in dunes at Boundary Bay (Page et al. 2011), however, it has not been observed within Mud Bay (GBIF 2022) and is not expected to nest within the Project area due to limited suitable terrestrial habitat (Hatfield 2021). Band-tailed pigeon (*Patagioenas fasciata*) is provincially blue-listed and a species of Special Concern under Schedule 1 of SARA (CDC 2022). This species has been reported in Mud Bay at Blackie Spit and adjacent areas of south Surrey (GBIF 2022). Nesting habitat (i.e., trees, shrubs) is habitually used by this species and breeding generally occurs in forested areas (CDC 2022), thus nests are not expected within the Project area due to lack of forest cover.

5.3.3.4 Shorebirds

Shorebirds have exhibited significant declines over the past 48 years (Rosenberg et al. 2019). This group includes several species at risk that are known to use Mud Bay and adjacent sites as an important stopover to rest and refuel during migration (Table A4.1). An additional species, lesser yellowlegs (*Tringa flavipes*) is under consideration for addition to Schedule 1 of SARA and is listed as threatened by COSEWIC (2020). While not currently a species at risk, most of the global population of western sandpiper (*Calidris mauri*) migrate through the region, over 10,000 individual western sandpipers were observed at Mud Bay in 2021 (GBIF 2022). This species has declined by 54% since 1991 (Canham et al. 2021), making it an important consideration.

5.3.3.5 Waterbirds

Mud Bay is an important area for several species of waterbirds, including ducks, cormorants, auks, herons, grebes, loons, gulls, and other allied species. Several species at risk are reported from Mud Bay (Table A4.1). Hatfield (2020, 2021) observed American widgeon (*Anas americana*), green-winged teal (*Anas carolinensis*), gadwall (*Mareca strepera*), Canada goose (*Branta canadensis*), cinnamon teal (*Anas cyanoptera*), northern shoveler (*Spatula clypeata*), and Great blue heron, *fannini* spp. along the Project area in baseline surveys. These species are generally using the area as roosting and foraging habitat. Nesting sites have not been found within the Project area.

5.3.3.6 Raptors

While several raptor species have been observed in Mud Bay, including some species at risk (e.g., rough-legged hawk (*Buteo lagopus*); short-eared owl (Asio flammeus), and peregrine falcon (Falco peregrinus); Table A4.1)), the absence of large nest-supporting trees precludes the presence of stick nests. One piling is present seaward of the Project area that is used by Bald Eagles for perching.

The Project area has the potential to be used by barn owl (Tyto alba) as foraging habitat, which includes dense grass fields, salt marsh, wet meadows, and other similar open pastures with adequate prey of voles and mice (CDC 2022; COSEWIC 2010). Barn owls are also fairly adaptable to human activity and nest and roost in old farm buildings and artificial nest structures (MOE 2013). No records were found for this species in Mud Bay

(GBIF 2022; Hatfield 2021); however, they have been observed hunting further west in Boundary Bay (ECCC 2021). No raptors or nests were found within the Project area during scans for the stick nests of herons, conspicuous raptors, and potential short-eared owl nesting site, performed by Hatfield (2021).

5.3.3.7 Mammals

Few terrestrial mammal sightings have been reported in the vicinity of the Project and no mammal species at risk have been reported for the area (though targeted surveys have not been conducted). Records are limited to common and introduced species, including: American beaver (*Castor canadensis*), common muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), coast mole (*Scapanus orarius*), eastern grey squirrel (*Sciurus carolinensis*), and eastern cottontail (*Sylvilagus floridanus*; GBIF 2022). Additional species that have the potential to occur in Mud Bay include river otter (*Lontra canadensis*), American mink (*Neovison vison*), coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), western spotted skunk (*Spilogale gracilis*), Douglas' squirrel (*Tamiasciurus douglasii*), and various mice, voles, and/or shrews (Hatfield 2021). Otter and mink are often associated with rivers, but can also occur in coastal habitats, and usually den where shoreline cover is abundant. No mammal species or dens were detected during Hatfield's (2021) baseline visual encounter surveys and habitat suitability was presumed to be low for Pacific water shrew (*Sorex bendirii*) based on lack of forest cover and isolation from existing populations (Hatfield 2021).

5.3.4 Marine Fauna

5.3.4.1 Shellfish and Other Marine Invertebrates

Mud Bay hosts a diverse assemblage of marine invertebrates. These invertebrates are an important component of the nearshore food web and are comprised of microorganisms, zooplankton, and macroorganisms, of which the latter is of great importance to shorebirds, waterbirds and fish (Baldwin and Lovvorn 1994; Schaefer 2004). As many as 43 different invertebrate species made up of bivalves, amphipods, gastropods, insects, isopods, decapods, and polychaetes have been found to comprise waterbird diets in Boundary Bay (Baldwin and Lovvorn 1994). These invertebrates occupy both salt marsh and eelgrass habitats and are also an important food source for fish such as sculpins, gunnels, perch, sticklebacks, rockfish, cod, salmon, eels, and herring, that rely upon these habitats (Otte and Levings 1975; Schaefer 2004; see review by Murphy et al. 2021).

5.3.4.2 Fish

Salt marshes and eelgrass beds are important habitats for a wide variety of fish for either their entire life or at various stages of their life cycles (Schaefer 2004; see review by Murphy et al. 2021). Fish may shelter, rear and breed among the tidal channels of salt marshes and mudflats during high tide within the Mud Bay Project footprint and nearby. Some of these include herring, salmonids, Pacific staghorn sculpin, and starry flounder (Schaefer 2004). The Serpentine and Nicomekl Rivers support populations of four Pacific salmon species (chinook (*Oncorhynchus tsawytscha)*, chum (*O. keta)*, coho (*O. Kisutch)*, and pink (*O. gorbuscha*)), the most notable are coho salmon, which also use the nearby estuarian habitats in Mud Bay as a juvenile refuge area and feeding grounds during outmigration to marine habitats (Beacham et al. 2017). In addition, herring are known to spawn in the eelgrass beds throughout Boundary Bay, including those at the eastern margin of Mud Bay (de Graaf 2007). Herring and herring egg masses provide important forage for salmonids, marine mammals, and diving ducks (Levings 2004; Schaefer 2004). Sand lance and surf smelt

have used the region's beaches for spawning; however, given that both species prefer higher-elevation, sand-gravel margins of tidal zones, potential spawning habitat is limited in Mud Bay (de Graaf 2007) and absent from the Project area (Golder Associates 2018).

5.3.4.3 Marine Mammals

Several species of marine mammals can be found in the surrounding waters of Boundary Bay throughout the year but are not found within the Project area. Grey whales often enter Boundary Bay during spring and summer (Murray 2016). However, large-bodied animals such as cetaceans and sharks are very unlikely to be found in the Project area, as the mudflat and salt marsh are only covered during very high tides; they lie at about 2 to 5 m chart datum (CD). Spotted harbour seals are visitors to the area, and colonies occur around the Delta shores (Murray 2016). During preliminary shorebird surveys, dozens of harbour seals were observed in Mud Bay; however, they were not observed within the footprint of the Project (Hatfield 2021). Steller sea lions are frequent visitors to Boundary Bay, garnering attention from tourists (www.whiterockseatours.com/tours/boundarybay-sea-lion-tour). Steller sea lions often congregate in the lower Fraser River during the spring eulachon run and are occasionally seen rafting upriver. They also congregate in estuaries during autumn to feed on pre-spawning salmon (COSEWIC 2013). The population is increasing but is sensitive to human disturbance while on land. However, because the Project area is adjacent to very shallow mudflats that stretch for hectares around, it is unlikely that cetaceans, large pinnipeds (i.e., sea lions), sharks, and rockfish (which inhabit depths of 17 to 250 m) would occur in the waters of the Project area, even at high tide.

5.4 HUMAN ENVIRONMENT

As described in Section 3.1, and 1.0, the Project is located on the northern shore of Mud Bay, which is in the northeastern portion of Boundary Bay (Figure 2, Figure 3). The Project area is within the City of Surrey and the Serpentine River estuary, immediately south of Highway 99 and includes recreational areas including Mud Bay Park and the Boundary Bay Dyke Trail. The land directly surrounding the Project area is primarily used for agriculture and is part of the ALR. The residential neighbourhood of Newton is approximately 1 km north of the Project area.

The Burlington Northern and Santa Fe railway embankment along Mud Bay marks the eastern limit of the Project area. To the west of the Project area is the border between Surrey and the neighbouring municipality of Delta. Highway 91 also intersects with Highway 99 to the west of the Project area.

5.4.1 Socio-Economic Setting

In 2021, the population of Surrey was 568,322 people, an increase of 9.7% from 2016 (Statistics Canada 2022).[5] The third fastest growing city in Canada, Surrey's average age in 2021 was 39.5 years and seniors (defined as adults aged 65 years and older) made up 15.3% of the population. In 2016 the labour force reached 419,065 persons with a participation rate of 65.5%. The unemployment rate was 6.5%, higher than that of the rest of the Metro Vancouver area (5.8%). 11.6% of the labour force was self-employed. On average, the level of educational attainment is high, with 27% of adults possessing a university degree, 24% college degree or diploma, and 30% high school diploma (Statistics Canada 2016a).

[5] At the time of writing, 2021 data for labor and income were still being compiled. As such, the 2016 data are referenced.

Surrey is undergoing rapid industrial development (City of Surrey 2022b). Average household income in 2016 was $93,586, and most census respondents occupied single-family detached homes (Statistics Canada 2016a). Surrey has a diverse industry base, and leading industries and major employers include accommodation and food services; construction; educational services; finance, insurance and real estate; health care and social assistance; information, culture and recreation; professional, scientific and technical services; and retail trade (Amurao 2021). Agriculture is the dominant industry in the immediate vicinity of the Project.

In Newton, the residential neighbourhood closest to Mud Bay Park and the Project, the population in 2016 was 149,040. Average household income was lower than the Surrey average at $90,049 (City of Surrey 2016). Newton is a vibrant and culturally diverse community with the region's largest South Asian community at 58% of the population.

Nearby Semiahmoo First Nation had a median household income of $47,232, an employment rate of 47.6% (declining at a rate of 0.16% per year over the 2001-2016 period), a labour force participation rate of 57.1%, and an unemployment rate of 16.7% in 2016 (Townfolio 2017). Tsawwassen First Nation had an employment rate of 45.1%, a labour force participation rate of 48.9%, and an unemployment rate of 7.7% (Statistics Canada 2016b).

Locally, the Project represents a short-term employment opportunity. Semiahmoo, Tsawwassen, and Kwantlen Nations have expressed interest in being involved in the construction of the Project, including opportunities for bidding on contracts and community employment. Semiahmoo has elsewhere emphasized the importance of developing an Indigenous Procurement Policy with the City (BCBC 2021).

The estimated workforce required is a crew of 16 (equipment operators and labourers), plus one Environmental Monitor, one or more archaeologist or archaeology monitors, and additional Qualified Professionals to guide the works as needed. This number may vary based upon the final methods selected.

Employment and procurement opportunities for local and Indigenous workers and businesses will be fostered through the City's Community Employment Benefits (CEB) initiative for the Disaster Mitigation and Adaptation Program in alignment with the Government of Canada's 2018 CEB policy. The CEB initiative will track eight target groups as defined by Infrastructure Canada including apprentices, Indigenous individuals, women, persons with disabilities, veterans, youth, and recent immigrants. The City has also added an additional target group to encourage opportunities for LGBTQ+ individuals. For enterprises the CEB initiative will target small to medium size businesses and social enterprises where possible. It is envisioned that there will be a pre-qualification process to evaluate individuals and businesses for inclusion in the program.

The CEB goals are to achieve 20% of the employment hours going to individuals belonging to at least one of the identified target groups and that approximately half (50%) of the procurement of construction and related services and goods go to targeted businesses. Additional information, including the Council-endorsed policy is publicly available on the City of Surrey website here: https://www.surrey.ca/services-payments/water-drainage-sewer/flood-control/coastal-flood-adaptation-strategy/community.

The project is also exploring options and opportunities to coordinate with and involve local youth through the Salmon Habitat Restoration Program (SHaRP) to perform a portion of the vegetation planting and adaptive management requirements of the project (https://www.surrey.ca/SHaRP).

5.4.2 Archaeological and Heritage Setting

There are three known archaeological sites within the vicinity of the Project. One of these, a cultural shell deposit (DgRr-29), is located inside the Project footprint. The other two sites are also cultural shell deposits and are located 1 km northwest and 0.5 km east of the Project footprint. (Archer 2020). An archaeological shovel testing program was conducted as part of an Archaeological Impact Assessment (AIA) and a surface inspection was also conducted within the foreshore area of Mud Bay to assess if the proposed construction activities might impact archaeological deposits (Archer 2020). No cultural materials protected by the HCA were identified during the study.

Mitchell (1996) provides a map of major archaeological sites yielding human remains in Boundary and Semiahmoo Bays, where hundreds of Indigenous human remains have been recovered by archaeologists. Crescent Beach, approximately 2 km from the Project site, is an area known to be rich in historical significance (Holmes 2019).

5.4.3 Human Health Setting

Surrey residents generally have access to high quality health care, community services and recreational facilities. Yet health and well-being are influenced by many different factors, including income, education, employment, and physical environments. Different population groups often have different opportunities and challenges in maintaining or improving their health, and Indigenous people and new immigrants often face barriers to accessing health services and sustaining health and wellness (PHSA 2016). There is a disparity between how well the Indigenous and non-Indigenous residents in the City are performing in terms of the factors affecting health and well-being, this is demonstrated, in part by the differences between Semiahmoo First Nation and City residents that are discussed below.

Income greatly impacts health by affecting living conditions such as access to adequate housing and healthy living options (PHSA 2016). People with higher levels of education tend to be healthier than those with less formal education, and education levels are linked to job opportunities, working conditions, and income level (PHSA 2016). Surrey residents in general, and Newton in particular, both have median household incomes higher than the Canadian average. In comparison, Semiahmoo First Nation has a median household income lower than the Canadian average.

Employment provides income and a sense of security, while underemployment or unemployment can lead to poorer physical and mental well-being due to reduced income, lack of employment benefits and elevated stress levels (PHSA 2016). The labour force participation rate is lower for Semiahmoo First Nation than for the City, and Semiahmoo First Nation has a much higher unemployment rate.

Physical environments can promote healthy behaviours by increasing access to healthy food outlets, affordable housing, walking or biking paths, and smoke-free environments (PHSA 2014). Surrey and Semiahmoo residents all have access to beaches, waterfront, and parks, and the DSSRG and Boundary Bay have multiple access points for foot traffic, cyclists, and equestrians.

Local Indigenous nations have historically fished and gathered raw materials and beach foods from the Project area. Beach foods included clams, mussels, sea urchins, sea cucumbers and seaweeds; plants included a wide variety of berries; the most common fish species was salmon, and waterfowl hunted included ducks and geese. Bivalves and crabs are particularly important traditional food sources for Semiahmoo, Tsawwassen, and Kwantlen First Nations; however, they are unable to harvest these because the waters and intertidal foreshore of Boundary Bay and Semiahmoo Bay are under sanitary contamination closures. Eating shellfish from these areas can be life threatening.

The nearby South Asian community in Newton may also be at an increased risk if residents collect bivalves unaware of the closure. Semiahmoo First Nation have expressed interest in testing clams and sedimentation and re-classifying Mud Bay for harvesting shellfish and improving water quality (*Mud Bay Nature-Based Foreshore Enhancements Project, Site S2 – Engagement Plan (June 2022))*.

Surrey is an urban-agricultural community; therefore, residents are sometimes exposed to farming-related odours. Air emissions from trucks, trains, and equipment are largely associated with the region's highways and byways.

6.0 EFFECTS ASSESSMENT

This section provides a summary of the potential physical, biological, and human environmental conditions and characteristics, including sensitive and vulnerable values, and their interaction with Project-related activities and components. The identification of Valued Components (VCs) and potential Project-related interactions and effects will be further refined through engagement with Indigenous nations, local governments, stakeholders, and regulators.

The effects assessment considers the Project area required for the constructed salt marsh and potential disturbance associated with ancillary construction areas for site access roads, ramps, material laydown, and equipment storage. The Project area considered includes the Mud Bay Park parking lot, access along the Colebrook Dyke to the Project location, and the Project footprint within Mud Bay foreshore which extends along the shoreline for a combined length of approximately 790 m of linear shoreline and approximately 105 m seawards of the Colebrook Dyke, as shown in Figure 2 and Figure 3.

6.1 VALUED COMPONENT IDENTIFICATION

VCs are representative of the important features of the natural and human environment that are likely to interact with the Project. VCs are selected based on the guidance outlined in the BCEAO's Effects Assessment Policy (April 2020). VCs should satisfy the following list of attributes to be included in an assessment:

- Relevant to at least one of the assessment matters and clearly linked to the values reflected in the issues raised in respect of the Project;
- Comprehensive, so that taken together, the VCs selected for an assessment should enable an understanding of the potential effects of the Project;
- Representative of the important features of the biophysical and human environment likely to be affected by the Project;
- Responsive to the potential effects of the Project; and
- Concise, so that the nature of the interactions between the Project and the VCs can be clearly articulated and understood and redundant analysis is avoided.

Candidate VCs were identified based on a consideration of some or all of the following criteria:

- Presence in the Project area;
- Potential for Project interaction with, and effect on, the candidate VC;
- Particular concern expressed by stakeholders;
- Relevance to legislative or regulatory requirements or government management priority (e.g., species at risk);
- Policy guidance;
- Relevance to Aboriginal Treaty rights or interests, including title;
- Sensitivity or vulnerability to disturbance; and
- Measurability of parameters related to the candidate VC.

Based on these criteria, the City has identified candidate VCs for inclusion in this effects assessment, as outlined in Table 10.

Table 10 Candidate valued components for the Project.

Valued Component	Rationale
Air Quality	Construction activities will result in the production of dust and emissions. Establishment of additional constructed salt marsh may increase carbon sequestration.
Acoustic	Construction activities will temporarily increase acoustic levels in the vicinity of the Project.
Marine Water and Sediment Quality	Construction of the Project will require the placement of imported sediments in the foreshore and may disturb existing sediment in the foreshore.
Marine Habitat	Construction of the Project has the potential to both positively and negatively interact with marine habitat through placement of imported sediments in the foreshore for salt marsh construction, stabilization of the imported sediments, and the planting of the constructed salt marsh bench. Post-construction, marine habitat will be enhanced upon establishment of the salt marsh.
Terrestrial Habitat	Construction of the Project has the potential to negatively interact with terrestrial habitat through the construction of temporary access routes for construction equipment and potential laydown areas.
Wildlife	Construction of the Project has the potential to both positively and negatively interact with wildlife and wildlife habitat, including provincially and federally listed at-risk species.
Marine Fauna	Construction activities in, on, or near the sea have the potential to positively and negatively interact with marine fauna (inclusive of marine mammals, fish, shellfish and other invertebrates).
Land Use	Construction of the Project will result in temporary interference of recreational activities in Mud Bay Park and on the Boundary Bay Dyke Trail.
Marine Use	Construction of the Project has the potential to temporarily interact with public marine use within the Mud Bay area.
Employment & Economics	The Project has the potential for some local job creation for the duration of the Project construction and monitoring and maintenance phases.
Visual resources	Construction activities will be visible from publicly accessible roads, bridges, and trails, but will be temporary. The Project will permanently alter the visual landscape within the Project footprint.
Transportation infrastructure	The Project has the potential to positively and negatively interact with transportation infrastructure during construction.
Community Infrastructure and Services	The Project has the potential for impacts to emergency response services associated with potential accidents and malfunctions during the construction phase of the Project.
Human Health	Interaction of the Project with environmental media, including sediment and water, have the potential to adversely impact human health.
Archaeological and Heritage Resources	Ground disturbance and vegetation removal activities have the potential to disturb archaeological and heritage resources.
Culture	Construction of the Project has the potential to positively and negatively interact with some traditional resource use and related cultural practices that could take place in the vicinity of the Project.

6.2 POTENTIAL PROJECT INTERACTIONS

Potential interactions between the components and activities associated with the Project and VCs during construction and maintenance activities have been examined. The nature of the interaction was rated as "no interaction," "negligible interaction," or "potential interaction," which provides a means to focus assessment of the Project on those interactions that are likely to result in an adverse effect.

- No interaction (-): little to no adverse interaction expected.
- Negligible interaction (●): potential interaction with the activity but the Project will not have a substantive influence on the short- or long-term integrity of the VC following the implementation of standard mitigation measures.
- Potential interaction (✓): potential adverse effect between the activity and the VC may have a substantive influence on the short- or long-term integrity of the VC. The potential effect(s) of the interaction is considered further in the effects assessment.

Where there is no interaction or there is a negligible interaction, the VC is not carried forward for further assessment. Interactions rated only as positive ("+ve") are also not carried forward. Where a potential adverse interaction has been identified, a high-level effects assessment is conducted to identify mitigation to avoid or minimize the effect and to facilitate the mitigation being specified as a condition of approval of the requested EAC Exemption Order, as required.

Table 11 Project activity interactions with valued components.

Activity	Air Quality	Acoustic	Marine Water and Sediment Quality	Marine Habitat	Terrestrial Habitat	Wildlife	Marine Fauna	Land Use	Marine Use	Employment and Economics	Visual Resources	Transportation Infrastructure	Community Infrastructure and Services	Human Health	Archaeological and Heritage Resources	Culture
Construction Option 1: Sediment Placement - Conventional Material Placement	●	●	✓	✓	-	✓	✓	●	●	+ve	●	●	●	●	✓	✓
Construction Option 2: Sediment Placement – Land-Based Pumping	●	●	✓	✓	-	✓	✓	●	●	+ve	●	●	●	●	✓	✓
Construction Option 3: Sediment Placement – Marine Dredging Vessel	●	●	✓	✓	-	✓	✓	●	✓	+ve	●	●	●	●	✓	✓
Construction: Sediment Stabilization	●	●	✓	✓	-	✓	✓	●	●	+ve	●	●	●	●	✓	✓
Construction: Access and Laydown Areas	●	●	●	✓	✓	✓	✓	✓	●	+ve	●	●	●	●	✓	✓
Construction: Vegetation Planting	-	-	+ve	+ve	-	● +ve	+ve	●	-	+ve	●	●	●	-	-	✓ +ve
Monitoring and Maintenance: Adaptive Management	● +ve	●	●	● +ve	-	● +ve	● +ve	●	●	+ve	●	+ve	-	-	✓	✓ +ve

The following interactions were used to determine which VCs were retained for the effects assessment:

- **Air Quality** and Greenhouse Gas Emissions – Construction activities will result in air emissions. However, with the adherence to regulatory requirements and the implementation of standard mitigation measures and best management practices (BMPs), any adverse effects are expected to be eliminated or reduced to negligible levels. Additionally, a positive Project interaction is the potential for the constructed salt marsh to support carbon sequestration. Therefore, the Air Quality and Greenhouse Gas Emissions candidate VC will not be carried forward in this assessment. Please see Section 6.8.1.1 for further discussion on Greenhouse Gas Emissions.
- **Acoustic** – Construction activities will result in noise emissions. The Project is proposed to be constructed in February 2025 to accommodate the timing windows and constructability considerations discussed in Section 1.1. Night work is expected due to the timing of low tide during this time of the year. Per the City's Noise Control Bylaw (By-law No. 7044), construction works outside of 7:00 am to 10:00 pm Monday to Saturday, or at any time on Sunday are not permitted unless it is impracticable to comply (written approval must be obtained from the Inspector). If required, written approval will be sought from the City's Inspector. Impacts to residents and businesses in the area are anticipated to be low due to the location of the construction and existing elevated noise levels associated with Highway 99 adjacent to the Project. The nearest residential community is Newton, located approximately 1 km from the Project (and Highway 99). Therefore, the acoustic candidate VC will not be carried forward in this assessment.
- **Marine Water and Sediment Quality** – Retained as a Project VC.
- **Marine Habitat** – Retained as a Project VC.
- **Terrestrial Habitat** – Retained as a Project VC.
- **Wildlife** – Retained as a Project VC.
- **Marine Fauna** – Retained as a Project VC.
- **Land Use** – Retained as a Project VC.
- **Marine Use** – Construction of the Project has the potential to temporarily interact with limited existing public marine use of Mud Bay by recreational watercraft that can access shallow waters (e.g., kayaks, paddle boards, pleasure craft); however, impacts are expected to have a negligible and temporary impact. To mitigate any effects, the City will notify the public by installing on-site signage, providing updates through local media in advance of the sediment placement, and submitting a notice to shipping, if marine works are required. The Project will slightly alter the configuration of the foreshore and result in an improved environment for recreational marine users. Navigation is protected under the *Canadian Navigable Waters Act* and the Project is within a Navigable Water. The potential for interference with navigation depends on the construction method selected. The placement of imported sediment from a marine dredging vessel has greater potential to interfere with navigation, than land-based construction options. If the Project does not interfere with Navigation, the City may submit a No Interference with Navigation notification, which includes a public notice. Alternatively, if the Project has the potential to interfere with navigation,

an application for approval will be submitted to Transport Canada that may result in an approval being required. Therefore, the marine use candidate VC will not be carried forward in this assessment.

- **Employment and Economics** – Construction of the Project is anticipated to occur in phases providing employment opportunities, however, due to the scale of the Project, employment and economic opportunities are expected to be limited. To a lesser scale, employment opportunities will also be created during the follow-up monitoring program. Further information of employment opportunities for Indigenous nations is discussed in Section 7.2. The employment and economics candidate VC is not be carried forward in this assessment.
- **Visual Resources** – Construction activities will have a temporary impact on visual quality and aesthetics in the vicinity of the Project. However, following the completion of the Project construction, the only resulting Project infrastructure that will appear as a notable change in the visual landscape are materials used for sediment stabilization (assumed to be brushwood dams) that may be protruding from the seaward edge of the constructed salt marsh. While there will be some changes in visual appearance of the intertidal area within the Project area, the construction approach is intended for the Project to establish into a salt marsh that mimics that of the natural salt marshes within the area. Therefore, the visual resources candidate VC will not be carried forward in this assessment.
- **Transportation Infrastructure** – The traffic impacts during construction are dependent on the construction option selected but anticipated to be managed using existing BMPs and approaches, which will be defined in the Traffic Management Plan. The main access to the Project site will be from the existing Colebrook Dyke/Boundary Bay Trail, from nearby Mud Bay Regional Park. The Project contributes to the development of new infrastructure and management approaches along the Highway 99 corridor to prepare for increased frequency of flooding in the face of climate change, which is a positive benefit. Therefore, the Project-related transportation infrastructure VC will not be carried forward in this assessment.
- **Community Infrastructure and Services** – Construction of the Project is anticipated to occur in phases and due to the scale of the Project and small workforce required, impacts to community infrastructure and services are expected to be minimal. Potential impacts to emergency response services may arise in association with potential accidents and malfunctions during the construction phase of the Project, however, these are expected to be negligible. Further discussion on potential accidents and malfunctions can be found in Section 6.9. Therefore, the community infrastructure and services candidate VC will not be carried forward in this assessment.
- **Human Health** – Potential effects to human health are related to potential Project-related effects to air quality, acoustics, land use, sediment, and water. As detailed above, the Project is not expected to result in a substantive influence on the short- or long-term integrity of the air quality or acoustic VCs. Sediment used in the intertidal area will be sampled to confirm it meets appropriate environmental standards and appropriate approvals will be obtained, as discussed in Section 6.3.1.1. Therefore, the human health candidate VC will not be carried forward in this assessment. Occupational health and safety are not considered in this assessment as they are addressed under separate regulations and standards.

- **Archaeological and Heritage Resources** – Retained as a Project VC.
- **Culture** – Retained as a Project VC.

6.3 POTENTIAL EFFECTS AND MITIGATION MEASURES

6.3.1 Biophysical Environment

6.3.1.1 Marine Water and Sediment Quality

As mentioned in Section 3.3.1, the imported marsh sediment used for the Project will be tested/analyzed prior to placement to ensure adequate quality and that, per *CEPA*, the sediment meets DAS criteria. In addition to the DAS criteria, the Canadian Council of Ministers of the Environment *Canadian Sediment Quality Guidelines for the Protection of Aquatic Life* (CCME Sediment Quality Guidelines), which outline limits for the physical, chemical, and biological properties of freshwater and marine sediments, will be used. These guidelines have been established to support and maintain aquatic life associated with bed sediments, meeting these standards will minimize the risk of residual adverse effects associated with potential changes in sediment quality as a result of the Project.

The deposition of imported marsh sediment will only occur during low tides when the Project footprint is completely exposed. This will reduce the resuspension of sediment into the water column and therefore turbidity. Further mitigation measures to prevent increased turbidity due to sediment runoff will include establishing sediment stabilization (see Section 3.3.4) concurrently with sediment deposition. Proposed sediment stabilization techniques include a component to retain and filter fine sediments. Lessons learned from the Pilot Studies will inform the optimal design for the Project to avoid residual effects, including addressing increased turbidity in the marine environment.

Erosion and sediment control measures will be installed prior to sediment deposition. Consistent with the City's Erosion and Sediment Control (By-law No. 16138), an Erosion and Sediment Control Permit will be sought prior to construction, which will include an Erosion and Sediment Control Plan. This will include a description of erosion and sedimentation potential for construction-related activities and present strategies and measures for the prevention of erosion and sediment transport during construction and adaptive management of the Project.

Construction option 2, land-based pumping, has the potential to increase localized freshwater input through the process of mixing dry sediments into a slurry. For every 1 m^3 of sediment, up to 5.6 m^3 of water will be added to pump it as a slurry, this is expected to be a local freshwater source, not sea water, due to the shallow nature of Mud Bay (see Section 3.3.3). However, Mud Bay is an estuarine environment with freshwater input from both the Serpentine and Nicomekl Rivers. Therefore, the temporary addition of freshwater from the sediment slurry is not expected to adversely affect marine habitat or fauna, as they already encounter significant freshwater inputs.

If construction option 2 were to be selected and an additive such as a fluidizer and/or plasticizer is necessary to support mixing the slurry, the additive(s) will not be deleterious to the marine environment, e.g., biodegradable, non-toxic. Specifications will be defined in the CEMP once the requirements for such additives have been determined.

In consideration of the above, residual adverse effects to Marine Water and Sediment Quality are unlikely to result from the Project, upon successful implementation of the following mitigation measures:

- Imported sediments will be analyzed and confirmed to meet DAS criteria and CCME Sediment Quality Guidelines prior to deposition;
- Sediment will be placed during low tides to avoid direct input to marine water;
- Edge stabilization will be done ahead of sediment deposition to trap sediment within the desired Project area;
- An Erosion and Sediment Control Permit from the City will be obtained prior to construction, this will include the creation of an approved Erosion and Sediment Control Plan for the Project; and
- An Environmental Monitor will be on-site during sediment deposition to monitor Erosion and Sediment Control;
- Slurry additives such as a fluidizer or plasticizer will not be deleterious to the marine environment, e.g., biodegradable, non-toxic. Specifications will be defined in the CEMP once the requirements for such additives have been determined.

6.3.1.2 Marine Habitat

The current salt marsh habitat within the Project footprint is patchy (1 – 75%; Hatfield 2020). Though there is the potential for the construction of the Project (especially construction option 1) to disturb the existing salt marsh, the goal of the Project is to increase the total salt marsh area by several hectares. Damaged salt marsh will be replanted and restored. The addition of the TLP has the potential to smother existing salt marsh. However, a review of studies conducted elsewhere in North America on TLP of sediment for tidal marsh resilience to sea level rise found that, in most cases, tidal marsh plants can recover through 5 to 15 cm of sediment addition, while depths of 20 to 30 cm had mixed success depending on the study, and depths of 60 to 90 cm had no vegetation recovery (Raposa et al. 2020). Both Pilot Studies will experiment with different TLP depths (10 and 20 cm) and the best method will be used in the Project.

A request for review will be submitted to DFO, allowing them to determine if a *Fisheries Act* Authorization is required due to death of fish or Harmful Alteration, Disruption or Destruction (HADD) of fish habitat. However, given that the Project is a habitat restoration project, creating additional salt marsh coverage (which is an important nursery habitat for juvenile fishes), an Authorization is not expected. Any avoidance and mitigation measures recommended by DFO will be implemented during Project construction.

Both (diatoms within) biofilm and eelgrass have specific light requirements for photosynthesis, and increased turbidity can reduce their photosynthetic capacity. Light availability is one of the factors that can limit biofilm and eelgrass distribution (Hemmera 2014; WorleyParsons 2015). However, as mentioned in Section 6.3.1.1, mitigation efforts will prevent increased turbidity due to construction activities; therefore it is not anticipated that biofilm or eelgrass will be negatively affected by imported sediment. Importantly, biofilm grows where conditions are suitable, meaning that if biofilm is absent from an area, the habitat is most likely unsuitable for its growth. However, when conditions are adequate, biofilm can grow over mudflats quickly, exemplified by its spring growth and proliferation elsewhere in the Fraser River delta.

Using bird count data as an indicator for biofilm abundance (Jardine et al. 2015, Hatfield 2020), there currently appears to be little biofilm present in the Project footprint. Additionally, if sea level rise occurs in the Project Area, then the mudflats will be submerged too frequently to support the photosynthetic needs of biofilm in the future. In addition, salinity levels can determine biofilm composition and distribution, and eelgrass distribution (Hemmera 2014; WorleyParsons 2015). Construction option 2 of the Project has the potential to increase freshwater locally; however, the limited amount and short duration of potential increased freshwater are not expected to negatively affect either habitat, as they both experience significant seasonal variation in freshwater input, especially during freshet. Residual adverse effects are not expected from the Project after the following mitigation measures are implemented:

- Mitigation of increased sediment loads (described in Section 6.3.1.1).
- Avoid damage to existing salt marsh and replant and restore where/if damage prevention is not possible, particularly in relation to construction access across the Salt Marsh, if required. The area required will be minimized and use of sediments, and temporary mats are being considered to provide protection. The mitigation measures will be confirmed in the CEMP.
- Implement any DFO avoidance and mitigation recommendations to prevent death of fish or HADD of fish habitat.

6.3.1.3 Terrestrial Habitat

Construction-related activities that may result in the loss of terrestrial at-risk plant species are limited to the preparation of ancillary construction areas for site access roads, ramps, material laydown, and equipment storage, as discussed in Section 3.2.4. Residual adverse effects are unlikely to result from the Project upon implementation of the following mitigation measures:

- Footprint disturbance will be minimized to reduce potential impacts to at-risk plant species.
- Surveys for at-risk plants will be conducted within the final Project footprint prior to site preparation and vegetation clearing. At-risk plant surveys will be undertaken by a qualified professional and take into consideration the *Protocols for Rare Plant Surveys* (Penny and Klinkenberg 2012) and guidance provided by the Alberta Native Plant Council. If at-risk plant species or assemblages are encountered during the surveys, potential adverse effects will be mitigated by buffering, relocating, or salvaging, with guidance from the qualified professional.
- A Reclamation Plan will be developed to ensure that areas of terrestrial habitat temporarily disturbed during construction of the Project are reclaimed. This includes revegetation of temporarily used sites when use is discontinued, and conditions are suitable for plant establishment.
- A Vegetation Management Plan will be developed to protect native vegetation and ecosystems from the potential introduction/spread of invasive plant species. Measures to manage invasive plant species will be developed with consideration for the *Invasive Plants Regulation* (Government of BC 2004) of the *Forest and Range Practices Act* and the *Weed Control Act*. Additional guidance provided by the Invasive Species Council of BC and the Invasive Species Council of Metro Vancouver will be considered.

6.3.1.4 Wildlife

Majority of the wildlife species at risk found within the Mud Bay area are bird species stopping over during migration or the non-breeding period (Table A4.1), many of which are protected under the *Migratory Birds Convention Act*, 1994. The shorebird and waterbird species generally use mudflats, beaches, and the shores of lakes and ponds for foraging and roosting (CDC 2022). Biofilm and benthic invertebrates are important components of shorebird diet, which could be altered by changes to sediments within the Project footprint in the short-term. Over time, the raised elevation habitat could provide a longer duration of accessible roosting habitat at high tide, while some mudflat foraging habitat may be replaced by salt marsh. Baseline shorebird surveys indicated that shorebird use within and adjacent to the Project area is low, relative to other areas of Mud Bay (Hatfield 2020, 2021). The potential adverse effects on birds are mitigated by the apparent low use of the Project area, potential for habitat enhancement (positive effects), and Project timing of construction activities to occur outside of the peak shorebird migration period.

Great blue heron, (*fannini* subspecies) occurs in the Project area, is resident, and feeds in intertidal areas as well as farmland. Great blue heron nesting colonies are known in the vicinity of the Project area (Hatfield 2021; KWL 2022a); however, they occur further than the recommended quiet buffer from the Project area. Disturbance is not to occur within 260 m of nests during the breeding season (January 15 to September 15; *Develop with Care* 2014). Once laydown areas and access routes are confirmed, prior to works, the area will be surveyed to ensure no nests are present nearby.

Critical habitat for Barn Owl has been recently mapped, which overlaps with the Project area (ECCC 2021). This species is red-listed in BC and threatened under SARA Schedule 1 (CDC 2022; ECCC 2021). On provincial lands, owls are not subject to prohibitions under SARA and are protected under the BC *Wildlife Act*. Short-eared owl usually breeds from March 25 to June 05 (Bird Studies Canada 2022) and may use terrestrial habitat outside of the Project area. Potential adverse effects are mitigated through project timing.

Snake hibernacula sites are not known within the Project area, but garter snakes have used the dyke at Boundary Bay as a mass overwintering site (discovered in March 2015). If laydown/access activities involve alteration of the existing dyke infrastructure, the potential for snake hibernacula may require mitigation (survey and plan for salvage and relocation).

Adult Audouin's night-stalking tiger beetles have been detected adjacent to the Project area and larvae are expected to develop within suitable soils nearby. Larval habitat has not been located for the population at Mud Bay and Boundary Bay, which adds uncertainty to potential effects on the larval stage of this species. The Project area overlaps with proposed federal critical habitat for the species and small changes to the sediment (e.g., depth, composition, slope, and pH) have the potential to impact larval burrow habitat and adult foraging habitat (ECCC 2022). Little is currently known about whether there is larval habitat present in the Project footprint, if the species can adjust to gradual sediment additions, and if larval salvage is possible.

While, there is no specific legislation[6] pertaining to this species within the Project area, to reduce Project-related effects on the Audouin's night-stalking tiger beetle, the City of Surrey and KWL are drafting a species-specific mitigation plan for the Mud Bay Nature-Based Foreshore Enhancement Project (personal

[6] The BC *Wildlife Act* only pertains to vertebrate species. For terrestrial species at risk (i.e., non migratory birds and non aquatic species), SARA prohibitions apply on federal lands only, unless an emergency protection order is in place to extend the prohibitions to provincial/private lands.

communication from KWL to Hatfield). The current understanding is that larval habitat is most likely to occur on the seaward face of the dyke and/or within remnant sand dune habitat within the Mud Bay and Boundary Bay area (personal communication from KWL to Hatfield). McGregor (2021) determined that adult *O. audouini* abundance was strongly associated with Douglas aster (*Symphyotrichum subspicatum*) vegetation communities (approximately 15 m seaward from the dyke at Boundary Bay) and suggested that potential impacts of construction and development on adult beetles could be determined by mapping and avoiding the distribution of this vegetation within the Project footprint.

The Audouin's night-stalking tiger beetle is vulnerable to rising sea levels; thus, the Project has the potential to benefit this species long-term by providing increased area of salt marsh habitat. However, the Project has the potential to remove habitat for adults as Douglas aster is not deemed for planting (Section 3.3.5). Direct impact to adults is to be largely mitigated through timing (i.e., adults are not expected to be present in February through March) and avoidance of Douglas aster vegetation in the Project footprint. However, there is an existing knowledge gap in distribution of larval habitats, which could be negatively impacted by ground disturbance, compaction, or sediment additions.

In summary, residual adverse effects to wildlife are unlikely to result from the Project upon implementation of the following mitigation measures:

- Avoid activities during the breeding bird season (March 30 – August 16).
- Follow recommendations of the draft Audouin's night-stalking tiger beetle mitigation plan to avoid impact to adult and immature stages of this species. Specific mitigations to reduce impact include:
    - Project timing to avoid the most active period for adult beetles (e.g., April 01 to August 31);
    - Minimize or eliminate Project footprint disturbances to plant communities dominated by Douglas aster (*Symphyotrichum subspicatum*), which adult Audouin's night-stalking tiger beetles are strongly associated with (McGregor 2021). Suitable habitat should be mapped by a qualified professional to inform final design;
    - As it is assumed that larvae are present in the soil year-round, project timing is not able to minimize impact to larvae. Project activities resulting in disturbance or compaction of soil should be minimized to maintain biophysical attributes required by larvae. Design and access/laydown options that avoid the seaward face of the dyke and high intertidal or supratidal elevations of the Project area would also mitigate larval impacts; and,
    - In collaboration with a recognized expert, assess presence of adult and larvae of Audouin's night-stalking tiger beetle in the Project footprint (or within the S1 Pilot Study) prior to works.
- Conduct pre-construction surveys for garter snake and associated winter hibernacula. Surveys should be conducted by a qualified professional and take into consideration the *Guidelines for Amphibian and Reptile Conservation During Urban and Rural Land Development* (Biolinx Environmental Research Ltd and E. Wind Consulting 2014) and *Best Management Practices for Amphibian and Reptile Salvages in British Columbia* (2016). If hibernacula are located, develop a plan to monitor or relocate snakes during construction, as snakes are protected from direct harm and disturbance under the provincial *Wildlife Act*.
- Conduct pre-construction surveys for heron and raptor nests to ensure that work within laydowns, access routes, and the Project area does not occur within the quiet zone buffer of a nest.

6.3.1.5 Marine Fauna

Construction of the project will alter some intertidal habitats by replacing mudflat with salt marsh. Though salt marshes support a larger diversity and greater abundance of organisms than barren (i.e., unvegetated) mudflats, some organisms will be displaced by the Project. A salvage will be done immediately before construction to relocate any crabs, sea stars, or other mobile macroinvertebrates found within the Project footprint. Bivalves (Family Hiatellidae) were abundant in the Project area during baseline studies, however, no larger edible bivalves (i.e., shellfish) were observed (Hatfield 2021). The addition of placed sediment is not expected to negatively impact infauna (i.e., shellfish) since they can migrate vertically through new material.

The aforementioned sediment mitigation measures will ensure that marine fauna (e.g., filter feeders like clams) are not negatively affected by sediments during the construction period. Additionally, temporary freshwater input from construction option 2 is not expected to affect marine fauna, as these organisms regularly experience hyposaline conditions (as previously described in Section 6.3.1.1).

If a brushwood dam is used for sediment stabilization, then there is the possibility of fish getting entrapped. To prevent this, regularly spaced channels will be incorporated into the design, allowing fish to escape with the ebbing tide.

If oyster bags are used for sediment stabilization and the barrier is placed before sediment backfilling, then this may also entrap fish. Similar preventative measures will be applied to the brushwood dam scenario and Erosion and Sediment Control barriers, as required, such as pre-work surveys and escape channels, will be employed to ensure no fish are trapped. As mentioned in Section 3.2.2, the bags will be made of only natural and biodegradable material. Oyster shells are a natural attractant for oyster settlement and may result in the creation of an oyster reef at the seaward edge of the salt marsh. Oyster reefs are beneficial for sediment retention and capture, wave attenuation, and increasing infaunal (e.g., shellfish) and epifaunal biodiversity; therefore, may be considered a positive effect (Karp et al 2018; Chowdhury et al 2019; Hogan and Reidenbach 2021).

In-water construction for the Project will be conducted during the applicable least risk timing window for fish (August 16 to February 28). The Project will result in an overall ‘net gain’ in aquatic habitat values. Adverse effects to marine fauna are expected to be negligible.

6.3.2 Human Environment

6.3.2.1 Land Use

Construction activities, specifically access and laydown areas, attributed to the Project will likely limit access to parking, as well as portions of the walking trails within Mud Bay and Boundary Bay Regional Parks during construction of the Project. It is not expected that the Project activities will have effects on the land use beyond the Project area, nor past the duration of the laydown areas.

Temporary construction activities will reduce the number of recreation users in the park due to limited parking and interference with trails. Steps will be taken to minimize any limitations on parking at Mud Bay Parking Lot, as this would not only limit access to Mud Bay Park but consequently to Boundary Bay Regional Park and the DSSRG. Laydown activities will be carried out in a way that maintains safe access to trails

and viewpoints, and fencing will be used to separate construction activities from the public. Where this is not possible, a flag person will direct the safe passage of trail users and alternative access routes will be provided wherever possible. On-site signage and updates through local media may be provided to the public in advance of the laydown, so that park users can plan accordingly.

As outlined in Section 1.2.2, prior to construction, a Park Permit will be obtained from Metro Vancouver (Bylaw No. 1177, Regional Parks Regulation) to authorize temporary closure of sections of the Boundary Bay Dyke trail. A Traffic Obstruction Permit will also be obtained from the City (Bylaw No. 13007, Highways, Traffic and Parking Regulation) prior to construction, which requires the development and implementation of a Traffic Management Plan that will define specifically what traffic control measures will be provided, how they will be implemented, and on what schedule.

With implementation and adherence to the above recommended mitigations, adverse effects on land use are expected to be negligible.

6.3.2.2 Archaeological and Heritage Resources

One of three known archaeological sites in the vicinity of the Project is within the Project area. A previous AIA conducted within the foreshore area of Mud Bay found no cultural materials protected by the *HCA*. However, there is potential at all stages of construction for archaeological deposits to be found. Site alteration permits will be obtained if archaeological deposits are required to be altered or removed as part of construction. However, construction techniques have been selected to avoid excavation to minimize the possibility of archaeological site and ground disturbance.

The Project will continue to engage with Semiahmoo, Tsawwassen, and other Indigenous nations. The City will inform its employees and contractors of this possibility through the CEMP and orientations. If archaeological materials or other heritage remains are uncovered during construction, work in the area must immediately cease and the Archaeology Branch and/or the project archaeologist be informed. The City will also promptly inform the relevant Indigenous Nations concerning any unanticipated archaeological findings as per recommendation in the AIA (Archer 2020).

A Local Indigenous nations have previously provided input and guidance into the development of the *Ancestral Remains and Burial Places Plan (2021)* specifically related to the City's DMAF projects, and have expressed interest in carrying out their own archaeological assessments. The City will further engage with participating Indigenous Nations and discuss options for additional Nation led archaeological assessments to take place.

Provided that existing guidance on archaeological finds is followed, the Project is not expected to have any adverse effects on archaeological and heritage resources.

6.3.2.3 Culture

The Project area was used historically by local Indigenous nations for fishing and gathering of raw materials and beach foods; however, sanitary contamination closures for bivalve harvesting within Boundary Bay currently exist. As a result of this closure, construction activities associated with the Project are not expected to adversely impact traditional cultural practices such as fishing and gathering.

Coastal and estuarine plants were used extensively by Indigenous nations for food, creating mats and baskets, dyes, and medicines for a variety of ailments. All proposed plant species for salt marsh construction are native to Boundary Bay, and opportunities may exist to work with local Indigenous nations to further refine the proposed plant species, potentially offering increased abundance and distribution of cultural resources in the long-term (i.e., once the salt marsh has established). Sourcing native plant species local to Boundary Bay will require the selection of sites with abundant seed and harvest materials. Opportunities may also exist to work with local Indigenous nations on the identification, collection, and propagation of the preferred plant species.

The City is unaware of any current uses within the Project area for ceremonial events or spiritual sessions. The City welcomes Indigenous nations to perform cultural blessings and ceremonies in general. Indigenous nations interested in performing ceremonial events, including those that are culturally sensitive, prior to, during, or after construction will be encouraged to do so, and will be provided with appropriate time and space as needed. The City will work with participating Indigenous nations to learn of cultural interests during the early engagement phase and address any concerns during construction timelines and phases.

The Project is not expected to have any adverse effects on culture.

6.3.3 Summary of Potential Adverse Effects and Mitigation Measures

Table 12 Summary of potential adverse effects and mitigation measures.

Valued Component	Project Activities and Potential Adverse Effects	Potential Mitigation Measures	Residual Effect
Marine Water and Sediment Quality	▪ There is potential that the import and placement of sediment to raise the salt marsh may increase turbidity during Project construction and the subsequent settlement period. ▪ Increased freshwater input and potential chemical additives related to construction option 2 have the potential to effect marine waters. ▪ The composition of the imported sediment may alter surrounding marine sediment and water quality conditions.	▪ Imported marsh sediments will be analyzed and confirmed to meet DAS criteria and CCME Sediment Quality Guidelines prior to deposition. ▪ Sediment will be placed during low tides to avoid direct input to marine water. ▪ Edge stabilization will be completed ahead of sediment deposition to trap sediment within the desired Project area. ▪ An Erosion and Sediment Control Permit from the City will be obtained prior to construction, this will include an approved Erosion and Sediment Control Plan for the Project. ▪ An EM will be on-site during sediment deposition to monitor Erosion and Sediment Control. ▪ Slurry additives such as a fluidizer or plasticizer will not be deleterious to the marine environment, e.g., biodegradable, non-toxic. Specifications will be defined in the CEMP once the requirements for such additives have been determined.	With the implementation the proposed mitigation measures, residual effects are expected to be negligible.
Marine Habitat	▪ During construction, sediment deposition (and associated turbidity) may reduce the photosynthetic capacity of biofilm and eelgrass by decreasing light attenuation. ▪ Changes in marine water and sediment quality have the potential to impact marine habitat. ▪ Extending the salt marsh platform will reduce mudflat area and has some potential to temporarily reduce biofilm coverage, if present, in the Project area.	▪ Potential marine habitat effects associated with sediment composition and placement will be mitigated as described above in the “Marine Water and Sediment Quality” section of this Table. ▪ Construction activities will be avoided during the breeding bird season (March 30 – August 16). ▪ The temporary loss of marine habitat will be offset by the creation of the raised salt marsh, which will increase habitat for a wide variety of organisms.	With the implementation the proposed mitigation measures, residual effects are expected to be negligible.
Terrestrial Habitat	▪ Ancillary construction areas for site access roads, material laydown, and equipment storage may overlap with terrestrial habitat and plant species at risk may be lost during the construction phase.	▪ Access roads and laydown areas within the Project area will be minimized to reduce potential impacts to at-risk plant species. ▪ A Reclamation Plan will be developed to ensure that areas of terrestrial habitat temporarily disturbed during construction of the Project are reclaimed. ▪ A Vegetation Management Plan will be developed to protect native vegetation and ecosystems from the potential introduction/spread of invasive plant species. ▪ Prior to site preparation and vegetation clearing, at-risk plant surveys will be undertaken by a qualified professional.	With the implementation the proposed mitigation measures, residual effects are expected to be negligible.
Wildlife	▪ Ancillary construction areas for site access roads, material laydown, and equipment storage may overlap with habitat for Audouin’s night-stalking tiger beetle adults and may cause mortality of larvae. ▪ Ancillary construction areas for site access roads, material laydown, and equipment storage may disturb garter snakes in hibernacula or directly result in mortality.	▪ Construction activities will be avoided during the breeding bird season (March 30 – August 16). ▪ Construction activities will be avoided during the active adult period for Audouin’s night-stalking tiger beetles (e.g., April 01 to August 31). ▪ Recommendations of draft mitigation plan for Audouin’s night stalking tiger beetle (developed by the City of Surrey and KWL, in collaboration with experts) will be followed. ▪ Project impacts to Douglas aster dominated plant communities and potential larval habitat will be minimized. ▪ Potential for Audouin’s night-stalking tiger beetle in the Project footprint will be assessed. If present, mitigations will be implemented, as determined by a qualified professional. ▪ Pre-construction surveys for raptor nests, heron rookeries, and garter snake hibernacula in the vicinity of laydown and access areas. ▪ Garter snake species will be salvaged and relocated, if necessary.	With the implementation the proposed mitigation measures, residual effects are expected to be negligible.

Table 12 (Cont'd.)

Valued Component	Project Activities and Potential Adverse Effects	Potential Mitigation Measures	Residual Effect
Marine Fauna	▪ The alteration from mudflat to salt marsh bench may displace a small number of select shellfish and other marine invertebrates. ▪ Sediment stabilization using brushwood dams or oyster bags may result in fish entrapment. ▪ Decreased salinity and increased sediment load may affect the abundance and distribution of Marine Fauna.	▪ Macroinvertebrates (i.e., crabs, sea stars - if any are within the Project footprint) will be relocated prior to sediment placement. ▪ Potential effects to marine fauna associated with sediment composition and placement will be mitigated as described above in the "Marine Water and Sediment Quality" section of this Table. ▪ Brushwood dams and/or oyster bags will have escape channels for fish, if needed. ▪ The temporary loss of marine habitat will be offset by the creation of the raised salt marsh, which will increase habitat for a wide variety of organisms. A *Fisheries Act* authorization is not expected to be required, however, an RFR will be submitted to DFO to confirm. ▪ In-water construction will be undertaken during the least-risk timing window for fish (August 16 to February 28).	With the implementation of the proposed mitigation measures, residual effects are expected to be negligible.
Land Use	▪ Access and laydown areas likely to limit access to parking at Mud Bay ▪ Access and laydown areas likely to limit access to portions of the walking trails within Mud Bay and Boundary Bay Regional Parks	▪ Limitations on parking at Mud Bay Parking Lot will be minimized while maintaining safe public access. ▪ Limitations on access to public footpaths will be minimized while maintaining safe public access to trails and viewpoints. ▪ A Park Permit will be obtained from Metro to authorize temporary closure of sections of the Boundary Bay Dyke trail. ▪ A Traffic Management Plan will be developed, and a Traffic Obstruction Permit will be obtained from the City.	With the implementation of the proposed mitigation measures, residual effects are expected to be negligible.
Archaeological and Heritage Resources	▪ Potential at all stages of construction for archaeological deposits to be found.	▪ Site alteration permits will be obtained if archaeological deposits are required to be altered or removed as part of construction. ▪ Construction techniques that minimize the possibility of archaeological site and ground disturbance have and will be selected, e.g.; avoiding excavation, selection of technique for brushwood dam installation. ▪ If archaeological materials or remains are uncovered, work in the area will immediately cease and the Archaeology Branch and/or project archaeologist will be informed. The City will also promptly inform the relevant Indigenous nations.	With the implementation of the proposed mitigation measures, residual effects are expected to be negligible.
Culture	▪ Based on available information, no adverse effects on the culture VC are expected as a result of Project activities.		N/A

6.4 RESIDUAL EFFECTS

With the successful implementation of the mitigation measures summarized in Table 12, including permitting requirements under *CEPA*, the *Fisheries Act*, the *HCA*, and applicable regional and municipal bylaws, along with the development and implementation of a CEMP and AM plan, potential residual adverse effects to environmental, economic, social, cultural, and health VCs will be negligible.

6.5 CUMULATIVE EFFECTS

The City is considering coastal retreat and salt marsh creation in Mud Bay Park, adjacent to the Project. If the City carries out these works, construction may occur in 2025 and potentially overlap with construction of the Project. Both the Project and the Mud Bay Park project would use the existing Colebrook Dyke to access their respective project sites. If the construction schedules overlap, a sequenced approach to construction activities will be undertaken in a way that minimizes the potential for cumulative adverse effects, such as the short-term disruption to the recreational use of Mud Bay Park. This sequencing will be considered as part of the Traffic Management Plan and CEMP, as discussed in Sections 6.3.2.1 and 6.6, if the Mud Bay Park project is confirmed and construction schedules overlap.

The City also plans to upgrade the Series 100 dyke that parallels the Project; however, it is planned to be completed prior to the construction of the Project and would not interact in such a way as to result in cumulative adverse effects.

6.6 FOLLOW-UP STRATEGY

6.6.1 Environmental Monitoring and Management

Prior to the construction phase of the Project, a CEMP will be prepared to support the implementation of mitigation measures as planned, as outlined in Section 6.3.3. This document will set out the requirements and measures that will be adopted to avoid, minimize, and mitigate the potential adverse environmental impacts related to the construction of the Project. The document will be provided to all Contractors working on site, and will include but not be limited to the following:

- Procedures to ensure that construction is conducted with mitigation and monitoring in place, to the satisfaction of a Qualified Professional, to minimize any potential Construction-related effects on fish species that may currently use the site;
- Specific actions and implementation of mitigation measures for protection of Audouin's night-stalking tiger beetle, as determined by a Qualified Professional; and
- Specific actions and monitoring to prevent spills of deleterious substances, including mitigation in the case of any spills.

The CEMP will also include identification of the measures that will be used to evaluate the effectiveness of proposed mitigation measures to meet the intended mitigation commitments and goals.

An Environmental Monitor will be retained for the duration of Project construction to support in the implementation of the CEMP, including the identification of additional actions necessary to prevent or reduce potential adverse effects associated with Project construction.

6.6.2 Adaptive Management

Post-construction, the monitoring and maintenance phase will require adaptive monitoring and management of the Project. An Effectiveness Monitoring and Adaptive Management Plan will be developed, this document will outline the approach, objectives, and protocols for the effectiveness monitoring for the Project. Specific elements of the Effectiveness Monitoring and Adaptive Management Plan will include:

- Roles and responsibilities;
- Monitoring schedule;
- Summary of monitoring techniques and equipment;
- Detailed list of performance indicators, metrics, and evaluation criteria;
- Identify thresholds for maintenance and/or experimental design changes during the AM phase;
- Maintenance plan for Project components;
- Decision making process for significant Project or experimental design changes during the AM phase; and
- Contingency plans for potential adverse Project outcomes.

6.7 POTENTIAL EFFECTS OF THE ENVIRONMENT ON THE PROJECT

This section provides a review of the possible effects of environment, including natural hazards, that are being considered and will be appropriately mitigated, to the extent possible. Contingency measures are presented.

The assessment considered the following potential effects of the environment on the Project:

- Seismic events, including tsunami;
- Severe weather conditions; and
- Climate change.

6.7.1 Seismic Events

6.7.1.1 Setting

The Lower Mainland lies within a seismically active region that is subject to frequent earthquakes, including some large historical earthquakes. Earthquakes in the west coast of Canada typically occur along fault lines in the offshore region, within the subducting Oceanic Plate, and within the continental crust (NRC 2016). Each year, the Geological Survey of Canada records more than 1,000 earthquakes in western Canada

(NRC 2016). Most are too small to be felt, but there is geologic evidence that large subduction earthquakes have occurred in the past (possibly at 300 to 900-year recurrence intervals), and the measured accumulation of strain between the tectonic plates suggests that they should be expected in the future (NRC 2016). The subduction of the deep Juan de Fuca Plate beneath the more shallow North American Plate has the potential to cause a magnitude 8 or 9 earthquake that could result in significant structural damage (Clague et al. 1995). Associated with seismic events is the risk of tsunami flooding the Project area.

6.7.1.2 Description of Effects on the Project

Depending on the type and magnitude of the seismic event, damage to Project works sustained during and post-construction, as a result of the geotechnical hazards mentioned above, may range from no major or minor damage to large scale damage.

If a large magnitude seismic event were to occur during construction, this would constitute an emergency and emergency response will be implemented by the City and Contractor. The Project is nature-based and does not involve the construction of any structures or buildings therefore the effects of seismic events on the Project are minimal.

Effects of a tsunami on the Project are similar to those of large storm flooding event and are discussed in the following section.

6.7.2 Severe Weather Conditions

6.7.2.1 Setting

Extreme weather conditions and weather-related events with the potential to adversely affect the Project include unusually heavy rains, fog, heavy snowfall, ice accumulations, and high winds. Precipitation within the Project area is mostly in the form of rain, where days with heavy rainfall (greater than 25 mm) generally occur more frequently from October through January. Snowfall occurs primarily during December and January. Wind data collected at the Vancouver International Airport indicate that wind speeds in the region can vary from 0 km/h to 82 km/h (annual maximum), with a mean average of 13.5 km/h in 2019 (ECCC 2020).

6.7.2.2 Description of Effects on the Project

Heavy rainfall has the potential to damage Project works during and post-construction, including constructed salt marsh components and drainage features, which could lead to runoff and debris entering the marine environment.

Extreme storm/wind events have the capacity to affect Project works, construction equipment, and infrastructure associated with construction of the Project. Given the location of the Project, coastal flooding presents the greatest risk. Were this to occur during construction, it could result in flooding of equipment and associated spills or releases of deleterious substances into the marine environment. The CEMP and Erosion and Sediment Control Plan will include mitigations for extreme weather and flooding, including timing, and contingency planning.

Storm events and extreme temperatures also have the potential to adversely affect the stability of the Living Dyke and the success of the planted marsh vegetation. The Pilot Studies will be used to inform the design of the Project to mitigate these risks.

6.7.3 Climate Change

6.7.3.1 Setting

The Intergovernmental Panel on Climate Change (IPCC) and the United States National Academy of Science agree that the global atmosphere is warming and attribute most of the warming observed over the past 50 years to anthropogenic sources that release Greenhouse Gases (GHGs) into the atmosphere (IPCC 2021, page 41). Every six years, the IPCC releases a climate change assessment report based on current knowledge and data related to climate change. The sixth and latest climate change assessment report was issued in 2021.

As the climate changes, coastal areas, such as the Surrey Lowlands, are experiencing more frequent and severe flooding due to sea level rise and increased precipitation. The coastal floodplain areas encompass 20% of the City's land and numerous residences, farms, rail, roads, and highways are increasingly vulnerable. It is predicted that over 2,500 people will be directly affected in the future, including billions of dollars in infrastructure and the movement of commodities.

The effects of climate change that could affect the Project include temperature rise, increased precipitation, more frequent intense storms, and sea level rise.

6.7.3.2 Description of Effects on the Project

The primary potential effects of climate change that could influence the Project are more frequent and/or intense storms, and sea level rise and these are inherently considered in the Project design, since it is proposed as a nature-based approach to adapt to sea level rise.

Effects of extreme weather and associated mitigations are discussed in Section 6.7.2. The AM approach will be developed to respond to the changing climate and support the implementation of contingency and maintenance measures. These will be outlined in the AM plan.

6.8 EMISSIONS, DISCHARGES, AND WASTE

6.8.1 Atmospheric Emissions

Sources of atmospheric emissions, including GHGs and particulate matter, resulting from the Project are expected to be associated with construction activities due to the use of land-based construction equipment and/or marine vessels for sediment placement and salt marsh construction. The construction phase is proposed to take place from February 2025 through to October 2025, where construction activities that require the use of mobile construction equipment are expected to be concentrated in the month of February to accommodate the least-risk windows (as discussion in Section 1.1). The monitoring and maintenance phase of the Project is expected to generate negligible atmospheric emissions due to limited activities that are expected that require the use of mobile construction equipment.

Potential impacts to Air Quality will be mitigated by implementing BMPs as discussed in Section 6.2.

6.8.1.1 Estimate of Project GHG Emissions

The Project will generate GHG emissions during construction, where an estimate of up to 248 tCO2e may be generated based on the selected construction methodology. The estimated GHG emissions represent a negligible contribution to BC's total GHG emissions, as discussed below. This estimate is based on emission factors and methodology for mobile combustion sources, as outlined in the following guidance documents:

- B.C. Best Practices Methodology for Quantifying GHG Emissions (Province of BC 2021);
- Methodology Book for the BC Provincial Inventory of GHG Emissions (Province of BC 2020); and
- National Inventory Report 1990 – 2018: GHG Sources and Sinks in Canada (ECCC 2020).

The GHG emissions estimate considers the use of mobile equipment for the conventional placement of sediments, and assumes that a construction approach of sediment placement by land-based pumping or the use of a marine dredging vessel would result in fewer GHG emission due to a significant reduction in the reliance on conventional construction equipment (i.e. dump trucks, dozers, etc.).

Based on this estimate, and consistent with the scale of the Project, the Project represents a negligible proportion of BC's total annual GHG emissions (0.0004%) based on BC's Provincial Inventory of 68.6 million tCO_2e (Government of BC 2022b). As such, the estimated GHG emissions also represent a negligible portion of the reduction targets for the *Climate Change Accountability Act*, where GHG reduction targets for BC require a 40% reduction by 2030 (38,800,000 tCO2e/ year) below the 2007 level, followed by a further 60% reduction for 2040 (25,900,000 tCO2e/year) and an 80% reduction by the year 2050 below 2007 levels (Government of BC 2018a).

Post-construction, a benefit of the Project is the carbon sequestration effect of salt marshes. This Project intends to gradually increase the elevation of the salt marsh in Mud Bay to adapt to sea level rise, offsetting the negative ecosystem impacts of coastal squeeze, which will result in increased carbon sequestration once the salt marsh is established. Salt marshes have been estimated to provide a sequestration effect 0.91 tCO2e/yr per ha (Intergovernmental Panel on Climate Change 2014).

6.8.2 Solid, Liquid, and Hazardous Waste

During the construction phase of the Project, wastes produced will either be disposed of in accordance with applicable regulations or will be reused or recycled, where feasible. Hazardous and non-hazardous wastes that may be produced during the construction phase of the Project are expected to be minimal, given the scale of the Project. A Waste Management Plan will be developed within the CEMP.

There are no planned discharges to Mud Bay. There will be run-off from the sediment placement but it will not contain deleterious substances and will be managed through the Erosion and Sediment Control Plan.

Once construction is complete and the Project is in the monitoring and maintenance phase, no discharges or wastes are expected.

6.9 ACCIDENTS AND MALFUNCTIONS

The following potential accidents[7] and malfunctions[8] have the potential to be associated with construction of the Project and could affect the biophysical environment and human health:

- Leaks and spills to land or the marine environment, e.g., gasoline, diesel, hydraulic oil, machine lubricants;
- Releases of sediment laden waters to the marine environment;
- Failure of temporary Erosion and Sediment Controls;
- Damage to utilities;
- Construction vehicle accidents; and
- Disturbance to environmentally or culturally sensitive areas, e.g., unauthorized entry to no-go areas.

BMPs to reduce the likelihood and consequence of accidents and malfunctions will be applied during Project construction. A CEMP and a Health and Safety Plan will be developed and implemented by the Contractor; detailing emergency response procedures and mitigation measures to be applied during various construction activities. The CEMP will include an Erosion and Sediment Control Plan, a Spill Prevention and Response Plan and will map no-go areas and utilities. The Contractor's Health and Safety Plan will provide detailed information on emergency response in case of accidental encounters with and damage to utilities, or vehicle/vessel collisions. With these measures, the City anticipates that the risk of an accident or malfunction is low (low likelihood and low consequence). There will be limited opportunity for accidents or malfunctions during the monitoring and management phase, outside of potential effects of the environment on the Project, which are discussed in Section 6.7.

[7] Accident: An unexpected occurrence, unplanned event, or unintended action that can result in an adverse effect.

[8] Malfunction: The failure of a piece of equipment, device, or system that can result in an adverse effect.

7.0 INDIGENOUS NATIONS INTERESTS

The Project is within the core territory of Semiahmoo First Nation, the traditional territories of the Katzie, Kwantlen, Sto:lo, and Tsawwassen First Nations, and may be of interest to 20 other Indigenous nations and organizations (see Section 2.1).

As a climate change adaptation project that seeks to protect the coastline from rising sea levels using nature-based approaches that will enhance biodiversity and coastal habitat, the Project is expected to align with the general goals of Indigenous laws, customs, and policies. However, to date no explicit laws, customs or policies that apply to the Project area have specifically been identified by the Indigenous nations thus far engaged. The Project will continue to engage with Indigenous nations to identify relevant laws, customs, and policies that align with the project during preparation of the DPD.

The Project does align with the economic policies of several Indigenous nations who wish to see their members engaged in economic and employment opportunities associated with the Project. These Nations have expressed their agreement during preliminary engagement as summarized in Table 13.

The following sections provide: a summary of issues, concerns, and questions raised by Indigenous nations during preliminary engagement on the proposed CFAS and DMAF projects; a preliminary assessment of potential effects of the Project on Indigenous rights and interests; and a summary of plans for future engagement with participating Indigenous nations on the Project. Please see Section 4.0 for further information on the proximity of the Project to Indigenous nations' territories, communities, and reserve lands; and Section 1.2.3 for information on applicable agreements between the Government of BC and Indigenous nations.

7.1 PRELIMINARY ENGAGEMENT WITH INDIGENOUS NATIONS: KEY ISSUES AND CONCERNS

As described in Section 2.1, Semiahmoo, Tsawwassen and Kwantlen First Nations were initially introduced to the Project throughout the CFAS planning process and during early project planning starting in 2016. Outreach and engagement with additional Indigenous nations proceeded between 2018 through 2021. Preliminary sharing of information included updates on the options for development and progress on the Project through emails, phone calls, in-person meetings, site tours, a focus group workshop, and an options workshop. Issues and concerns raised by the Nations during these activities were discussed and logged in tracking tables. This tracking method included accommodation measures suggested by the Nations, and responses and accommodation measures from the City. The information shared and logged was used to help inform the Project design.

Locally, the Project represents a short-term employment opportunity. Semiahmoo, Tsawwassen, and Kwantlen Nations have expressed interest in being involved in the construction of the Project, including opportunities for bidding on contracts and community employment. Semiahmoo has elsewhere emphasized the importance of developing an Indigenous Procurement Policy with the City (BCBC 2021).

Table 13 summarizes the concerns, issues, and opportunities related to the Project, as shared by the seven Indigenous nations (listed in alphabetical order) that provided comments either through direct communication with the City and/or during meetings (see Section 2.1). The results of this communication

and engagement has informed the discussion of potential impacts of the Project on Indigenous nations presented in Section 7.2. These issues raised by Indigenous nations during preliminary engagement are also captured in a tracking table of Project communication with Indigenous nations, presented in the Mud Bay Nature-Based Foreshore Enhancements Project, Site S2 – Engagement Plan (June 2022).

Table 13 Summary of concerns, issues, and opportunities identified during preliminary engagement with Indigenous nations.

Indigenous Nation	Concerns, Issues, Opportunities	Response from the City of Surrey
Katzie First Nation	▪ *Interested in early involvement on DMAF projects and whether capacity funding would be available.	▪ The City shared how Katzie First Nation could be involved in the Mud Bay Foreshore Enhancement, and Nicomekl Riverfront Park projects. Capacity funding to participating Indigenous nations will be provided via the EAO's EAC Exemption Order review process.
Kwantlen First Nation	▪ Interested in economic opportunities and monitoring opportunities, interested in educational opportunities, supporting environmental mapping and environmental restoration. ▪ *Asked how invasive species might impact Mud Bay Project. ▪ *Asked if Semiahmoo's report on investigative works in Mud Bay will be shared. ▪ Have ancestral ties to Surrey and are striving to re-establish a connection there. Interested in potential bidding opportunities.	▪ City encourages Kwantlen First Nation to bid on procurement opportunities. There will be opportunities for Indigenous employment through Community Benefits under the DMAF Program. ▪ The City will explore opportunities for education on DMAF projects. The Nicomekl Riverfront Park project could explore idea of an Educational App. ▪ *The City mentioned *spartina anglica* is of concern in the area. They will monitor for colonization and undertake control measures as required. *The City explained that the intent is to have Semiahmoo's report included as part of report by Golder which will also include work by Archer.
Musqueam Indian Band	▪ *Provided input on the Draft Ancestral Remains and Burial Places Plan.	▪ Input on the respectful care and management of ancestral remains pertaining to the coastal projects was included in the Draft Ancestral Remains and Burial Places Plan.
Penelakut Tribe	▪ *Provided input on the Draft Ancestral Remains and Burial Places Plan.	▪ Input on the respectful care and management of ancestral remains pertaining to the coastal projects was included in the Draft Ancestral Remains and Burial Places Plan.
Semiahmoo First Nation	▪ *Potential impacts to ancestral remains and burial places for four coastal projects including Mud Bay Living Dyke.	▪ A draft Ancestral Remains and Burial Places Plan document has been developed (2021) as part of Heritage Inspection Permit amendment #20A0288 for four CFAS projects, including the Project.

Table 13 (Cont'd.)

Indigenous Nation	Concerns, Issues, Opportunities	Response from the City of Surrey
Semiahmoo First Nation (Cont'd.)	▪ Concern that Provincial Archaeological database is not current and recommendations to check with Indigenous nations on archaeology potential of Project site. ▪ *Cultural soils need to remain on project sites	▪ The City will engage with Indigenous nations regarding archaeology potential of the Project site. ▪ *The City will ensure cultural soils are managed in a culturally respectful manner
	▪ Have ecological risks of the marsh nourishment project been identified?	▪ Some constraints to reduce ecological risk were identified that the Project team has incorporated into the preliminary design.
	▪ There is potential for a wet site in the area and has some concerns about impacts of the design approaches discussed, particularly the brushwood dam.	▪ The City appreciates the input and will re-evaluate design options and will report concerns at upcoming Roundtable meetings. The city also proposed using different methods for confirming archaeological significance in Project area.
	▪ Will the City be collaborating with the National Canadian Safety and Security Program doing research along the coast in consultation with Indigenous nations?	▪ The City will be collaborating with National Canadian Safety and Security Program by sharing findings and will continue to work in collaboration with Indigenous nations on this.
	▪ How would an EA (without an EAC Exemption Order) affect Project timelines?	▪ Project consultant explained that a full EA could take years and may prevent the Project from being completed within the required federal DMAF funding timeline. Project would have to be cancelled or rescoped.
	▪ Expressed appreciation for discussions and has interest in the plans for the Project and the BC EAC Exemption Order process. However, they need more time to reflect on whether to lend their support for the exemption. May have more questions. Will need to meet internally to discuss further.	▪ Boundary Bay Living Dike Roundtable Co-chair will arrange another meeting to continue discussions with Semiahmoo First Nation and the City. There will also be opportunities to engage, provide feedback and resolve issues via the BCEAO's EAC Exemption Order process.
	▪ Interested in having a high level of involvement in the construction of the Project, including construction and community employment benefits.	▪ The City will notify Semiahmoo First Nation of employment opportunities at biweekly meetings. There will be opportunities for Indigenous employment through Community Benefits under the DMAF Program. ▪ Employment benefits will be tracked and reported, per federal requirements.

Table 13 (Cont'd.)

Indigenous Nation	Concerns, Issues, Opportunities	Response from the City of Surrey
Semiahmoo First Nation (Cont'd.)	▪ Interested in water quality in Boundary Bay. Desire for fishing areas to be opened to rekindle traditional land use and harvesting methods (such as reef netting).	▪ These interests were expressed at initial Living Dyke Roundtable[9] Meeting and were integrated into Project design.
	▪ Semiahmoo has broad interests in Boundary Bay. The bay is important ecologically, economically, socially, culturally and spiritually.	▪ The City is working with Semiahmoo First Nation to ensure these interests are included in the Project.
	▪ Early engagement occurred with archaeologists representing Semiahmoo First Nation. Mud Bay was identified as an area with a low probability of containing cultural artefacts or human remains due to tidal nature and acidity of soil.	▪ Semiahmoo First Nation protocols will be followed during surveying and construction. A draft Ancestral Remains and Burial Places Plan document has been developed (2021) as part of Heritage Inspection Permit amendment #20A0288 for four CFAS projects, including the Project, with the input of Indigenous nations.
Tsawwassen First Nation	▪ *Tsawwassen First Nation has no additional comments at this time for the Ancestral Remains and Burial Places Plan and is okay with Semiahmoo transporting ancestral remains to a secure location when needed.	▪ Input on the respectful care and management of ancestral remains pertaining to the coastal projects was included in the Draft Ancestral Remains and Burial Places Plan.
	▪ Interested in community employment benefits and involvement in the construction of the Project.	▪ The City encourages Tsawwassen First Nation to bid on procurement opportunities. There will be opportunities for Indigenous employment through Community Benefits under the DMAF Program. Targets for employment benefits are being tracked and reported, per federal requirements.

[9] Spearheaded by West Coast Environmental Law and the Lower Fraser Fisheries Alliance, the group represents local governments, Indigenous, and non-governmental partners who are collaborating to pilot a living dike project that would field test an innovative nature-based coastal flood adaptation project. Members include Semiahmoo First Nation, Tsawwassen First Nation, Tsleil-Waututh Nation, Musqueam Indian Band, Lower Fraser Fisheries Alliance (a First Nations organization, City of Surrey, City of Delta, City of Richmond, Ministry of Forests, Lands, Natural Resources, and Rural Development, South Coast Conservation Land Management Program, Emergency Management BC, Fisheries and Oceans Canada, Natural Resources Canada, National Research Council Canada (NRCan), West Coast Environmental Law, Municipal Natural Assets Initiative, and Ducks Unlimited).

Table 13 (Cont'd.)

Indigenous Nation	Concerns, Issues, Opportunities	Response from the City of Surrey
Tsleil-Waututh Nation	▪ *Provided input on the Draft Ancestral Remains and Burial Places Plan. ▪ Requested that the Project lead(s) will comply with the HCA and, when necessary, retain an archaeological professional to conduct the appropriate assessments.	▪ Input on the respectful care and management of ancestral remains pertaining to the coastal projects was included in the Draft Ancestral Remains and Burial Places Plan.
	▪ Requested that a final copy of any archaeological assessment reports resulting from fieldwork are forwarded to the Nation's Archaeology Team upon their completion.	▪ The City is open to sharing archaeological assessment reports with Tsleil-Waututh upon completion.
	▪ *Asked if City had identified ecological risks of the marsh nourishment	▪ *Constraints to reduce ecological risk have been identified and were incorporated into the preliminary design and IPD effects assessment. The EAO's EAC Exemption Order process will also seek feedback on the assessment conclusions associated with the ecological risks of the design and proposed mitigations. Indigenous nations will be able to provide feedback on the assessment, which may support further refinement the Project design.

Notes: *engagement occurred directly between the Nations and the City of Surrey and did not include the Roundtable.

7.2 POTENTIAL IMPACTS ON INDIGENOUS INTERESTS

Project components and activities have the potential to interact with and potentially affect Indigenous Interests both directly and indirectly through the linked VCs. These linked VCs and the associated Project effects were carried forward from Section 6.2. Based on feedback received to date, the following summary presents an assessment of potential Indigenous interests, how they may be affected by the Project, and proposed measures to avoid, mitigate or otherwise manage effects in Table 14.

In consideration of the available information regarding potential Project impacts on Indigenous rights and interests, the measures proposed to avoid, mitigate, or otherwise manage potential effects, and the analysis of residual effects for relevant VC assessments, it is expected that the Project will result in negligible effects on Indigenous rights and interests.

As engagement on the Project progresses, further and more specific information on Indigenous interests may be provided within the DPD, as informed by the preference of individual participating Indigenous nations. We welcome additional feedback from participating Indigenous nations on this preliminary assessment of potential impacts on Indigenous interests.

Table 14 Potential impacts on Indigenous Interests.

Indigenous Interest	Linkages to Valued Components	Project Activities and Potential Effect	Proposed Measures to Avoid, Mitigate or Otherwise Manage Effects
Indigenous Land Use: Fishing	▪ Marine Water and Sediment Quality; ▪ Marine Habitat; and ▪ Marine Use.	▪ Marine construction and maintenance activities related to the Project (construction option 3) may have temporary effects on access to locations for crabbing by Indigenous nations (i.e., Semiahmoo). ▪ Construction and maintenance activities related to the Project may have temporary effects on marine water quality which could in turn affect fishing and shellfish collecting. ▪ Construction and maintenance activities may have a temporary, minor effect on quality of experience when accessing areas for fishing due to noise. Project infrastructure may have a minor effect on visual quality.	The following mitigations, as described in Section 6.2 and 6.3 for the VCs: marine water and sediment quality, marine habitat, and marine use, are expected to minimize potential Project effects on the accessibility and abundance of Indigenous fishing resources during construction and maintenance activities: ▪ Imported marsh sediments will be analyzed and confirmed to meet DAS criteria and CCME Sediment Quality Guidelines prior to placement. ▪ Sediment will be placed during low tides to avoid direct input to marine water. ▪ Edge stabilization will be completed ahead of sediment deposition to trap sediment within the desired Project area. ▪ An Erosion and Sediment Control Permit from the City will be obtained prior to construction, this will include an approved Erosion and Sediment Control Plan for the Project. ▪ An EM will be on-site during sediment deposition to monitor any potential sediment spills. ▪ Slurry additives such as a fluidizer or plasticizer will not be deleterious, e.g., biodegradable, non-toxic. Specifications will be defined in the CEMP once the requirements for such additives have been determined. ▪ Shellfish (i.e., crabs - if any are within the Project footprint) will be relocated prior to sediment deposition. ▪ The temporary loss of marine habitat will be offset by the creation of the raised salt marsh, which will increase habitat for a wide variety of organisms. A *Fisheries Act* authorization is not expected to be required, however, an RFR will be submitted to DFO to confirm. ▪ The City will provide public notification by installing on-site signage, providing updates through local media and issuing a notice to shipping, as required, in advance of the sediment placement to minimize temporary interference with marine use. ▪ If the Project has the potential to interfere with navigation, as associated with construction option 3, an application for approval will be submitted to Transport Canada, and management measures will be defined in the CEMP, in collaboration with Indigenous Nations. Construction and maintenance activities may have a temporary, minor effect on quality of experience when accessing areas for fishing due to noise and visual quality; however, these impacts are expected to be negligible due to the Project objective (habitat enhancement), location (adjacent to Highway 99), and scheduling (construction likely to occur at night to accommodate the timing windows and constructability considerations discussed in Section 1.4.
Indigenous Land Use: Gathering	▪ Terrestrial Habitat; ▪ Marine Habitat; ▪ Land Use; and ▪ Culture.	▪ Construction and maintenance activities related to the Project may have temporary effects on access to locations for gathering by Indigenous nations. ▪ Construction and maintenance activities related to the Project may have temporary effects on the abundance of Indigenous gathering resources. ▪ Construction and maintenance activities may have a temporary, minor effect on quality of experience when accessing areas for gathering due to noise. Project infrastructure may have a minor effect on visual quality.	The following mitigations, as described in Section 6.3 for the VCs: terrestrial habitat, marine habitat, and land use, are expected to minimize potential Project effects on Indigenous gathering resources during construction and maintenance activities: ▪ Potential marine habitat effects associated with sediment composition and placement will be mitigated as described above. ▪ The temporary loss of marine habitat will be offset by the creation of the raised salt marsh, bench which will increase habitat for a wide variety of organisms. ▪ Project area will be minimized to reduce potential impacts to at-risk plant species. ▪ A Reclamation Plan will be developed to ensure that areas of terrestrial habitat temporarily disturbed during construction of the Project are reclaimed. ▪ A Vegetation Management Plan will be developed to protect native vegetation and ecosystems from the potential introduction/spread of invasive plant species. ▪ At-risk plant surveys will be undertaken by a qualified professional.

Table 14 (Cont'd.)

Indigenous Interest	Linkages to Valued Components	Project Activities and Potential Effect	Proposed Measures to Avoid, Mitigate or Otherwise Manage Effects
Indigenous Land Use: Gathering (Cont'd.)			▪ Limitations on parking at Mud Bay Parking Lot will be minimized while maintaining safe public access. ▪ Limitations on access to public footpaths will be minimized while maintaining safe public access to trails and viewpoints. ▪ A Park Permit will be obtained from Metro to authorize temporary closure of sections of the Boundary Bay Dyke trail. ▪ A Traffic Management Plan will be developed, and a Traffic Obstruction Permit will be obtained from the City. Opportunities may also exist to work with local Indigenous nations in a way that could potentially increase the abundance and distribution of gathering resources by: ▪ Potential further refinement the proposed plant species for salt marsh construction, ▪ Potential to collaborate on the identification, collection, and propagation of the preferred plant species for salt marsh construction. Construction and maintenance activities may have a temporary, minor effect on quality of experience when accessing areas for gathering due to noise and visual quality; however, these impacts are expected to be negligible due to the Project objective (habitat enhancement), location (adjacent to Highway 99), and scheduling (construction likely to occur at night to accommodate the timing windows and constructability considerations discussed in Section1.4).
Indigenous Land Use: Other Cultural Interests	▪ Land Use; ▪ Culture; and ▪ Archaeological and Heritage Resources.	▪ Construction activities could have a direct effect on identified tangible and intangible cultural heritage sites in the land-based area associated with the Project site, though there is a low potential for archaeological deposits to be found. ▪ Construction and maintenance activities may affect cultural values related to Mud Bay due to changes in visual quality as a result of the Project. ▪ Construction and maintenance activities may temporarily affect an Indigenous community's access to, and experience at, specific locations when undertaking cultural activities.	The following mitigations, as described in Section 6.3 for the VCs: land use and archaeological and heritage resources, are expected to minimize potential Project effects on lands and resources related to other cultural values during construction and maintenance activities: ▪ Limitations on parking at Mud Bay Parking Lot will be minimized while maintaining safe public access. ▪ Limitations on access to public footpaths will be minimized while maintaining safe public access to trails and viewpoints. ▪ A Park Permit will be obtained from Metro to authorize temporary closure of sections of the Boundary Bay Dyke trail. ▪ A Traffic Management Plan will be developed, and a Traffic Obstruction Permit will be obtained from the City. ▪ Site alteration permits will be obtained if archaeological deposits are required to be altered or removed as part of construction. ▪ Construction techniques that minimize the possibility of archaeological site and ground disturbance will be selected. ▪ If archaeological materials or remains are uncovered, work in the area will immediately cease and the Archaeology Branch and/or project archaeologist will be informed. The City will also promptly inform the relevant Indigenous nations. ▪ Opportunities may exist to work with local Indigenous nations to further refine the proposed plant species for salt marsh construction. ▪ Opportunities may exist to work with local Indigenous nations on the identification, collection, and propagation of the preferred plant species for salt marsh construction. Construction and maintenance activities may have a temporary, minor effect on quality of experience when accessing areas for gathering due to noise and visual quality; however, these impacts are expected to be negligible due to the Project objective (habitat enhancement), location (adjacent to Highway 99), and scheduling (construction likely to occur at night to accommodate the timing windows and constructability considerations discussed in Section 1.4).

Table 14 (Cont'd.)

Indigenous Interest	Linkages to Valued Components	Project Activities and Potential Effect	Proposed Measures to Avoid, Mitigate or Otherwise Manage Effects
Economic Benefits	▪ Employment & Economics; and ▪ Archaeological and Heritage Resources.	▪ The Project has the potential for some local job creation for the duration of the Project construction and monitoring and maintenance. ▪ The Project may have positive effects for Indigenous nations through potential direct employment as an onsite environmental and/or cultural heritage monitor (or similar).	Construction of the Project is anticipated to occur in phases providing employment opportunities, however, due to the scale of the Project, employment and economic opportunities are expected to be limited. To a lesser scale, employment opportunities will also be created during the follow-up monitoring program, as discussed in Section 6.2. Employment opportunities for Indigenous nations will be considered as follows: ▪ The City encourages local Indigenous nations to bid on procurement opportunities. There will be opportunities for Indigenous employment through Community Benefits under the DMAF program. ▪ The City notifies Semiahmoo of procurement opportunities at biweekly meetings. There will be opportunities for Indigenous employment through Community Benefits under the DMAF program. ▪ Employment benefits will be tracked and reported, per federal requirements. ▪ The City will further engage with participating Nations and discuss options for additional First Nation led archaeological assessments to take place.
Aboriginal Title and Rights	▪ Land Use; ▪ Marine Use; ▪ Culture; and ▪ Employment & Economics.	▪ Project Construction and maintenance activities may interact with each of the following components of asserted Aboriginal Title overlapping the Project area: use and occupation, decision-making, and economic benefits. ▪ The Project could potentially restrict or prevent access or other uses temporarily during construction activities. ▪ Project-related activities may affect the timing of access and quality of experience of Indigenous members using the area. ▪ The Project has the potential for some local job creation for the duration of the Project construction and monitoring and maintenance.	Based on the available information regarding Aboriginal Title and Rights in the Project area, proposed measures (as describe below) are expected to minimize potential Project effects on Aboriginal Title and Rights during construction and maintenance activities: ▪ Ongoing engagement with potentially affected Indigenous nations on the design of the Project and development of the AM plan will be undertaken. ▪ Opportunities for Indigenous nations to contribute to decision making over the area impacted by the Project will be provided through ongoing engagement. ▪ Proposed measures to avoid, mitigate or otherwise manage effects related to "Indigenous Land Use" as listed above will be implemented. ▪ Proposed Measures to avoid, mitigate or otherwise manage effects related to "Economic Benefits" as listed above will be implemented.

7.3 FUTURE ENGAGEMENT WITH PARTICIPATING INDIGENOUS NATIONS AND ORGANIZATIONS

The ongoing participation of Indigenous nations is vital to the planning and implementation of the Project. The City is committed to maintaining strong relationships with Indigenous nations and organizations who have an interest in the Project and plans to reconvene the CFAS Advisory Group to review and discuss the Project during the BCEAO's 90-day EAC Exemption Order review process, with the aim of implementing the plans and principles described in the Project's Engagement Plan (June 2022).

Indigenous nations who choose to participate in the EAC Exemption Order review process will define how they would like to be engaged. For example, engagement with participating Indigenous nations may include in-person meetings at locations of their choosing, study-tours, focus groups and workshop participation, telephone and email exchanges, and periodic updates. Other forms of engagement may include:

- A Project open house;
- Focus groups and key partner meetings (including meeting with the CFAS Advisory Group and the Living Dike Roundtable);
- A Project information portal (www.surrey.ca/mudbay); and
- Distribution of Project information materials through established CFAS channels.

As the EAC Exemption Order review process proceeds, a Nation may wish to increase or decrease their level of participation. Levels of engagement include:

- Staying informed (update emails, newsletters, sharing deliverables such as IPD and EA as they become public, etc.);
- Being involved (providing feedback on draft copies of deliverables, attending Project meetings, meeting with regulators, etc.); and
- Collaborating (involving representatives from Indigenous nations in elements of Project design, being present during surveying/assessments, having archaeological teams in the field, etc.).

Results of early engagement, including issues raised, will inform the development of the DPD.

8.0 ENGAGEMENT WITH OTHER GOVERNMENTS, THE PUBLIC, AND OTHER PARTIES

CFAS included a considerable engagement component. The City intends to reconvene the CFAS Advisory Group to build on the success of preliminary engagement completed as part of the CFAS program through the implementation of the plans and principles described in the Project's Engagement Plan (June 2022).

This section provides an overview of general, public engagement. A summary of common values, interests, and concerns that were identified and carried through into the development of CFAS Actions, including Site S2, is also provided.

8.1 SUMMARY OF ENGAGEMENT

Since the onset of the CFAS program, the City has undertaken a considerable amount of engagement activities with relevant stakeholders including Indigenous nations, regulators, land owners, and the public. During this preliminary engagement, interests, values, and concerns around the Project area were identified, considered, and incorporated into the development of the Project. Going forward, the City intends to build on the success of this early engagement, through the implementation of the plans and principles described in the *Mud Bay Nature-Based Foreshore Enhancements Project, Site S2 – Engagement Plan (Sept 2022)*.

Engagement will likely include an open house on the Project and stakeholder and partner outreach, a Project information portal (www.surrey.ca/mudbay), and Project information materials distributed through established CFAS channels. These mechanisms are designed to help Indigenous nations, governments and the public better understand the risks and mitigations associated with Project activities.

Additionally, the Project will continue regular meetings with the CFAS Advisory Group[10] and the Living Dike Roundtable. The Living Dike Roundtable group will continue to meet throughout Project planning and will be actively engaged through construction, monitoring, and evaluation.

To date, comments raised by Project stakeholders during engagement activities include issues related to the following:

- Impacts to ecology and biodiversity;
- Impacts to estuarine marsh, intertidal mudflats, shallow water;
- Impacts to salmon habitat and migratory routes;
- Adverse impacts to heritage buildings, historic sites & Semiahmoo cultural sites;
- Concerns over parking to access park for recreation;
- Recreation benefits including multi-use pathway;

[10] A volunteer group of representatives from key partner and stakeholder organizations and agencies that met several times over the course of CFAS development and who were an integral part of the decision-making process. Participants include: local and regional governments; agencies, ministries, and crown corporations; Non-governmental Organizations; academic institutions; and farms and agriculture businesses.

- Emergency access to foreshore areas;
- Adverse aesthetic impacts;
- Employment opportunities; and
- Cultural interpretation and public education.

Table A4.1 (in Appendix A4) summarizes preliminary engagement with public and stakeholder groups as it relates to the Project.

Based on the engagement completed during CFAS, Table 15 summarizes public interest in the Project and the City's response(s) to date. The table includes specific issues and concerns, and potential opportunities, the Project presents, along with the proposed approach(es) or steps to be taken to address issues/concerns in the design and development of the Project.

Table 15 Preliminary engagement on common values, interests, and concerns.

Concerns, Issues, Opportunities	Response
Living dike – great opportunity to maintain the integrity of the ecological value of these areas, however, it is paramount to ensure there are no additional ecological impacts.	Project incorporates the living dike concept and other nature-based elements, including designs following the Green Shores approach.
Consider small trials (put sediment in place and observe where it ends up), increase rates of deposition.	Will work with NRCan and other partners to develop Project as "Living Laboratory" involving monitoring of the site before, during and after construction. Monitoring to include physical processes such as winds, waves, water levels and morphology changes, as well as biological processes (ecosystem health and biodiversity).
Impacts to biodiversity.	Project to minimize impacts to biodiversity and potentially improve conditions.
Impacts to estuarine marsh, intertidal mudflats, shallow water.	Project to minimize marsh and mudflat impact and new habitat areas to be created.
Adverse impacts to heritage buildings, historic sites & Semiahmoo cultural sites.	Archaeological survey of site to be conducted.
Concerns over parking to access park for recreation.	To be explored during design development.
Adverse aesthetic impacts.	To be explored during design development.
Increase recreation opportunities, but only if there is no associated environmental damage.	To be explored during design development.
Use green shore approach.	Project design objective.
Evaluate dyke expansion to ensure that salmon habitat and migratory routes are not negatively impacted (Salmon Safe).	Project to minimize marsh and mudflat impact and new habitat areas to be created. Avoidance of in-water construction during primary times of salmon migration.

Table 15 (Cont'd.)

Concerns, Issues, Opportunities	Response
Improved emergency access to foreshore areas.	To be explored during design development.
Recreation benefits – open space, nature trails, enhanced bird watching.	To be explored during design development.
Wetland/marsh land enhancements.	Project seeking to make wetland and marsh enhancements.
Multi-use pathway – cycling and pedestrian benefits.	To be explored during design development.
Employment benefits.	Local procurement and employment opportunities being explored with local Indigenous nations. DMAF-focused Sustainable Procurement Guidelines are being developed.
Cultural interpretation.	To be explored during design development.
Public education – climate adaptation and sea level rise.	To be explored during design development.
Could be opportunities to reduce coastal squeeze effect and maintain intertidal areas by changing the slope profile .	To be explored during design development.
Opportunities to use the space on top of the dykes for social gathering or environmental education.	To be explored during design development.
Look at options that reduce wave run-up issues and soft shore processes on the water side to provide a lower required dyke/crest height.	Project design objective.
Create a terrestrial habitat network on top of the new dyke.	Project design objective.
Design new dykes to provide more habitat	Project design objective.

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APPENDICES

Appendix A1

Table of Concordance

Table A1.1 BC EAA Concordance Table for Initial Project Description Information Requirements[11].

Information Requirement	IPD Document Section	Tables/Figures
EXECUTIVE SUMMARY		
A plain language summary of the IPD that is clear and concise.		
GENERAL INFORMATION AND CONTACTS		
Project name;	1.0	Table 1
Project location;	1.0	Table 1 Figure 2 Figure 3
Project industrial sector and type (e.g., open pit metal mine); and	1.0	Table 1
Proponent name, mailing address, phone numbers, email address and website URL. Include the name and contact information of the primary representative for the EA.	1.0	Table 1
PURPOSE AND RATIONALE		
A general rationale for why the Project has been proposed; and	1.1	
Potential Project benefits.	1.1	
LEGISLATIVE AND REGULATORY CONTEXT		
The type and size of the Project, with specific reference to EA Regulatory Triggers [e.g., the BCEAO Reviewable Project Regulations and *Impact Assessment Act* (Canada) thresholds];	1.2.1	
A list of anticipated authorizations and permits;	1.2.2	Table 2 Table 3
Consider the requirements of any applicable agreements between the Province and Indigenous nations, including treaties;	1.2.3	
Consider the requirements of any applicable international agreements between the Province and state or federal governments;	1.2.2	
A description of relevant government policies that the Project may not be compatible with; and	1.2.2	
Proposed timing for conducting the provincial EA and federal EA, if applicable.	1.2.1 1.4	Figure 4
PROJECT STATUS AND HISTORY		
Project history, including past ownership;	1.3	
State if it is a new project or a modification to an existing project;	1.3	

[11] As outlined under the *Environmental Assessment Act* Early Engagement Policy, Appendix 1, and adapted to address information requirements outlined in the Certificate Exemption Policy.

Information Requirement	IPD Document Section	Tables/Figures
A list of any existing permits or tenure in place;	4.2	
A description of any previous proposal(s) for the Project or a similar proposal and the outcomes and history of the proposal(s), if applicable; and	N/A	-
If the project was previously declined or terminated, a description of how this proposal differs and how the issues for which the previous proposal was declined or terminated have been addressed.	N/A	-
PROJECT TIMING		
A list of proposed Project phases (e.g. construction, operation, decommissioning, and reclamation) and the anticipated timing and duration of each phase; and	1.4	Figure 4
Include any known seasonal timing constraints.	1.4	Table 6
PROJECT LOCATION, ACTIVITIES AND COMPONENTS		
A description of the proposed Project's location in a local and regional context, including proximity to communities or locations of interest to the public, government, or Indigenous nations, and key designated or protected areas such as parks or Wildlife Habitat Areas;	3.1 4.0	Figure 2 Figure 3 Table 4
Proposed Project activities and components;	3.2 3.3	Figure 5 Figure 6 Figure 7
Proposed on and off-site facilities and equipment;	3.2 3.3	
A brief description of proposed activities related to processing, transportation and/or shipping of materials to/from the site;	3.3	
A description of any other project(s) that are needed for the proposed Project to proceed and be feasible (e.g. a pipeline would be needed for an oil and gas facility to proceed);	3.3	
A description of the work that has been conducted to arrive at the proposed Project as described in the IPD;	3.4	
A list of design or siting constraints that are flexible and those that are not flexible;	3.3.6	
A list of other design or siting options that may be considered; and	3.3 3.4	
Anticipated daily and annual maximum production or operational capacity of the Project (if applicable).	N/A	-
MAPS AND SHAPEFILES		
Local and regional scale maps of the Project showing its location and known off-site components;	1.3	Figure 2 Figure 3

Information Requirement	IPD Document Section	Tables/Figures
Maps must be presented in the required standard format with legible grids and suitable scaling (typically 1:100,000 to 1:150,000 for centralized projects such as a mine, and up to 1:1,500,000 or 1:1,250,000 scale for linear projects such as a pipeline or transmission line); and		
Maps must also include a National Topographic System Map number, latitude and longitude references, titles, a north arrow, and relevant legends.		
INDIGENOUS NATION INTERESTS		
A description of the proximity of the proposed Project to Indigenous nations' territory, communities, locations of interest, *Indian Act* reserve lands, lands subject to a Treaty, or other relevant agreements;	4.1 7.0	Table 7
A description of potential Project interactions with any identified Indigenous interests;	7.2	Table 14
A description of alignment of the IPD with Indigenous nation laws, customs and policies; and	4.1	
A list of any issues, concerns, or questions raised by Indigenous nations during engagement on the draft IPD or other information shared in relation to the proposed Project.	2.1 7.1	Table 13
BIOPHYSICAL ENVIRONMENT		
A description of the natural setting characteristics, including coastal, foreshore, riparian, mountainous, watersheds, and agricultural land;	5.3	
A description of disturbed area characteristics, including: brownfield; contaminated site(s), and any history of development;	5.3	
Identification of sensitive or vulnerable species, ecosystems, and/or habitats in the Project area; and	5.3	
A list of existing data, including monitoring reports, previous EAs, regional studies, and/or other sources of information that support the understanding of the existing biophysical conditions; Results of technical and desktop studies undertaken for the Project in order to obtain information on current conditions.	5.2	Table 8
HUMAN AND COMMUNITY WELLBEING		
A description of the proposed Project's proximity to local communities, including seasonal or temporary residences;	5.4	
Identification of the municipalities within which the proposed Project is located or where effects may occur;	5.4	
A description of the proposed Project's proximity to important or sensitive communities and natural places such as: municipal boundaries, parks, schools, hospitals, housing, water supplies, roads, railways, and protected and recreational areas;	5.4	

Information Requirement	IPD Document Section	Tables/Figures
A list of existing data, including monitoring reports, previous EAs, regional studies, and/or other sources of information that support the understanding of the existing human environment conditions;	5.2	Table 8
Identification of any sensitive or vulnerable economic, social, heritage, or health values that may be affected by the Project; and	5.4	
An outline of the anticipated number construction and operating jobs for each Project phase, where the workforce will be drawn from (including anticipated percent of workforce from local community), and where the workforce will be housed. Refer to the *Human and Community Wellbeing Guidelines* for further information.	5.4.1 6.2	
A description of how the Project may affect the local and regional economy.	6.2	
EMISSIONS, DISCHARGES, AND WASTE		
A high-level outline of anticipated direct Project waste and emissions to land, air, and water, including estimated GHG emissions. ▪ This information would include direct emissions that are expected to be above provincial or national standards and emissions that have the potential to interact with Indigenous interests, the biophysical environment, and/or the human environment. ▪ An estimate of Project GHG emissions by phase; ▪ A description of the potential effects on the province being able to meet its targets under the *Greenhouse Gas Reduction Targets Act*; and ▪ An estimate of upstream GHG emissions.	6.8	
A description of proposed mitigation measures and/or Project design changes to address emissions, including GHGs.	6.26.8	
PUBLIC AND ENVIRONMENTAL SAFETY		
A description of potential malfunctions or accidents associated with the industry or specific to the proposed Project and how they will be managed. ▪ Include any proposed outreach to help Indigenous nations, governments and the public better understand the risks and mitigations; and ▪ Include any issues raised about public and environmental safety during engagement with Indigenous nations, the public, provincial and federal government agencies, and stakeholders and how issues were considered in developing any mitigation measures or design changes.	6.9 8.0	
ALTERNATIVE MEANS OF CARRYING OUT THE PROJECT		
A high-level description of the alternative options for the proposed Project, including a rationale for the preferred option that demonstrates how positive and negative effects and/or issues raised during engagement have been considered;	3.4	

Information Requirement	IPD Document Section	Tables/Figures
The alternative means of undertaking the proposed Project may include information related to: ▪ the use of best available technologies; ▪ the technical and economic feasibility; ▪ the potential effects, risks and uncertainties of those alternatives; ▪ the preferred option and a rationale for this preference; and, ▪ the different options for the Project location, Project routing, technologies, mitigation, or design.		
EFFECTS OF THE ENVIRONMENT ON THE PROJECT		
An overview of potential effects of natural hazards or processes and climate change on the proposed Project.	6.7	
LAND AND WATER USE		
An outline of the anticipated Project footprint and proposed area of disturbance;	3.1	Figure 3 Table 4
A description of the land required for the proposed Project, including whether the Project is located on private lands, provincial or federal Crown lands, or IR lands;	4.1 4.2	Figure 2
Include the applicable zoning, Agriculture Land Reserve designation, land and resource management plans, and other Land Use designations (e.g. parks and protected areas) and the legal land descriptions and/or tenure numbers of those lands, if known;	4.0	
A description of past uses of the land required for the proposed Project, including whether the site has been previously developed; and	4.0 5.1	
A description of water requirements for the proposed Project, if applicable, and the proposed source of water.	4.3 3.3.3	
LAND USE PLANS		
A list of all relevant Land Use plans, including provincial Land Use plans, Indigenous Land Use plans, and relevant municipal plans; An outline of how the Project is consistent or inconsistent with Land Use plans and provide a rationale; and, A justification for updates/changes to relevant provincial Land Use plans and a description of how engagement was considered.	4.1 4.3	
An identification of any rezoning or changes in land designations that would be required for the proposed Project.	4.0	
PROJECT INTERACTIONS		
A description of potential positive and negative direct and indirect effects of the Project on the biophysical and human environments, and Indigenous rights and interests, including any potential cumulative effects;	6.0 7.2	Table 10 Table 11 Table 14

Information Requirement	IPD Document Section	Tables/Figures
A description of measures to prevent or reduce the potential negative effects to an acceptable level. Include measures that could be integrated into Project design, compliance with applicable regulations, standards, codes of practice, or Best Management Practices, corporate management systems, and/or Project-specific measures that will be implemented;	6.2 6.3	Table 12
A description of proposed monitoring programs that will be implemented to measure the effectiveness of mitigations to prevent or reduce the potential negative Project effects; and	6.6	
Any proposed mitigation measures to be included in the table of conditions.	6.3	Table 12
A summary of any biophysical feasibility studies undertaken that may be pertinent to understanding potential interactions; Results of technical and desktop studies undertaken for the Project in order to obtain information on current conditions, potential interactions and modeling of effects.	5.2	
Identification of existing cumulative effects in the region that the Project may interact with. Refer to the *Effects Assessment Policy* for more information.	6.5	
INDIGENOUS, PUBLIC AND STAKEHOLDER ENGAGEMENT		
Description of outcomes of issues-resolution with technical advisors and Indigenous nations, including but not limited to design changes and proposed mitigation measures;	2.0 7.0 8.0	
Description of any engagement with landowners, land rights holders, other commercial, industrial, agricultural, and recreational land users, as well as the public, including key interests or issues identified and how these interests/issues were considered in Project design; and	2.0 7.0 8.0	
A table identifying the issues that have been raised through Early Engagement, including the public comment period, and an explanation of how those issues have been considered and addressed, where appropriate, by the proponent	7.0 8.0	Table 13 Table 15
A list of any activities proposed to be undertaken during the Early Engagement period to inform the development of the Detailed Project Description or the Application, should the Project proceed to an EA;	2.0 7.0 8.0	
EXEMPTED PROJECT DESCRIPTION		
A draft Exempted Project Description (a physical description of the project's components and activities), including maps, which ultimately would be reviewed, finalized, and included in the decision materials. The draft Exempted Project Description will include maps and be developed following guidelines provided by the BCEAO.		Figure 2 Figure 3

Appendix A2

Nature-Based Foreshore Enhancements Memorandum of Understanding

BOUNDARY BAY WILDLIFE MANAGEMENT AREA
MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding is made the 3rd day of November, 2021,

BETWEEN:

CITY OF SURREY, 13450 – 104 Avenue, Surrey, BC V3T 1V8

("Surrey")

AND

CITY OF DELTA, 4500 Clarence Taylor Crescent, Delta, BC V4K 3E2

("Delta")

AND

HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA, as represented by the Ministry of Forests, Lands, Natural Resource Operations and Rural Development, 10428 – 153 Street, Suite 200, Surrey, BC V3R 1E1

(the "Province"),

individually referred to as a "Party" and collectively referred to as the "Parties".

WHEREAS:

A. The Province designated the Boundary Bay Wildlife Management Area (the "WMA") with the purpose of conservation of critical, internationally significant habitat for year-round, migrating and wintering waterfowl populations, along with important fish and marine mammal habitat.

B. Global sea level rise will progressively reduce salt marsh habitat extents in Boundary Bay unless a nature-based solution is developed to offset these impacts.

C. Surrey and Delta, as the responsible dyking districts, perform the construction, operation and maintenance of drainage and flood protection systems along the Boundary Bay coast adjacent to the WMA within the boundaries of Surrey and Delta, respectively.

D. Traditional flood protection approaches can result in environmental impacts and new, nature-based approaches are being introduced worldwide. Nature-based approaches either complement or substitute traditional flood protection methods and enhance or protect environmental habitats and ecosystem services. While municipalities are not responsible for offsetting the impacts of sea level rise to shoreline and estuarian habitat, nature-based approaches can meet the objectives of flood control and habitat enhancement, with mutual benefits to all Parties.

E. Subsequent to the dissolution of the Colebrook Dyking District, the Province had initiated a process to transfer the assets, rights, claims, obligations and liabilities of the Colebrook Dyking District to Surrey. The Government Transfer – Shared Cost Arrangement (the "GTSCA") was signed on March 23, 2016, under which the Province provided a financial contribution to Surrey for upgrading the Colebrook Dyking District dykes. The original GTSCA expired on March 31, 2020, and a new agreement was signed on May 3, 2021.

F. Surrey and Delta have been awarded Government of Canada funding, through the Disaster Mitigation and Adaptation Fund ("DMAF"), for implementation of innovative, nature-based flood protection pilot sites (the "Project"), as described in s. 3. The Project will be located on the foreshore of Boundary Bay, within the WMA, and will aim to provide flood protection and offset habitat loss resulting from sea level rise. The Project is anticipated to increase the integrity of the flood protection system, including the portion of the Colebrook Dyke adjacent to Highway 99 and evaluate the effectiveness of nature-based approaches to mitigating coastal erosion and wave attack. The Project's aim to augment natural biophysical processes and facilitate salt marsh adaptation to future sea levels, thus increasing the resilience of these valued natural environments within the WMA.

G. To establish the terms and conditions of Project implementation in consideration of DMAF funding, Surrey and Delta entered into an Ultimate Recipient Agreement for Construction of Boundary Bay Dyke and Foreshore Enhancement (the "Ultimate Recipient Agreement"), signed on February 21, 2020.

NOW THEREFORE, the Parties hereby agree to a Memorandum of Understanding ("MOU") as follows:

1. The goal of the Project is to pilot an alternative foreshore flood protection approach, by developing and testing a method of supplying sediment and vegetation on the foreshore, to help existing salt marsh habitats increase in elevation and keep up with sea level rise. The concept, developed for West Coast Environmental Law, is also known as the "Living Dyke".

2. The Project was conceptualized by the Boundary Bay Living Dike Roundtable (the "Roundtable"), with representation from environmental non-governmental organizations, First Nations organizations, local and provincial government bodies, and others. The Roundtable will continue to be involved in the Projects throughout their duration. The role of the Roundtable in this Project will be agreed upon through a Terms of Reference document. The Parties are expected to join the Roundtable and sign its Terms of Reference.

3. The Project will be implemented at two sites, located in Boundary Bay within the WMA, as shown in Appendix A.

    a. The Delta pilot site (the "Site D1") is anticipated to:
        i. be located on the foreshore in front of Delta's legislated Boundary Bay Dyke, but not in its immediate proximity;
        ii. be constructed in the lower marsh habitat;
        iii. be approximately 250 metres long;
        iv. only include the alternative nature-based foreshore work and not be integrated with the existing legislated Boundary Bay Dike; and
        v. begin construction on or before December 31, 2022.

    b. The Nature-based Coastal Climate Adaptation site (the "NBCCA Site") is anticipated to:
        i. be designed based on the success of Site D1 using an adaptive approach;
        ii. be located on the foreshore in front of Surrey's legislated dyke;
        iii. be constructed in the low marsh and high marsh habitat;
        iv. be approximately 1,165 metres long;
        v. require separate upgrades to the legislated Colebrook Dyke in an integrated manner, as outlined in Appendix B, thus spanning over the jurisdictional border between Surrey and the Province; and
        vi. begin construction on or before December 31, 2022.

4. Substantial Completion, as determined by Surrey, of both Project sites will be achieved on or before December 31, 2027. Surrey will submit a written notice to Delta and the Province upon Substantial Completion of each Project site.

5. Surrey will lead the design and construction of the two Project sites with input from Delta and the Roundtable, as further described in s. 6 and 7. Project permitting and post-construction monitoring and maintenance responsibilities will be shared between Surrey and Delta, as further described in s. 10-16.

6. Surrey will submit to the Province a Project proposal (the "Proposal") describing the proposed works in detail. Authorization of Surrey to use Crown land within the WMA for the purpose of implementing the Project will be subject to review and approval of the Proposal by the Province. If authorized, the Province will issue a letter of authorization to Surrey to undertake the Project.

7. Pending approval of the Proposal by the Province and a letter of authorization to undertake the Project in the WMA, Surrey will carry out the construction of both Project sites.

8. Surrey will implement the Project at Surrey's own cost. Surrey acknowledges the receipt of ten million four hundred thousand Canadian dollars ($10,400,000) from the Province through the GTSCA, a portion of which will be used to pay for the Project, with the remaining balance paid by Surrey. In regular intervals, Surrey will seek contribution from the Government of Canada for the funding committed through DMAF, using all costs of the Project, in accordance with the Ultimate Recipient Agreement for Construction of Boundary Bay Dike and Foreshore Enhancements, signed on February 21, 2020 between Surrey and Delta. Surrey does not intend to redistribute Government of Canada funding contributions committed through DMAF to the Province.

9. The Project is experimental. The aim of the Project is to construct and evaluate possible novel approaches to nature-based flood protection and climate change adaptation by emulating and reinforcing natural processes.

10. The environmental assets constructed as part of the Project will generally include native plants and sediments, most likely sourced locally within the Fraser River Delta, in addition to monitoring and research equipment. The environmental assets will be primarily located within the WMA. Although the footprint of the Colebrook Dyke ("Dyke Infrastructure" integrated into the design of

the NBCCA Site, as illustrated in Appendix B), will need extend into the WMA, it will be capped by the nature-based infrastructure. There are portions of the Project where the WMA boundary extends beyond the high-water mark and already includes a portion of the current dyke alignment. In these instances, since one side of the dyke is artificially constrained by the Highway 99 corridor, the dyke infrastructure will remain in the WMA. Reasonable attempts will be made to avoid construction of new hard infrastructure within the WMA as part of this Project and no additional dyke infrastructure will be constructed in the WMA unless it is capped by the nature-based infrastructure.

11. The NBCCA Site is deemed reviewable under the BC *Environmental Assessment Act* [SBC 2018, c. 51]. Surrey has retained a consultant to lead the process of requesting an exemption from obtaining an environmental assessment certificate. The process will, among other things, include environmental baseline conditions assessment, impact assessment and consultation.

12. Delta will be responsible for environmental permitting and other authorizations for Site D1. Surrey will be responsible for environmental permitting and other authorizations for the NBCCA Site, in addition to those described in s. 11. Surrey will support Delta with documentation needed for permitting and authorization applications. Project cost-sharing arrangements are further defined in the Ultimate Recipient Agreement.

13. Surrey will employ an adaptive management approach to improve the Project outcomes and apply lessons learned between the two Project sites. Surrey will also implement monitoring activities, some in collaboration with external research partners, to inform the adaptive management approach, maximize learnings and inform the development of national guidelines. Adaptive management and monitoring methods will be described in the Proposal and will conclude on or before December 31, 2027 (with the exception of post-construction monitoring activities, as described in s. 15 and s. 16), with the possibility of an extension subject to Government of Canada DMAF funding or other funding sources.

14. Surrey agrees to undertake post-construction monitoring and maintenance for the NBCCA Site, in a way determined by Surrey and acting reasonably, for the period from Substantial Completion date of the NBCCA Site until the dates ordered by environmental permitting and other authorizations.

15. If the environmental permitting or other authorizations (as described in s. 12) result in post-construction Project monitoring and maintenance requirements for Site D1, Delta agrees to undertake such monitoring and maintenance , in a way determined by Delta and acting reasonably, for the period from Substantial Completion date of Site D1 until the dates ordered by environmental permitting and other authorizations. Delta will submit a written notice to Surrey once post-construction monitoring and maintenance of Site D1 has been completed.

16. Surrey will submit a written notice to the Province once post-construction monitoring and maintenance of the two Project sites, as described in s. 15 and s. 16, has been completed. Following submission of such notice, maintenance of the environmental assets constructed at the two Project sites within the WMA will be the responsibility of the Province and under its discretion, as the active steward of the wildlife habitat within the WMA. Dyke infrastructure assets will remain the responsibility of Surrey and Delta, as further described in s. 18.

17. Upon Substantial Completion, the Province will own all assets constructed as part of the Project within the WMA. The Province agrees that it will not abandon or dispose of the environmental assets constructed as part of this Project for at least 20 years after Substantial Completion of the two Project sites. The Province will ensure that the environmental assets are used for the purposes of the Project, and will notify Surrey and Delta in advance in writing at any time within the 20 years after Substantial Completion, if the Province sells, leases, encumbers or otherwise disposes of, directly or indirectly, any environmental asset other than to the Government of Canada, Surrey, Delta or a regional government.

18. Subject to due process for a formal transfer of ownership and authority of the Colebrook Dyke, Surrey will endeavor to maintain the integrity and not negatively impact the Colebrook Dyke, currently located adjacent to the NBCCA Site. Should a nature-based solution prove unviable, Surrey will continue to meet the required obligations under the *Dike Maintenance Act* [RSBC 1996, c. 95] as they relate to the "Dyke Infrastructure" portion of the Project, as outlined in Appendix B.

19. Contingent on the approval of the Proposal by the Province, Delta and the Province agree to authorize Surrey access to the two Project sites for the purpose of surveying, construction, monitoring and maintenance activities related to the Project. Contingent on the approval of the Proposal by the Province, Surrey and the Province agree to authorize Delta access to the two Project sites for the purpose of monitoring and maintenance activities related to the Project. Figure 2 in Appendix A outlines the possible access requirements on Boundary Bay Dike to

connect with municipal road allowances and include utilizing 88th Street, 96th Street, 104th Street, Erwin Road/112nd Street, Highway 91/99 Connector Ramp within Delta.

20. This MOU takes effect on the date it is signed by all authorized signatories identified below and ends on the earlier of:

    a. The date Surrey provides a written notice to the Province and Delta that the monitoring and maintenance of the three Project sites is complete.
    b. 20 years after Substantial Completion of the two Project sites.

21. Time will be of the essence for this Project.

22. In the event of severe storm damage threatening the integrity of flood control works, nothing in this MOU shall impede the response by Surrey, Delta or the Province.

As evidenced by their acceptance of this MOU, the Parties, by their authorized signatories, have executed the document on the dates set out below.

Authorized signatures:

CITY OF SURREY

Doug McCallum
Mayor

November 3, 2021
DATE

Jennifer Ficocelli
City Clerk

November 2, 2021
DATE

CITY OF DELTA

George V. Harvie
Mayor

Nov 20/21
DATE

Robyn Anderson
City Clerk

November 17, 2021
DATE

HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF BRITISH COLUMBIA, as represented by the Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Scott Barrett
Director, Resource Management; Statutory Decision Maker, BC Wildlife Act

November 29, 2021
DATE

Appendix A – Project Location and Extent

Figure 1. Location and extent of Site D1 and potential Project access routes within Delta

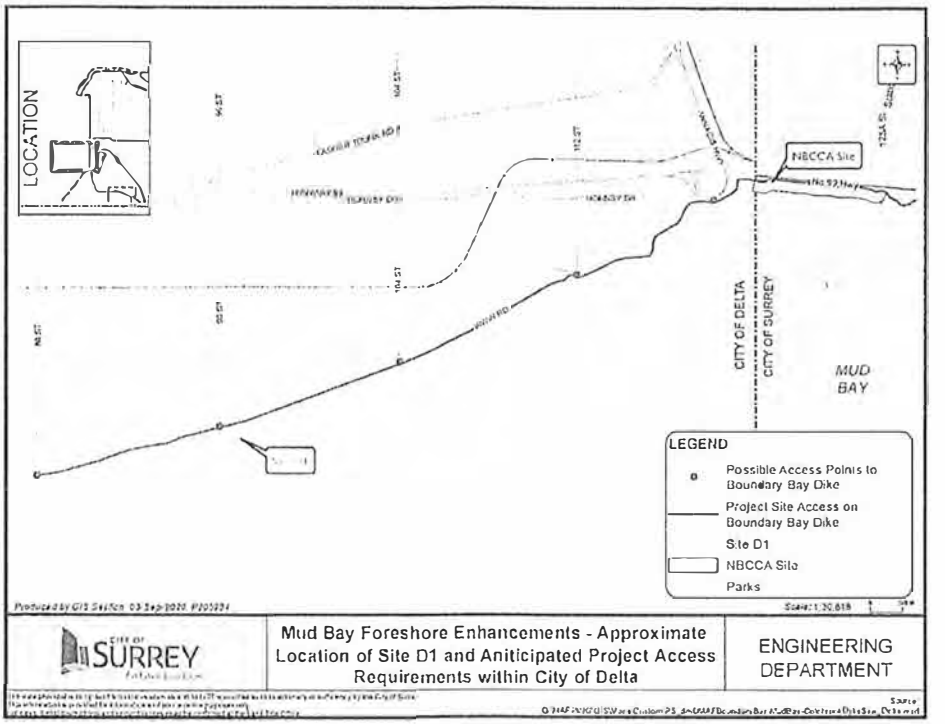
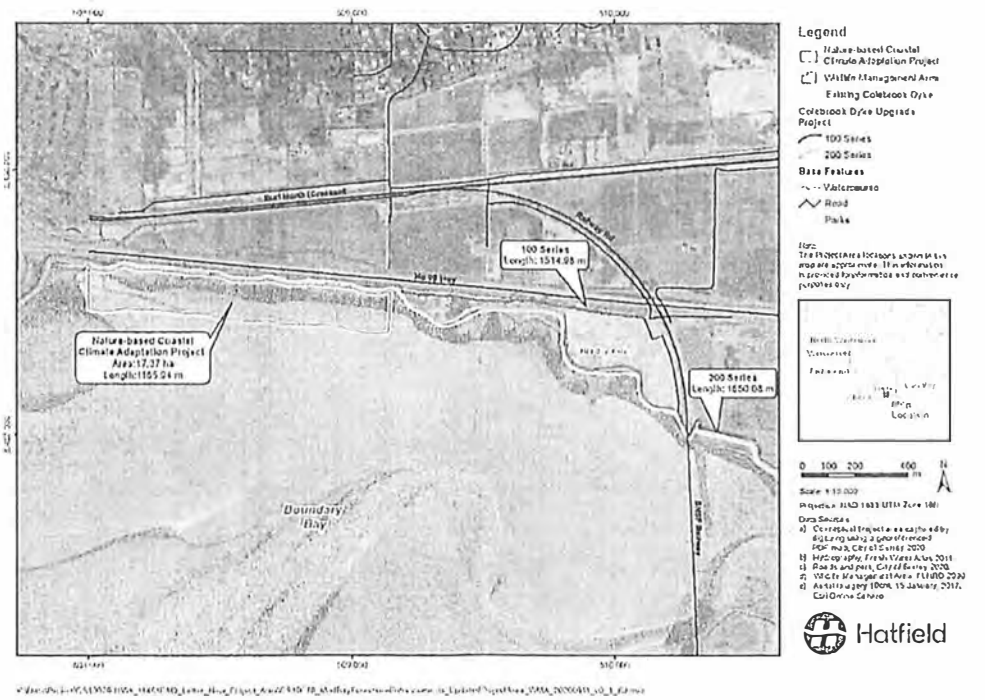


Figure 2. Location and Extent of the NBCCA Site



Appendix B – Cross-sectional Concept Design of the NBCCA Site

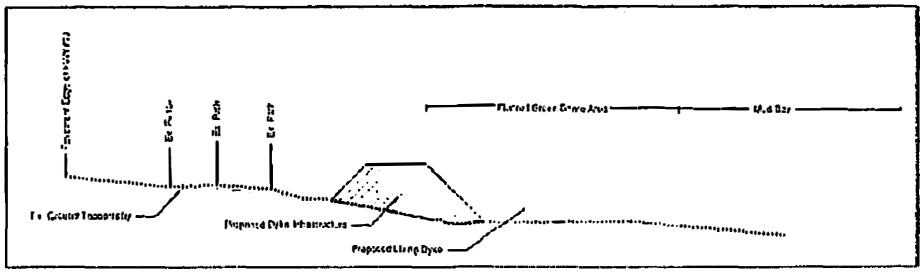


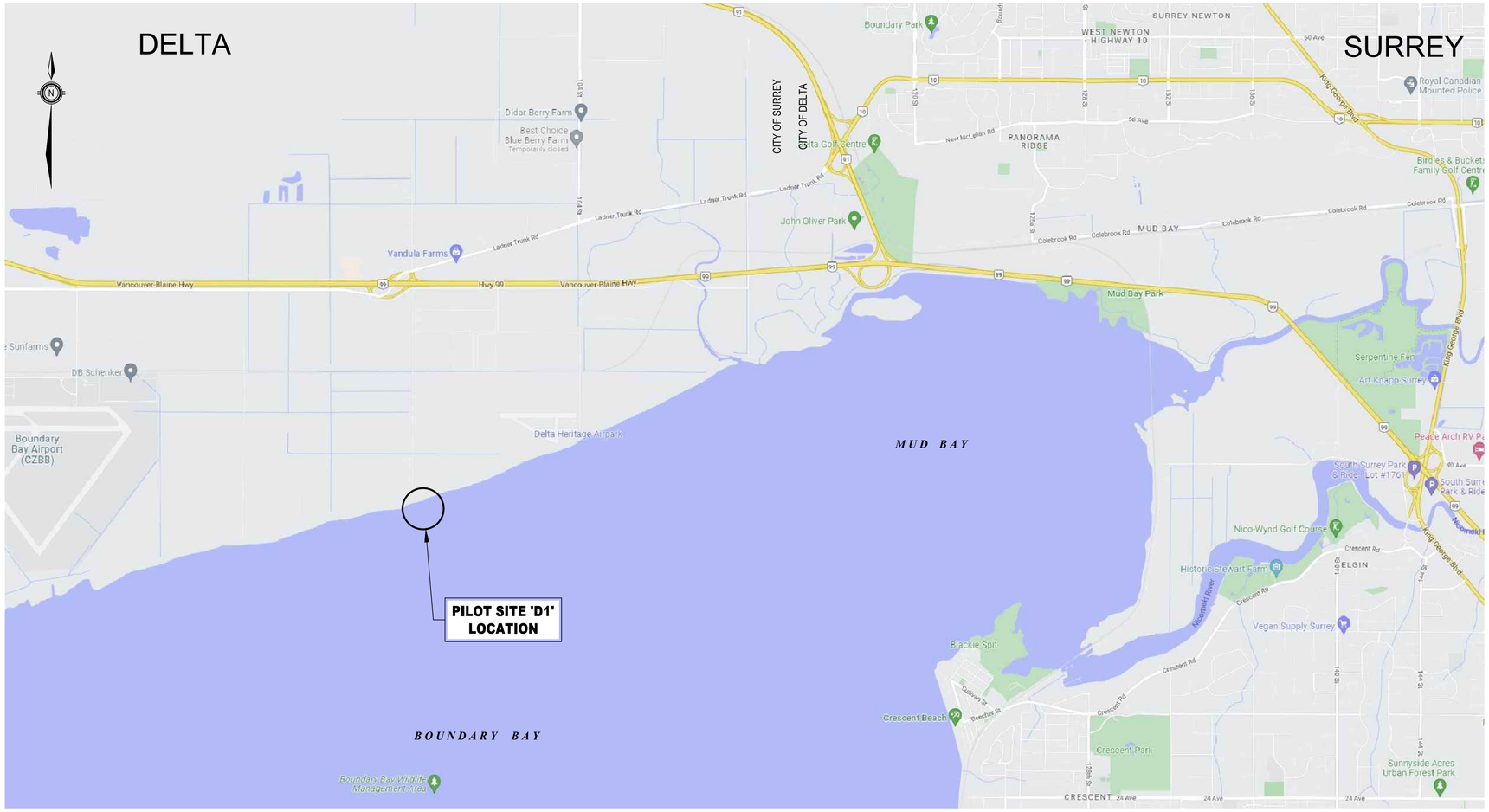
Figure 3. The image depicts a cross-sectional concept of the NBCCA Site (*Proposed Living Dyke*), including the integration with the Colebrook Dyke (*Proposed Dyke Infrastructure*). All information shown is approximate and conceptual.

Appendix A3

S2 70% Design Drawing

0 2000 (1:200,000) 10,000m

LOCATION MAP
SCALE 1:200,000



SITE MAP
SCALE 1:25,000

0 200 (1:25,000) 1,000m

SURVEY CONTROL

HORIZONTAL DATUM IS UTM NAD 83.
VERTICAL DATUM IS GEODETIC CGVD28GVRD2018.
DATUM WAS CONFIRMED BY TIES TO LOCAL MONUMENTS 80H1267, 80H1257 AND 5253.

SITE CONTOURS BASED PRIMARILY ON 2018 LIDAR SUPPLEMENTED WITH LIMITED TOPOGRAPHIC SURVEY IN MAY 2022.

INSTALLED	NORTHING	EASTING	ELEV
KWL-SPIKE-7250	5437626.469	508059.860	2.845
KWL-SPIKE-7263	5437589.188	507833.209	3.360

MONUMENTS	NORTHING	EASTING	ELEV
801256	5435611.076	503789.390	3.412
801257	5435415.629	503130.040	3.356
5640	5437481.455	510110.420	10.636
801258	5435225.979	502317.797	3.278
5616	5437881.115	508673.408	0.771
5253	5437939.989	509139.707	0.729
5893	5437651.958	508003.136	2.739
801267	5433024.238	497190.868	3.275

DMAF NATURE-BASED COASTAL ADAPTATION
COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE D1

KERR WOOD LEIDAL
consulting engineers

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2021-02-25	MS	SB	AJK	ISSUED FOR CLIENT REVIEW
B	2022-02-11	ARM	SB	DNM	ISSUED FOR 50% DESIGN
C	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION
COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE D1 - LOCATION MAP, SITE MAP
DRAWING LIST & SURVEY CONTROL

Project No. 0471-336
Group CIVIL
Drawing No. G-101
Rev. C

SAVED 2022/05/14, 5:38 PM

Paper Size = ANSI D
At Full Size, this border measures 520 mm x 800 mm

0 10 50 100 millimeters

0 25 (1:3,000) 150m

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KERR WOOD LEIDAL
consulting engineers

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

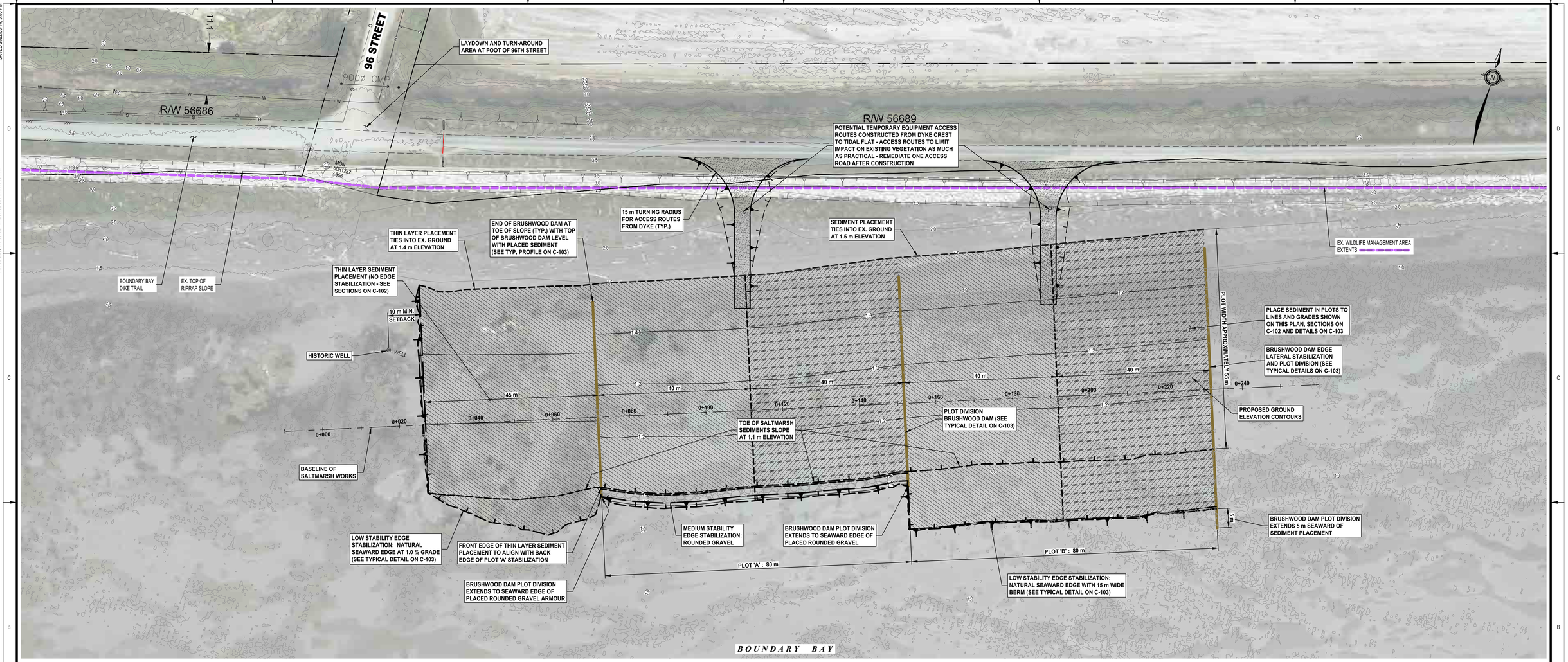
Rev	Date	Des	Dwn	Chk	Description
A	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

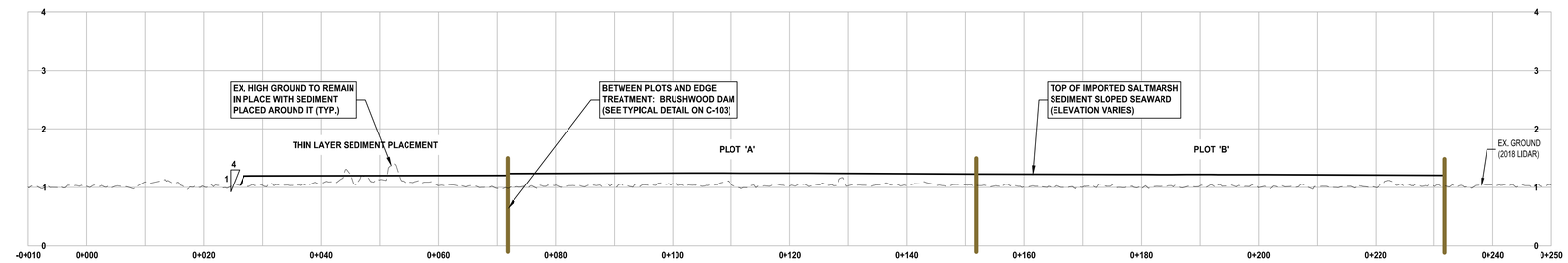
Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT SITE ACCESS AND LAYDOWN PLAN

Project No. 0471-336
Group CIVIL
Drawing No. G-102
Rev. A





SITE D1 PROFILE ACROSS ALL PLOTS

0 5 (H 1:500) 25m
0 0.5 (V 1:50) 2.5m

LEGEND

- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL
- SALTMARSH SEDIMENT
- SALTMARSH SEDIMENT AMENDED WITH ADDITIONAL FINE SEDIMENT
- ROUNDED GRAVEL
- BRUSHWOOD DAM

KERR WOOD LEIDAL
consulting engineers

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

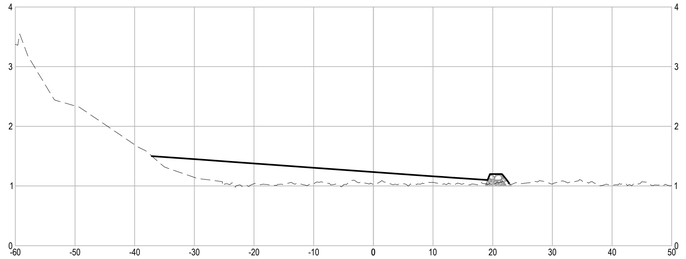
Rev	Date	Des	Dwn	Chk	Description
A	2021-03-01	MS	SB	AJK	ISSUED FOR CLIENT REVIEW
B	2022-02-11	ARM	SB	DNM	ISSUED FOR 50% DESIGN
C	2022-02-25	ARM	SB	DNM	UPDATED 50% DESIGN BASED ON CLIENT REVIEW
D	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

Rev	Date	Des	Dwn	Chk	Description

CITY OF DELTA
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE D1
GRADING PLAN

Project No.	Drawing No.	Rev.
0471-336	C-101	D
Group: CIVIL		



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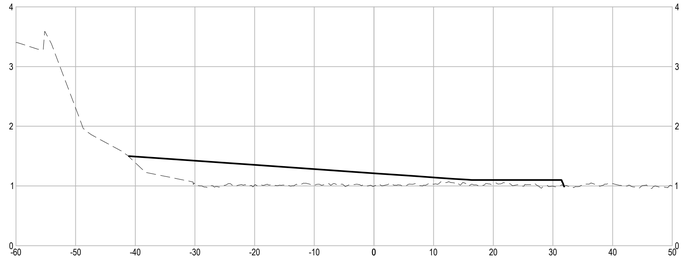

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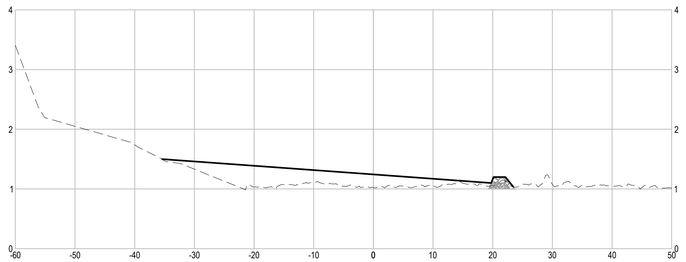

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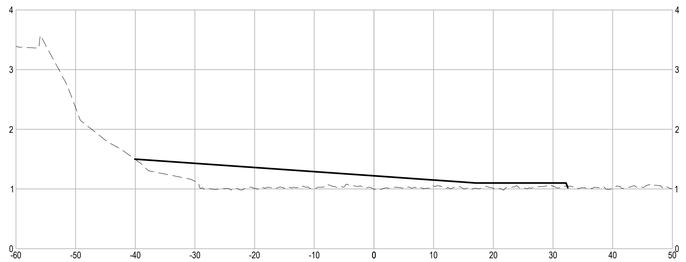
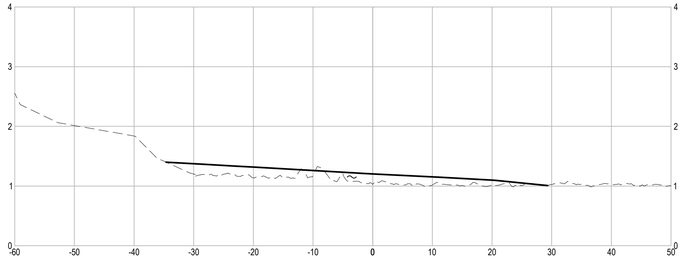
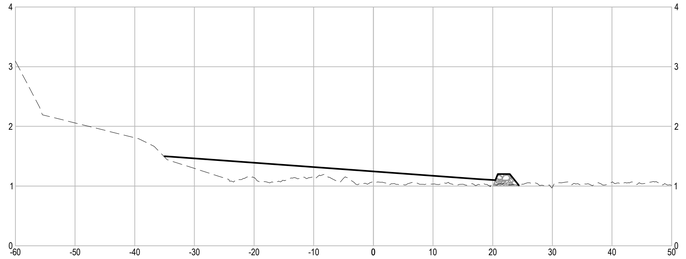


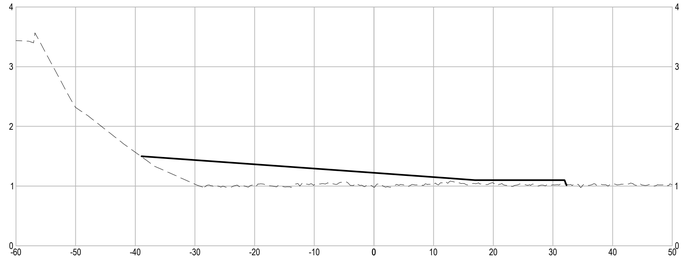
STA. 0+200



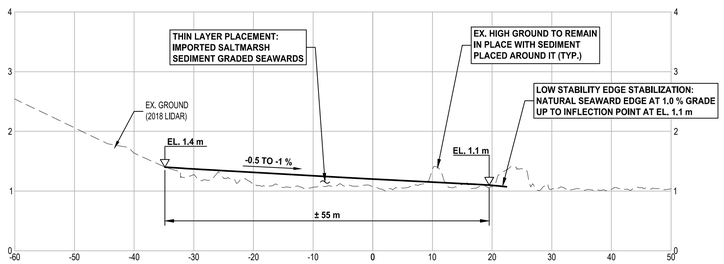
STA. 0+060



STA. 0+100

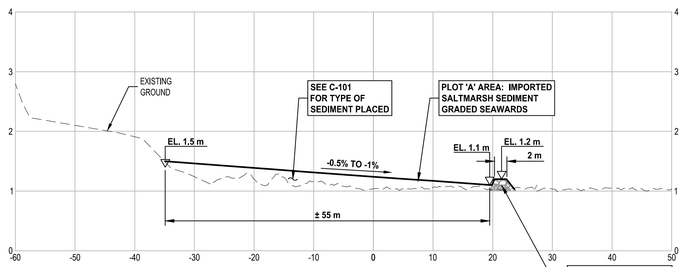


STA. 0+180



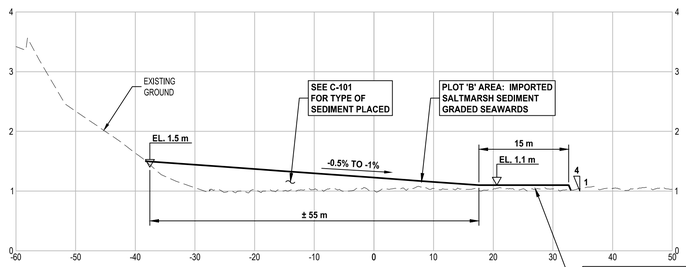
STA. 0+040

SITE D1 THIN LAYER PLACEMENT AREA TYPICAL SECTION



STA. 0+080

SITE D1 PLOT 'A' AREA TYPICAL SECTION



STA. 0+160

SITE D1 PLOT 'B' AREA TYPICAL SECTION

0 5 (H 1:500) 25m
0 0.5 (V 1:50) 2.5m

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2022-02-11	ARM	SB	DNM	ISSUED FOR 50% DESIGN
B	2022-02-25	ARM	SB	DNM	UPDATED 50% DESIGN BASED ON CLIENT REVIEW
C	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

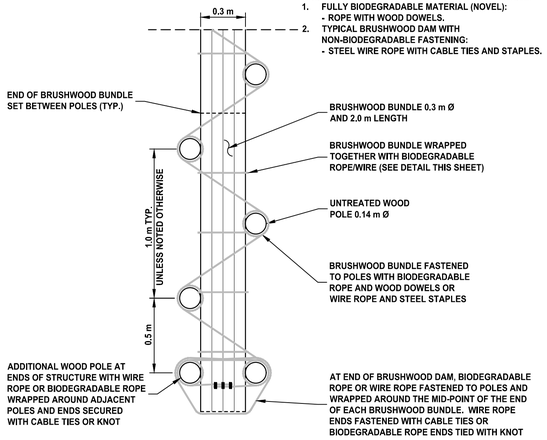
Rev	Date	Des	Dwn	Chk	Description

CITY OF DELTA
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

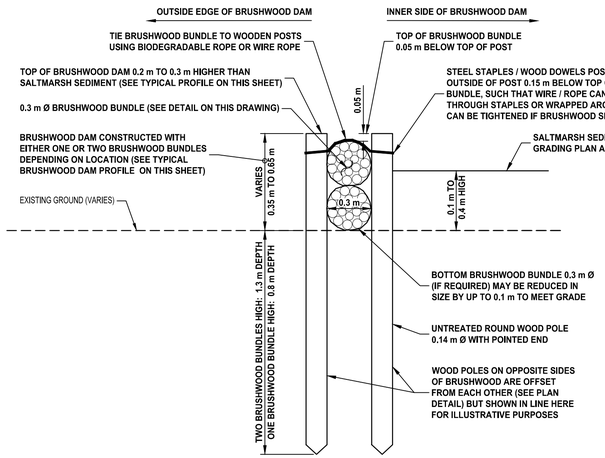
COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE D1
CIVIL SECTIONS

Project No.	Drawing No.	Rev.
0471-336	C-102	C
Group: CIVIL		

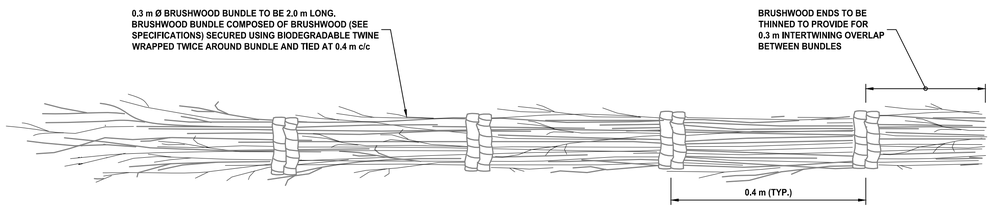
NOTE, TWO BRUSHWOOD FASTENING MATERIAL OPTIONS SHOWN TO BE CONFIRMED BASE ON INPUT FROM CLIENT AND THE BOUNDARY BAY LIVING DYKES ROUNDTABLE:
1. FULLY BIODEGRADABLE MATERIAL (NOVEL):
   - ROPE WITH WOOD DOWELS.
2. TYPICAL BRUSHWOOD DAM WITH NON-BIODEGRADABLE FASTENING:
   - STEEL WIRE ROPE WITH CABLE TIES AND STAPLES.



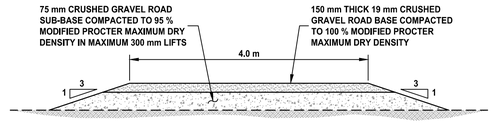
BRUSHWOOD DAM - PLAN DETAIL
Scale 1:20



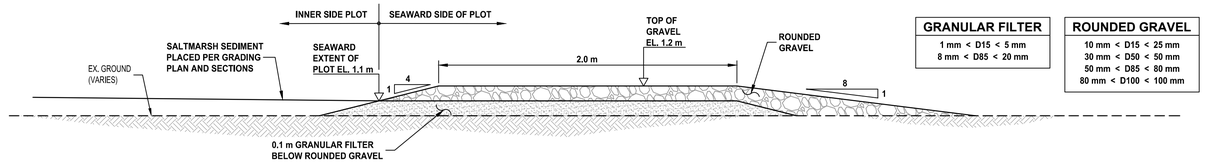
BRUSHWOOD DAM - TYPICAL SECTION
Scale 1:20



BRUSHWOOD BUNDLE DETAIL - PLAN
N.T.S.



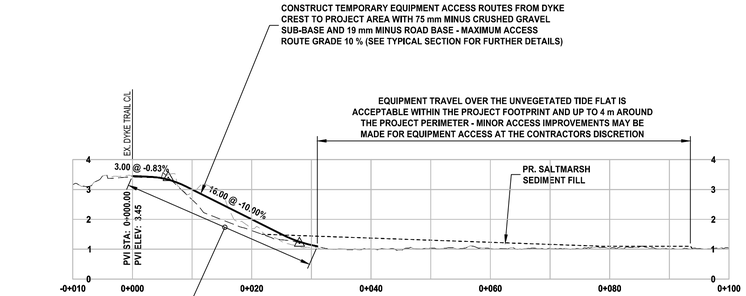
SITE D1 - TEMPORARY ACCESS ROUTE TYPICAL SECTION
SCALE 1:50



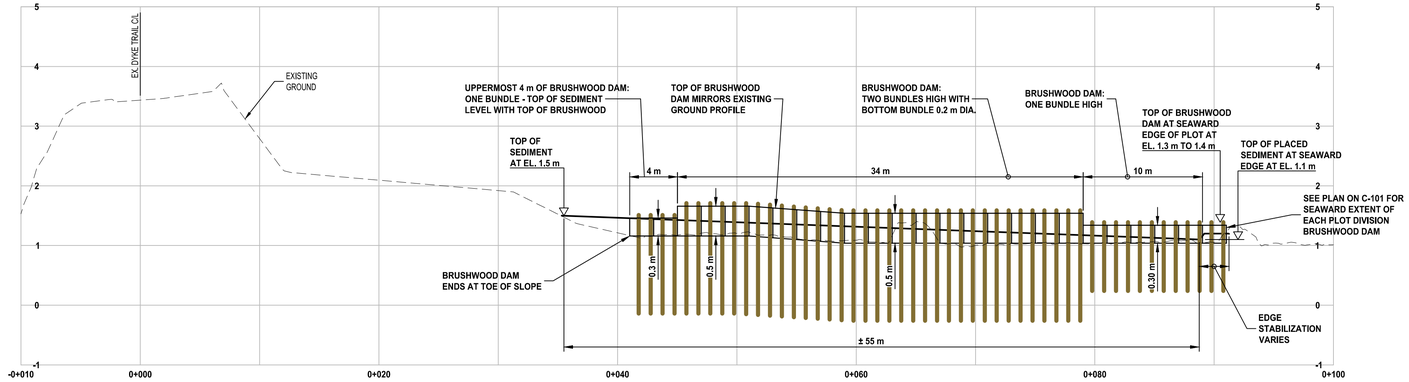
GRANULAR FILTER
1 mm < D15 < 5 mm
8 mm < D85 < 20 mm

ROUNDED GRAVEL
10 mm < D15 < 25 mm
30 mm < D50 < 50 mm
50 mm < D85 < 80 mm
80 mm < D100 < 100 mm

ROUNDED GRAVEL EDGE STABILIZATION - TYPICAL SECTION
SCALE 1:20

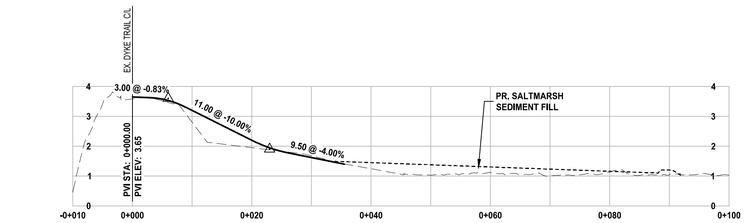


NORTH-EAST TEMPORARY ACCESS ROUTE PROFILE
SCALE HOR 1:500, VER 1:100



0 2 (H 1:250) 10m
0 0.5 (V 1:50) 2m

BRUSHWOOD DAM SITE D1 PLOT DIVISION TYPICAL PROFILE
SCALE HOR 1:250, VER 1:50
(SHOWN AT STA. 0+072)



(SEE TYPICAL NOTES ON NORTH-EAST ACCESS ROUTE PROFILE)

SOUTH-WEST TEMPORARY ACCESS ROUTE PROFILE
SCALE HOR 1:500, VER 1:100

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2021-02-26	MS	MAR		ISSUED FOR CLIENT REVIEW
B	2022-02-11	ARM	LA	DNM	ISSUED FOR 50% DESIGN
C	2022-02-25	ARM	SB	DNM	UPDATED 50% DESIGN BASED ON CLIENT REVIEW
D	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE D1
TYPICAL DETAILS - SHEET 1

Project No.	Drawing No.	Rev.
0471-336	C-103	D
Group: CIVIL		

PLANTING ZONE	LOCATION	SPECIES & PERCENT IN EACH ZONE		DENSITY	TOTAL AREA
MARSH EDGE SPACED GROUPED	12 m WIDE BAND AT EDGE OF MARSH	ARROWGRASS PICKLEWEED	50% 50%	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	1,927 m^2
TRANSITION MARSH SPACED GROUPED	4 m WIDE BAND LANDWARDS OF THE MARSH EDGE	ARROWGRASS PICKLEWEED SALTGRASS	35% 35% 30%	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	643 m^2
MARSH PLATFORM SPACED GROUPED	REMAINDER OF MARSH AREA, EXCEPT THE THIN LAYER PLACEMENT ZONE	ARROWGRASS PICKLEWEED PACIFIC ALKALI GRASS SALTGRASS TUFTED HAIRGRASS FOXTAIL BARLEY BALTIC RUSH SEASIDE PLANTAIN	5% 10% 15% 20% 15% 10% 10% 15%	• EVENLY SPACED PLUGS: PLUGS SPACED 1.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 2.5 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD). • WIDER SPACING TO ENCOURAGE NATURAL RECRUITMENT.	5,591 m^2
THIN LAYER PLACEMENT: NO PLANTING	THIN LAYER PLACEMENT AREA WEST OF PLOT 'A'	• NA - NO PLANTING		• NA - NO PLANTING	

LEGEND

- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL

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PRELIMINARY
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Info:

Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2022-02-11	ARM	SB	DNM	ISSUED FOR 50% DESIGN
B	2022-02-25	ARM	SB	DNM	UPDATED 50% DESIGN BASED ON CLIENT REVIEW
C	2022-05-09	ARM	SB	GW	ISSUED FOR 90% DESIGN

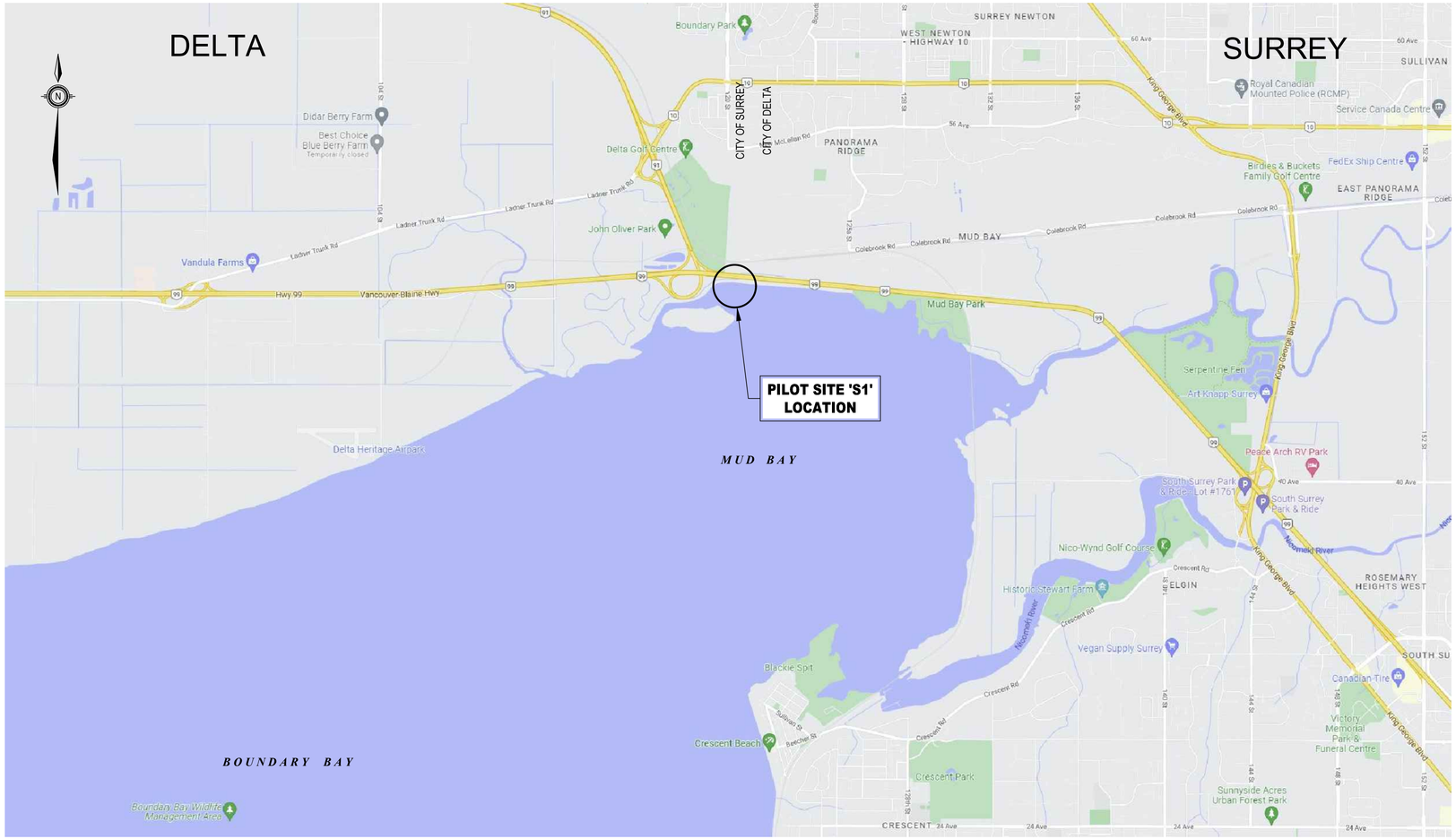
Rev	Date	Des	Dwn	Chk	Description

CITY OF DELTA
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT PILOT SITE D1 PLANTING PLAN

Project No.	Drawing No.	Rev.
0471-336	L-101	C
Group: CIVIL		

LOCATION MAP
SCALE 1:200,000



SITE MAP
SCALE 1:25,000

SURVEY CONTROL

HORIZONTAL DATUM IS UTM NAD 83.
VERTICAL DATUM IS GEODETIC CGVD28GVRD2018. DATUM WAS CONFIRMED BY TIES TO LOCAL MONUMENTS 80H1267, 80H1257 AND 5253.

SITE CONTOURS BASED PRIMARILY ON 2016 STANTEC SURVEY AND SUPPLEMENTED WITH LIMITED KWL TOPOGRAPHIC SURVEY IN 2020 AND 2022.

INSTALLED	NORTHING	EASTING	ELEV
KWL-SPIKE-7250	5437626.469	508059.860	2.845
KWL-SPIKE-7263	5437589.188	507833.209	3.360

MONUMENTS	NORTHING	EASTING	ELEV
801256	5435611.076	503789.390	3.412
801257	5435415.629	503130.040	3.356
5640	5437481.455	510110.420	10.636
801258	5435225.979	502317.797	3.278
5616	5437881.115	508673.408	0.771
5253	5437939.989	509139.707	0.729
5893	5437651.958	508003.136	2.739
801267	5433024.238	497190.868	3.275

DWG No.	DRAWING TITLE
G-201	LOCATION MAP, SITE MAP, DRAWING LIST AND SURVEY CONTROL
G-202	SITE ACCESS AND LAYDOWN PLAN
C-201	PILOT SITE S1 - GRADING PLAN
C-202	PILOT SITE S1 - CIVIL SECTIONS - SHEET 1
C-203	PILOT SITE S1 - CIVIL SECTIONS - SHEET 2
C-204	PILOT SITE S1 - TYPICAL DETAILS - SHEET 1
C-205	PILOT SITE S1 - TYPICAL DETAILS - SHEET 2
L-201	PILOT SITE S1 - PLANTING PLAN

DMAF NATURE-BASED COASTAL ADAPTATION
COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S1

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

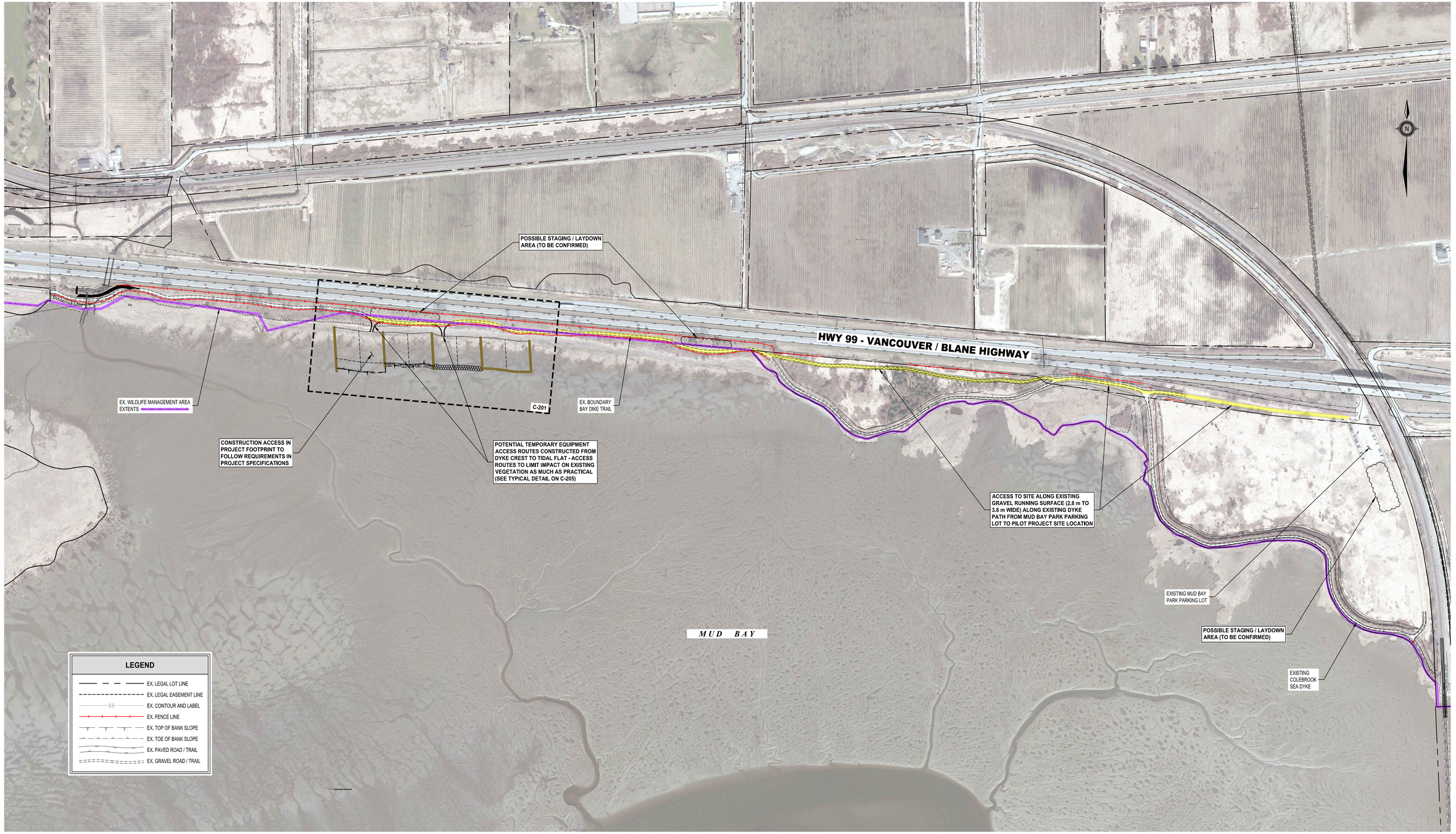
Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2021-02-25	MS	SB	AJK	ISSUED FOR CLIENT REVIEW
B	2022-02-11	ARM	SB	DNM	ISSUED FOR 50% DESIGN
C	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S1 - LOCATION MAP, SITE MAP
DRAWING LIST & SURVEY CONTROL

Project No.	Drawing No.	Rev.
0471-336	G-201	C
Group: CIVIL		



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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT SITE ACCESS AND LAYDOWN PLAN

Project No. 0471-336
Group CIVIL
Drawing No. C-202
Rev. A

HWY 99 - VANCOUVER / BLANE HIGHWAY

REMOVE EXISTING CHAINLINK FENCE IN FOOTPRINT OF ACCESS PATHS - STOCKPILE FOR RE-USE FOLLOWING DYKE UPGRADE

POTENTIAL TEMPORARY EQUIPMENT ACCESS ROUTES CONSTRUCTED FROM DYKE CREST TO TIDAL FLAT - ACCESS ROUTES TO LIMIT IMPACT ON EXISTING VEGETATION AS MUCH AS PRACTICAL (SEE TYPICAL DETAIL ON C-205)

PLOT DIVISION BRUSHWOOD DAM ENDS AT EXISTING GROUND ELEVATION 1.6 m (SEE BRUSHWOOD DAM PLOT DIVISION TYPICAL PROFILE ON C-204)

EX. BOUNDARY BAY DIKE TRAIL

EX. WILDLIFE MANAGEMENT AREA EXTENTS

THIN LAYER SEDIMENT PLACEMENT UP TO 1.6 m ELEVATION FOR ALL PLOTS (NO EDGE STABILIZATION)

EX. TOP OF DYKE SLOPE

PLACE SEDIMENT IN PLOTS TO LINES AND GRADES SHOWN ON THIS PLAN, SECTIONS ON C-202, C-203 AND DETAILS ON C-204

THIN LAYER SEDIMENT PLACEMENT OVER EXISTING GROUND EL. 1.2 m TO 1.6 m (SEE SECTIONS ON C-202 - 0.1 m DEEP IN PLOTS 'A' AND 'B' AND 0.2 m DEEP IN PLOTS 'C' AND 'D'

PLOT WIDTH APPROXIMATELY 90 m

PROPOSED GROUND ELEVATION CONTOURS

0+380 0+400 0+420 0+440 0+460 0+480 0+500 0+520 0+540 0+560 0+580 0+600 0+620 0+640 0+660 0+680 0+700 0+720 0+740 0+760

40 m

TOE OF SALTMARSH SEDIMENT SLOPE AT 1.0 m ELEVATION

PLOT DIVISION BRUSHWOOD DAM (SEE TYPICAL DETAILS ON C-204)

TOE OF SALTMARSH SEDIMENT SLOPE AT 1.0 m ELEVATION

4 m WIDE DRAINAGE OUTLETS (SEE DETAIL ON C-205)

BASELINE OF SALTMARSH WORKS RUNS PARALLEL TO HIGHWAY FROM EUGENE CREEK CULVERT OUTLET EASTWARD TO MUD BAY PARK

PLOT 'B' : 80 m

PLOT 'A' : 80 m

MEDIUM STABILITY EDGE STABILIZATION: ROUNDED GRAVEL (SEE DETAIL ON C-205)

BRUSHWOOD DAM PLOT DIVISION EXTENDS TO SEAWARD EDGE OF PLACED ROUNDED GRAVEL

MEDIUM STABILITY EDGE STABILIZATION: OYSTER SHELL BAGS (SEE TYPICAL DETAILS ON C-205)

HIGH STABILITY EDGE STABILIZATION: BRUSHWOOD DAM (SEE TYPICAL DETAILS ON C-204)

PLOT 'C' : 80 m

BRUSHWOOD DAM PLOT DIVISION EXTENDS 5 m SEAWARD OF SEDIMENT PLACEMENT

PLOT 'D' : 80 m

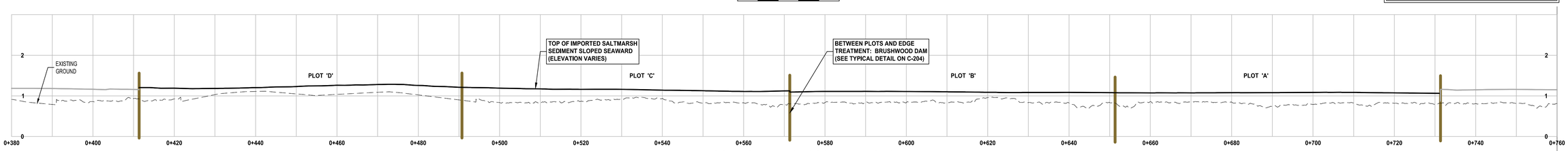
LOW STABILITY EDGE STABILIZATION: NATURAL SEAWARD EDGE WITH 15 m WIDE BERM (SEE TYPICAL DETAIL ON C-204)

LEGEND

- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL
- SALTMARSH SEDIMENT
- SALTMARSH SEDIMENT AMENDED WITH ADDITIONAL FINE SEDIMENT
- ROUNDED GRAVEL
- BRUSHWOOD DAM

MUD BAY

0 5 (1:500) 25m



SITE S1 PROFILE ACROSS ALL PLOTS

0 5 (H 1:500) 25m
0 0.5 (V 1:50) 2.5m

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2021-03-01	MS	SB	AJK	ISSUED FOR CLIENT REVIEW
B	2022-02-11	ARM	SB	DNM	ISSUED FOR 50% DESIGN
C	2022-02-25	ARM	SB	DNM	UPDATED 50% DESIGN BASED ON CLIENT REVIEW
D	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S1
GRADING PLAN

Project No. 0471-336
Group CIVIL
Drawing No. C-201
Rev. D

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2022-02-11	ARM	SB	DNM	ISSUED FOR 50% DESIGN
B	2022-02-25	ARM	SB	DNM	UPDATED 50% DESIGN BASED ON CLIENT REVIEW
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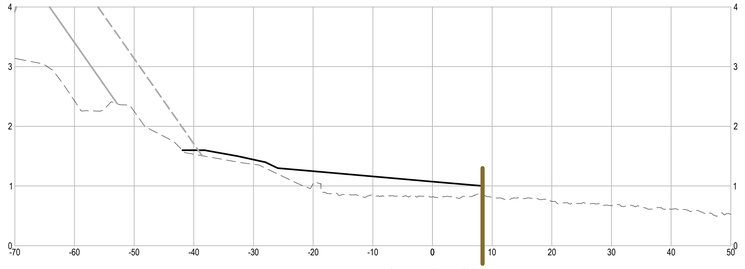
Rev	Date	Des	Dwn	Chk	Description

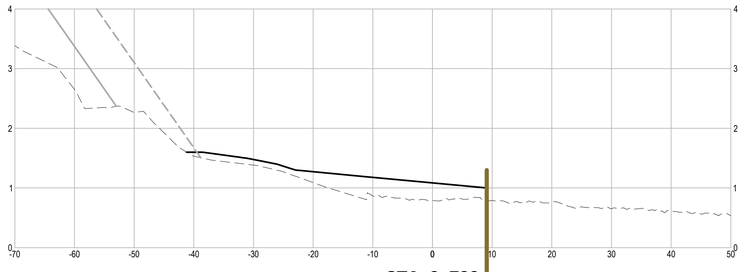
CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S1
CIVIL SECTIONS - SHEET 1

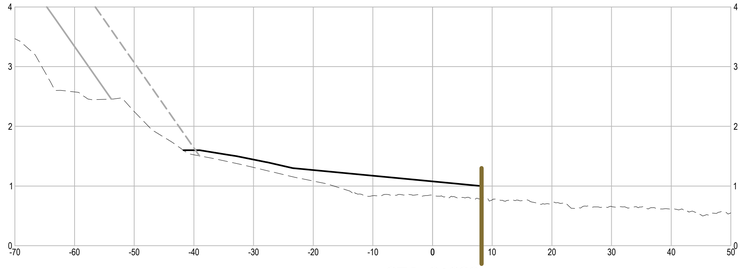
Project No. 0471-336
Group CIVIL
Drawing No. C-202
Rev. C



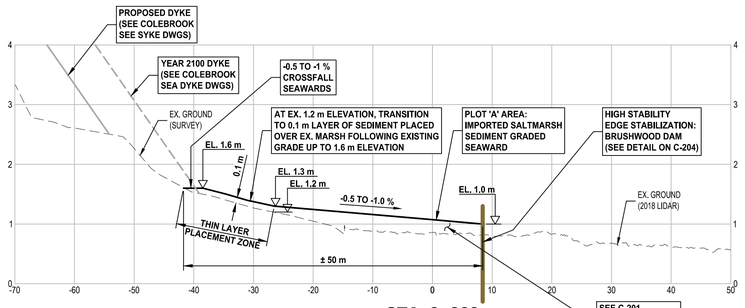
STA. 0+720



STA. 0+700



STA. 0+680



STA. 0+660

SITE S1 PLOT 'A' TYPICAL SECTION

0 5 (H 1:500) 25m
0 0.5 (V 1:50) 2.5m

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

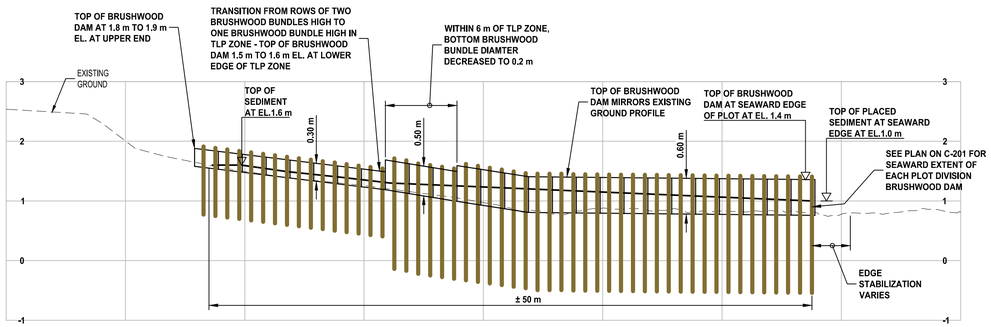
Seal:

Rev	Date	Des	Dwn	Chk	Description	Rev	Date	Des	Dwn	Chk	Description
A	2022-02-11	ARM	SB	DNM	ISSUED FOR 50% DESIGN						
B	2022-02-25	ARM	SB	DNM	UPDATED 50% DESIGN BASED ON CLIENT REVIEW						
C	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN						

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT PILOT SITE S1 CIVIL SECTIONS - SHEET 2

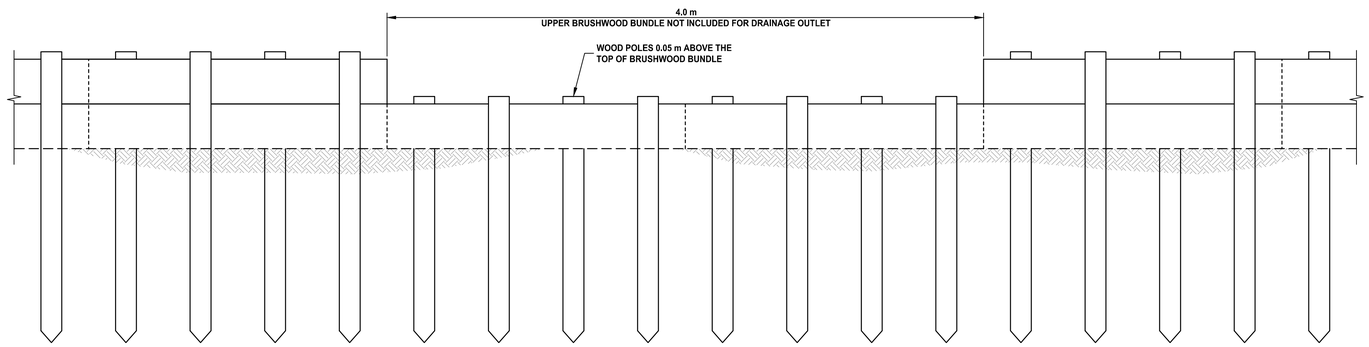
Project No. 0471-336
Drawing No. C-203
Rev. C
Group CIVIL



0 2 (H 1:250) 10m
0 0.5 (V 1:50) 2m

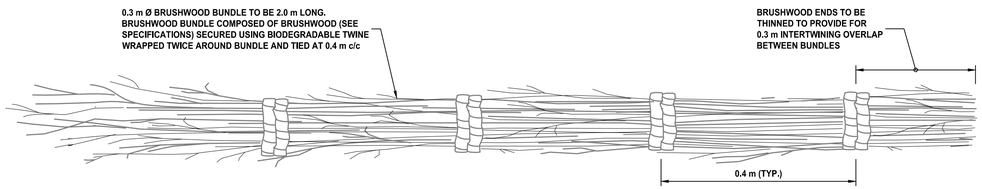
BRUSHWOOD DAM SITE S1 PLOT DIVISION TYPICAL PROFILE

SCALE HOR 1:250, VER 1:50
(SHOWN AT STA. 0+651)



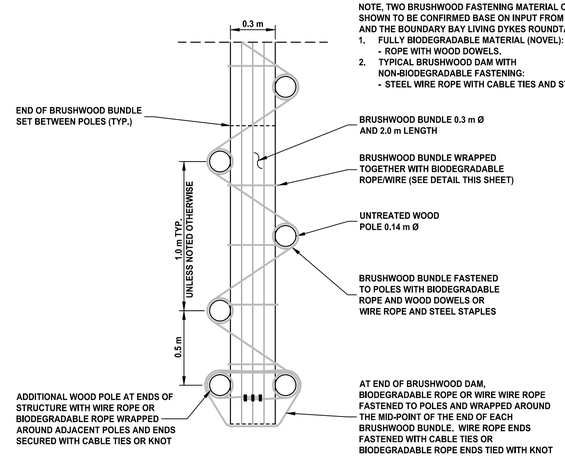
BRUSHWOOD DAM DRAINAGE OPENING DETAIL

SCALE 1:20



BRUSHWOOD BUNDLE DETAIL - PLAN

N.T.S.

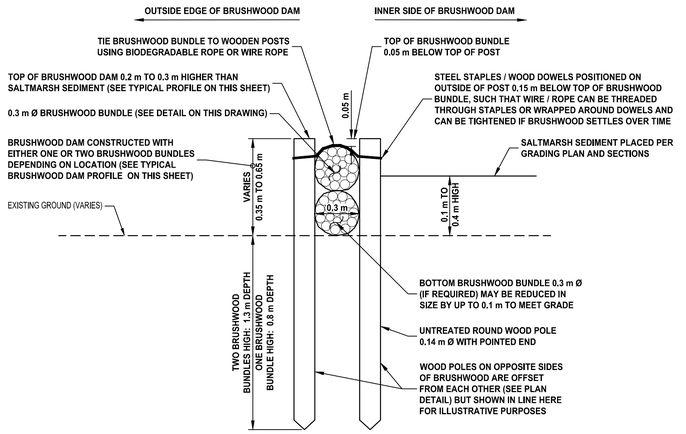


NOTE, TWO BRUSHWOOD FASTENING MATERIAL OPTIONS SHOWN TO BE CONFIRMED BASE ON INPUT FROM CLIENT AND THE BOUNDARY BAY LIVING DYKES ROUNDTABLE:
1. FULLY BIODEGRADABLE MATERIAL (NOVEL):
   - ROPE WITH WOOD DOWELS.
2. TYPICAL BRUSHWOOD DAM WITH NON-BIODEGRADABLE FASTENING:
   - STEEL WIRE ROPE WITH CABLE TIES AND STAPLES.

BRUSHWOOD BUNDLE 0.3 m Ø AND 2.0 m LENGTH
BRUSHWOOD BUNDLE WRAPPED TOGETHER WITH BIODEGRADABLE ROPE/WIRE (SEE DETAIL THIS SHEET)
UNTREATED WOOD POLE 0.14 m Ø
BRUSHWOOD BUNDLE FASTENED TO POLES WITH BIODEGRADABLE ROPE AND WOOD DOWELS OR WIRE ROPE AND STEEL STAPLES
AT END OF BRUSHWOOD DAM, BIODEGRADABLE ROPE OR WIRE WIRE ROPE FASTENED TO POLES AND WRAPPED AROUND THE MID-POINT OF THE END OF EACH BRUSHWOOD BUNDLE. WIRE ROPE ENDS FASTENED WITH CABLE TIES OR BIODEGRADABLE ROPE ENDS TIED WITH KNOT

BRUSHWOOD DAM - PLAN DETAIL

Scale 1:20



BRUSHWOOD DAM - TYPICAL SECTION

Scale 1:20

KERR WOOD LEIDAL
consulting engineers

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

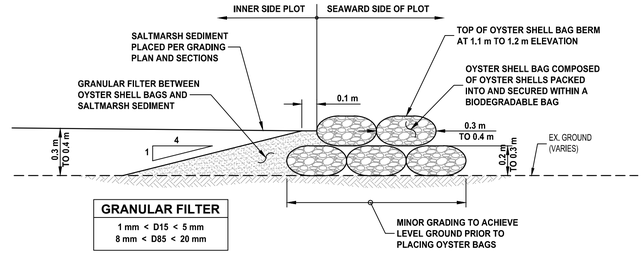
Rev	Date	Des	Dwn	Chk	Description
A	2021-02-26	MS	MAR		ISSUED FOR CLIENT REVIEW
B	2022-02-11	ARM	LA	DNM	ISSUED FOR 50% DESIGN
C	2022-02-25	ARM	SB	DNM	UPDATED 50% DESIGN BASED ON CLIENT REVIEW
D	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

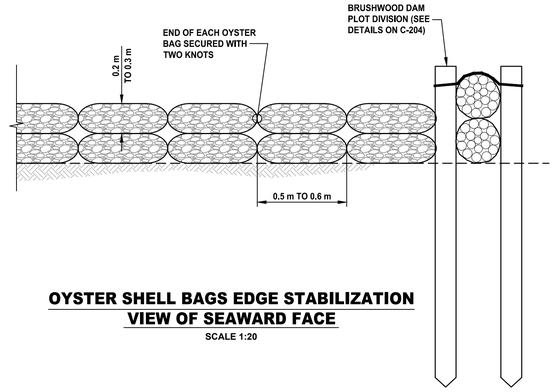
COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S1
TYPICAL DETAILS - SHEET 1

Project No.	Drawing No.	Rev.
0471-336	C-204	D
Group: CIVIL		



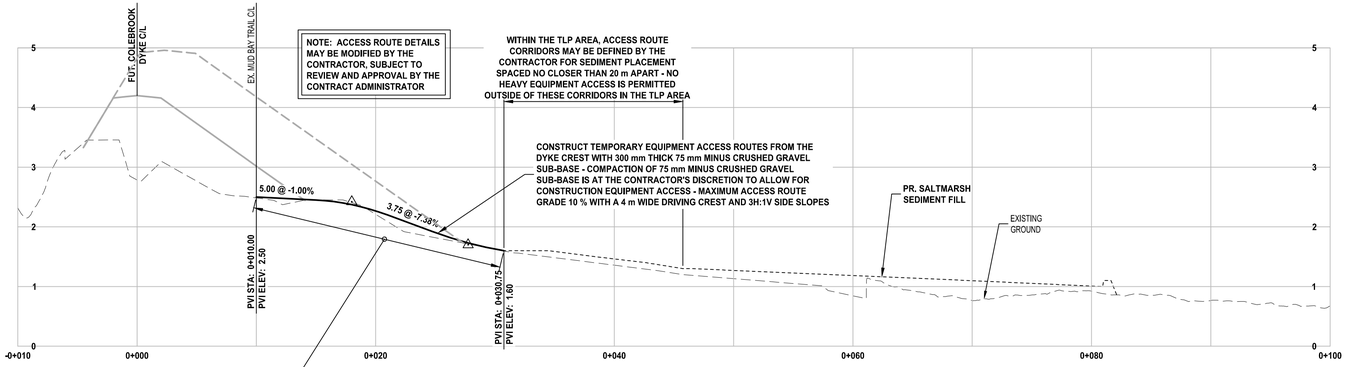
OYSTER SHELL BAGS EDGE STABILIZATION - TYPICAL SECTION

SCALE 1:20



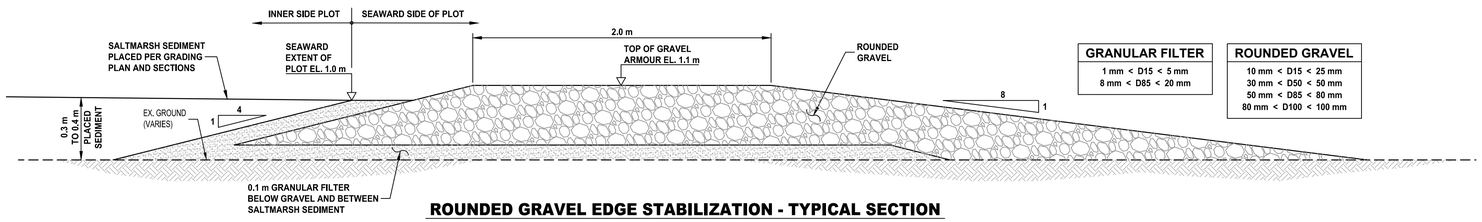
OYSTER SHELL BAGS EDGE STABILIZATION VIEW OF SEAWARD FACE

SCALE 1:20



SITE S1 - TEMPORARY ACCESS ROUTE TYPICAL PROFILE

SCALE HOR 1:250, VER 1:50



ROUNDED GRAVEL EDGE STABILIZATION - TYPICAL SECTION

SCALE 1:20

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S1
TYPICAL DETAILS - SHEET 2

Project No. 0471-336
Group CIVIL
Drawing No. C-205
Rev. A

HWY 99 - VANCOUVER / BLANE HIGHWAY

POTENTIAL EQUIPMENT ACCESS ROUTES CONSTRUCTED FROM DYKE CREST TO TIDAL FLAT - ACCESS ROUTES TO LIMIT IMPACT ON EXISTING VEGETATION AS MUCH AS PRACTICAL (SEE TYPICAL DETAIL ON C-205)

BH 16-36

UPPER EDGE OF PLACED SEDIMENT

EX. TOP OF DYKE SLOPE

UPPER EDGE OF MARSH PLATFORM PLANTING ZONE AT FINISHED GROUND EL. 1.4 m (EX. GROUND EL. 1.2 m) IN PLOTS 'C' AND 'D'

EX. BOUNDARY BAY DIKE TRAIL

UPPER EDGE OF MARSH PLATFORM PLANTING ZONE AT FINISHED GROUND EL. 1.3 m (EX. GROUND EL. 1.2 m) IN PLOTS 'A' AND 'B'

EX. WILDLIFE MANAGEMENT AREA EXTENTS

EXISTING GROUND CONTOURS BASED ON SURVEY

THIN LAYER PLACEMENT ZONE: NO PLANTING

PROPOSED CONTOURS

MARSH PLATFORM PLANTING ZONE

TRANSITION EDGE PLANTING ZONE

MARSH EDGE PLANTING ZONE

BASELINE OF SALTMARSH WORKS RUNS PARALLEL TO HIGHWAY FROM EUGENE CREEK CULVERT OUTLET EASTWARD TO MUD BAY PARK

NO PLANTING

0+380 0+400 0+420 0+440 0+460 0+480 0+500 0+520 0+540 0+560 0+580 0+600 0+620 0+640 0+660 0+680 0+700 0+720 0+740 0+760

EVENLY SPACED PLUGS: 20 m | GROUPED PLUGS: 20 m | EVENLY SPACED PLUGS: 20 m | GROUPED PLUGS: 20 m

PLOT 'D' : 80 m

EVENLY SPACED PLUGS: 20 m | GROUPED PLUGS: 20 m | EVENLY SPACED PLUGS: 20 m | GROUPED PLUGS: 20 m

PLOT 'C' : 80 m

EVENLY SPACED PLUGS: 20 m | GROUPED PLUGS: 20 m | EVENLY SPACED PLUGS: 20 m | GROUPED PLUGS: 20 m

PLOT 'B' : 80 m

EVENLY SPACED PLUGS: 20 m | GROUPED PLUGS: 20 m | EVENLY SPACED PLUGS: 20 m | GROUPED PLUGS: 20 m

PLOT 'A' : 80 m

MUD BAY

0 5 (1:500) 25m

PLANTING ZONE	LOCATION	SPECIES & PERCENT IN EACH ZONE		DENSITY	TOTAL AREA
MARSH EDGE SPACED GROUPED	12 m WIDE BAND AT EDGE OF MARSH	ARROWGRASS PICKLEWEED SEACOAST BULLRUSH SALTGRASS SEA MILKWORT	40 % 30 % 10 % 15 % 5 %	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	3844 m^2
TRANSITION MARSH SPACED GROUPED	4 m WIDE BAND LANDWARDS OF THE MARSH EDGE	ARROWGRASS PICKLEWEED SALTGRASS	35 % 35 % 30 %	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	1281 m^2
MARSH PLATFORM SPACED GROUPED	REMAINDER OF MARSH AREA, EXCEPT THE THIN LAYER PLACEMENT ZONE	ARROWGRASS PICKLEWEED PACIFIC ALKALI GRASS SALTGRASS SEA MILKWORT FOXTAIL BARLEY BALTIC RUSH SEASIDE PLANTAIN	5 % 10 % 15 % 20 % 15 % 10 % 10 % 15 %	• EVENLY SPACED PLUGS: PLUGS SPACED 1.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 2.5 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD). • WIDER SPACING TO ENCOURAGE NATURAL RECRUITMENT.	5189 m^2
THIN LAYER PLACEMENT: NO PLANTING	OVER EXISTING MARSH PLATFORM AS SHOWN ON DWGS.	• NA - NO PLANTING		• NA - NO PLANTING	

LEGEND

- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL

KERR WOOD LEIDAL
consulting engineers

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

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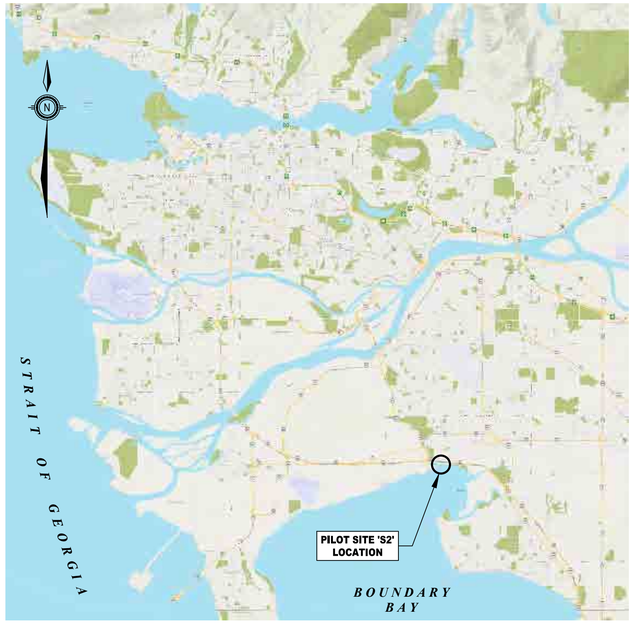
C	2022-05-09	ARM	SB	DNM	ISSUED FOR 90% DESIGN

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

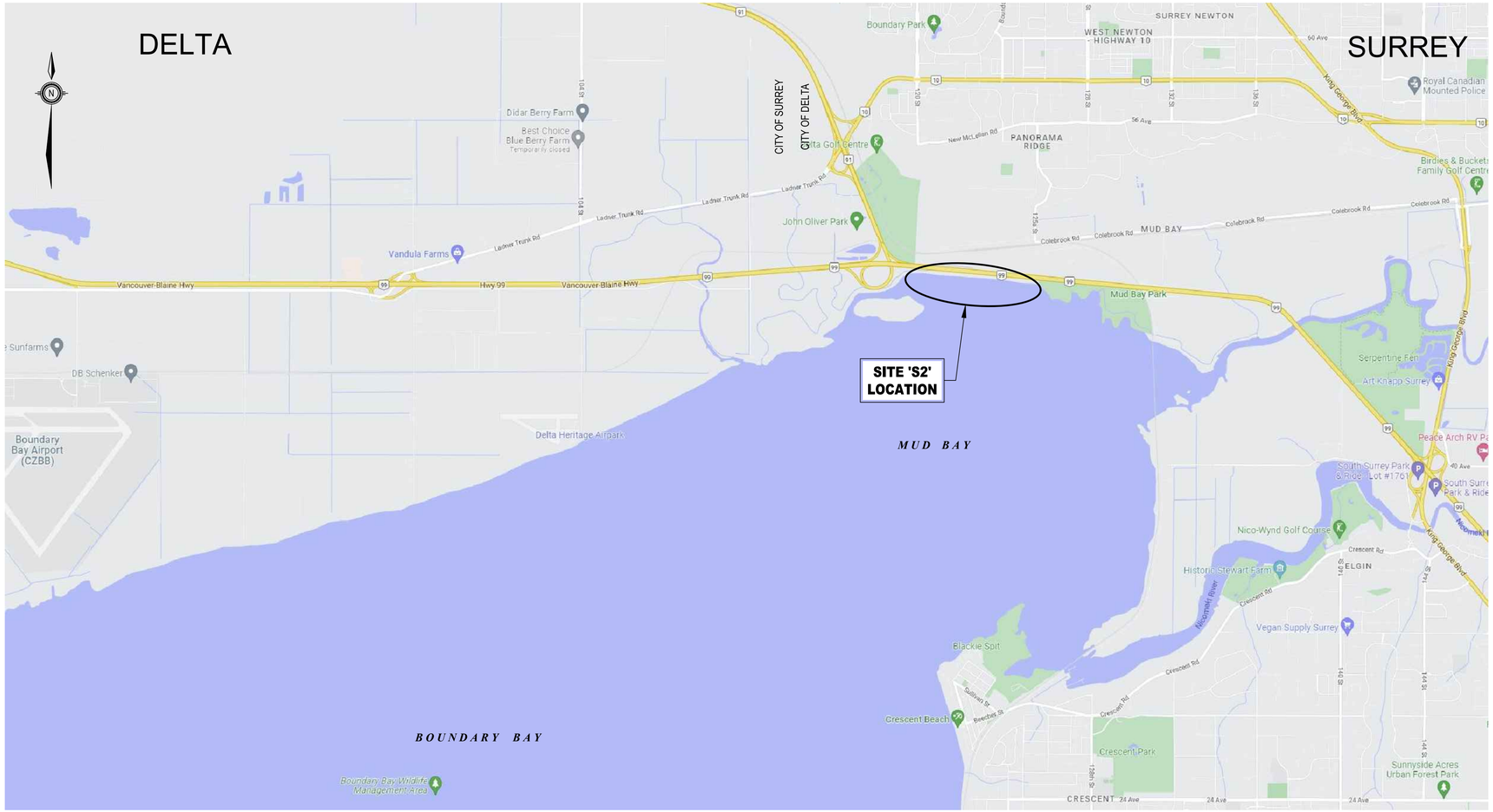
COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S1
PLANTING PLAN

Project No. 0471-336
Group CIVIL
Drawing No. L-201
Rev. C



0 2000 (1:200,000) 10,000m

LOCATION MAP
SCALE 1:200,000



0 200 (1:25,000) 1,000m

SITE MAP
SCALE 1:25,000

SURVEY CONTROL

HORIZONTAL DATUM IS UTM NAD 83.
VERTICAL DATUM IS GEODETIC CGVD28GVRD2018.
DATUM WAS CONFIRMED BY TIES TO LOCAL MONUMENTS 80H1267, 80H1257 AND 5253.

SITE CONTOURS BASED PRIMARILY ON 2016 STANTEC SURVEY AND SUPPLEMENTED WITH LIMITED KWL TOPOGRAPHIC SURVEY IN 2020 AND 2022.

INSTALLED	NORTHING	EASTING	ELEV
KWL-SPIKE-7250	5437626.469	508059.860	2.845
KWL-SPIKE-7263	5437589.188	507833.209	3.360

MONUMENTS	NORTHING	EASTING	ELEV
801256	5435611.076	503789.390	3.412
801257	5435415.629	503130.040	3.356
5640	5437481.455	510110.420	10.636
801258	5435225.979	502317.797	3.278
5616	5437881.115	508673.408	0.771
5253	5437939.989	509139.707	0.729
5893	5437651.958	508003.136	2.739
801267	5433024.238	497190.868	3.275

DMAF NATURE-BASED COASTAL ADAPTATION
COASTAL FORESHORE ENHANCEMENT PROJECT
SITE S2

KERR WOOD LEIDAL
consulting engineers

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

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A	2021-02-25	MS	SB	AJK	ISSUED FOR CLIENT REVIEW
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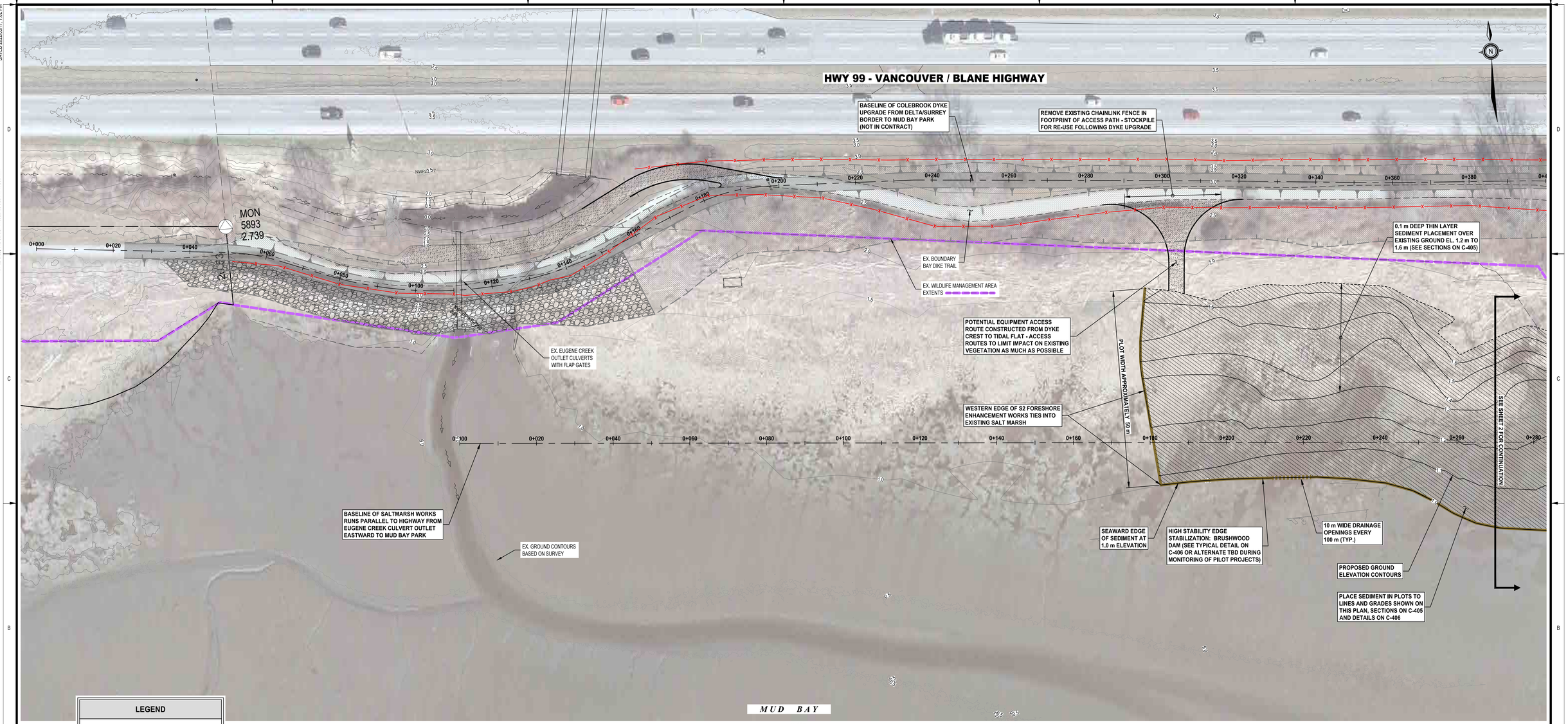
C	2022-05-09	ARM	SB	DNM	ISSUED FOR 70% DESIGN

Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

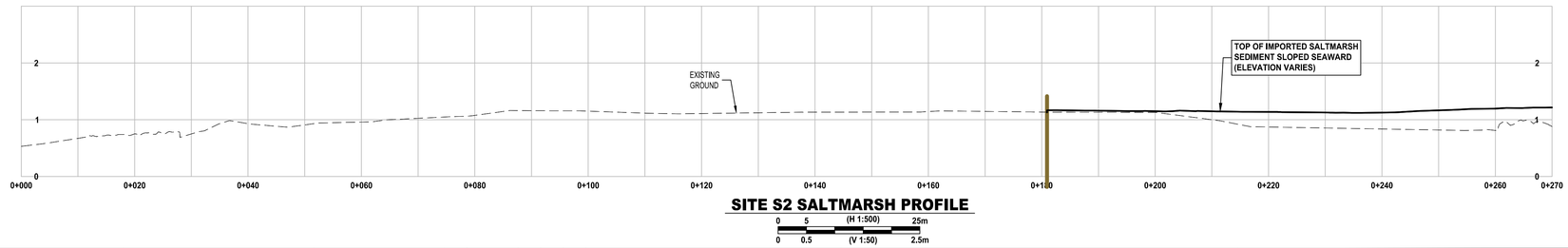
COASTAL FORESHORE ENHANCEMENT PROJECT
SITE S2 - LOCATION MAP, SITE MAP
DRAWING LIST & SURVEY CONTROL

Project No.	Drawing No.	Rev.
0471-336	G-401	C
Group: CIVIL		



LEGEND

- SALTMARSH SEDIMENT
- BRUSHWOOD DAM
- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- 0.5 EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL



SITE S2 SALTMARSH PROFILE

0 5 (H 1:500) 25m
0 0.5 (V 1:50) 2.5m

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

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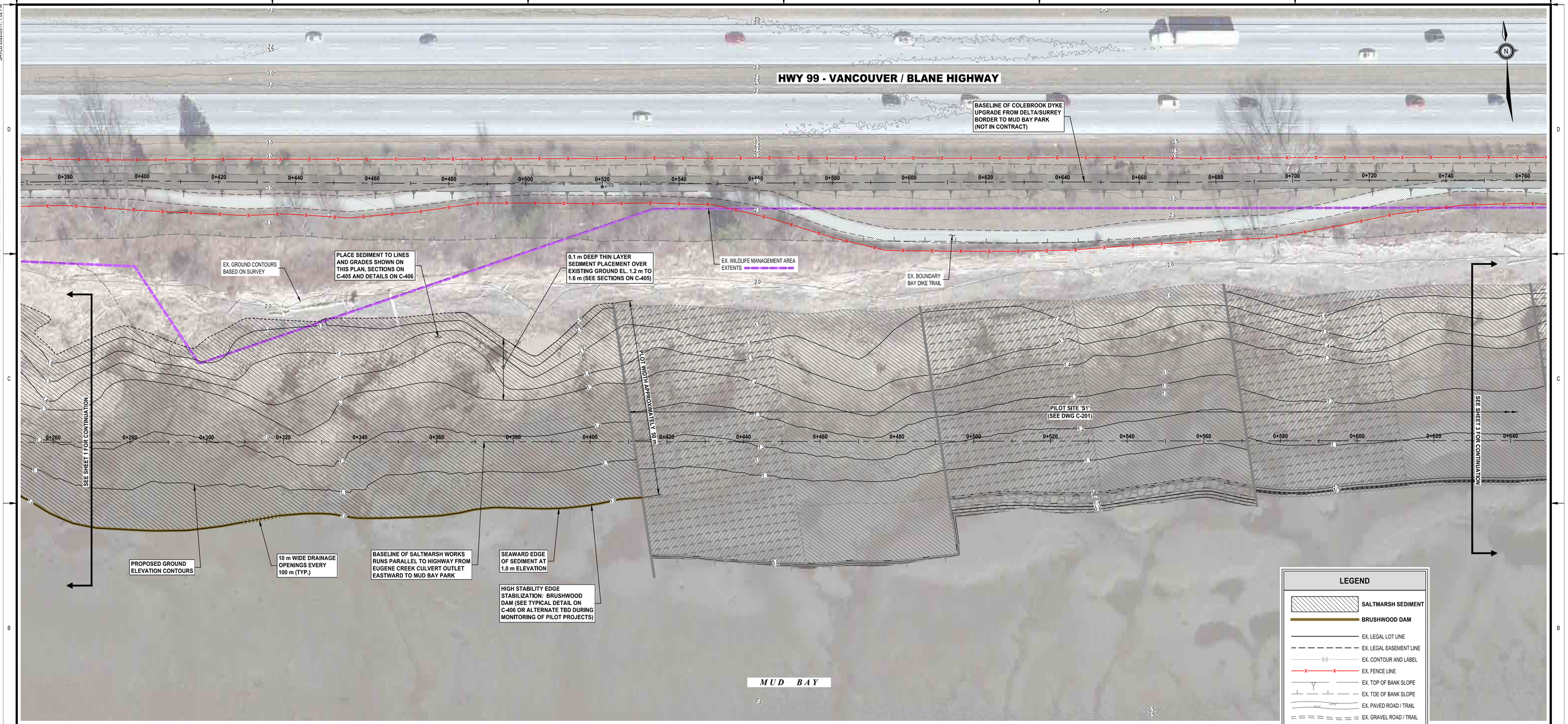
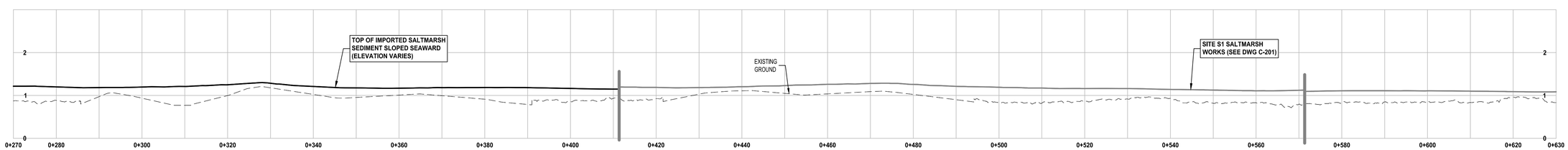
CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S2
GRADING PLAN - SHEET 1

Project No. 0471-336
Group CIVIL
Drawing No. C-401
Rev. C





SITE S2 SALTMARSH PROFILE

0 5 (H 1:500) 25m
0 0.5 (V 1:50) 2.5m

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PRELIMINARY
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Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT SITE S2 GRADING PLAN - SHEET 2

Project No.	Drawing No.	Rev.
0471-336	C-402	C
Group: CIVIL		

HWY 99 - VANCOUVER / BLANE HIGHWAY

BASELINE OF COLEBROOK DYKE UPGRADE FROM DELTA/SURREY BORDER TO MUD BAY PARK (NOT IN CONTRACT)

EX. WILDLIFE MANAGEMENT AREA EXTENTS

EX. BOUNDARY BAY DIKE TRAIL

0.1 m DEEP THIN LAYER SEDIMENT PLACEMENT OVER EXISTING GROUND EL. 1.2 m TO 1.6 m (SEE SECTIONS ON C-405)

PLOT WIDTH APPROXIMATELY 50 m

SEE SHEET 7 FOR CONTINUATION

SEE SHEET 4 FOR CONTINUATION

BASELINE OF SALTMARSH WORKS RUNS PARALLEL TO HIGHWAY FROM EUGENE CREEK CULVERT OUTLET EASTWARD TO MUD BAY PARK

PROPOSED GROUND ELEVATION CONTOURS

PLACE SEDIMENT IN PLOTS TO LINES AND GRADES SHOWN ON THIS PLAN. SECTIONS ON C-405 AND DETAILS ON C-406

10 m WIDE DRAINAGE OPENINGS EVERY 100 m (TYP.)

HIGH STABILITY EDGE STABILIZATION: BRUSHWOOD DAM (SEE TYPICAL DETAIL ON C-406 OR ALTERNATE TBC DURING MONITORING OF PILOT PROJECTS)

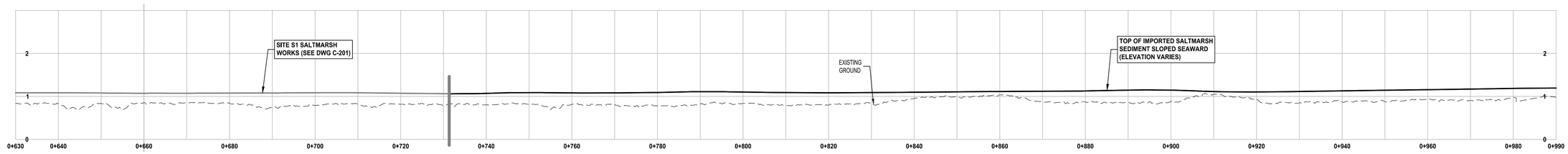
SEAWARD EDGE OF SEDIMENT AT 1.0 m ELEVATION

LEGEND

- SALTMARSH SEDIMENT
- BRUSHWOOD DAM
- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL

MUD BAY

0 5 (1:500) 25m



SITE S2 SALTMARSH PROFILE

0 5 (H 1:500) 25m
0 0.5 (V 1:50) 2.5m

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PRELIMINARY
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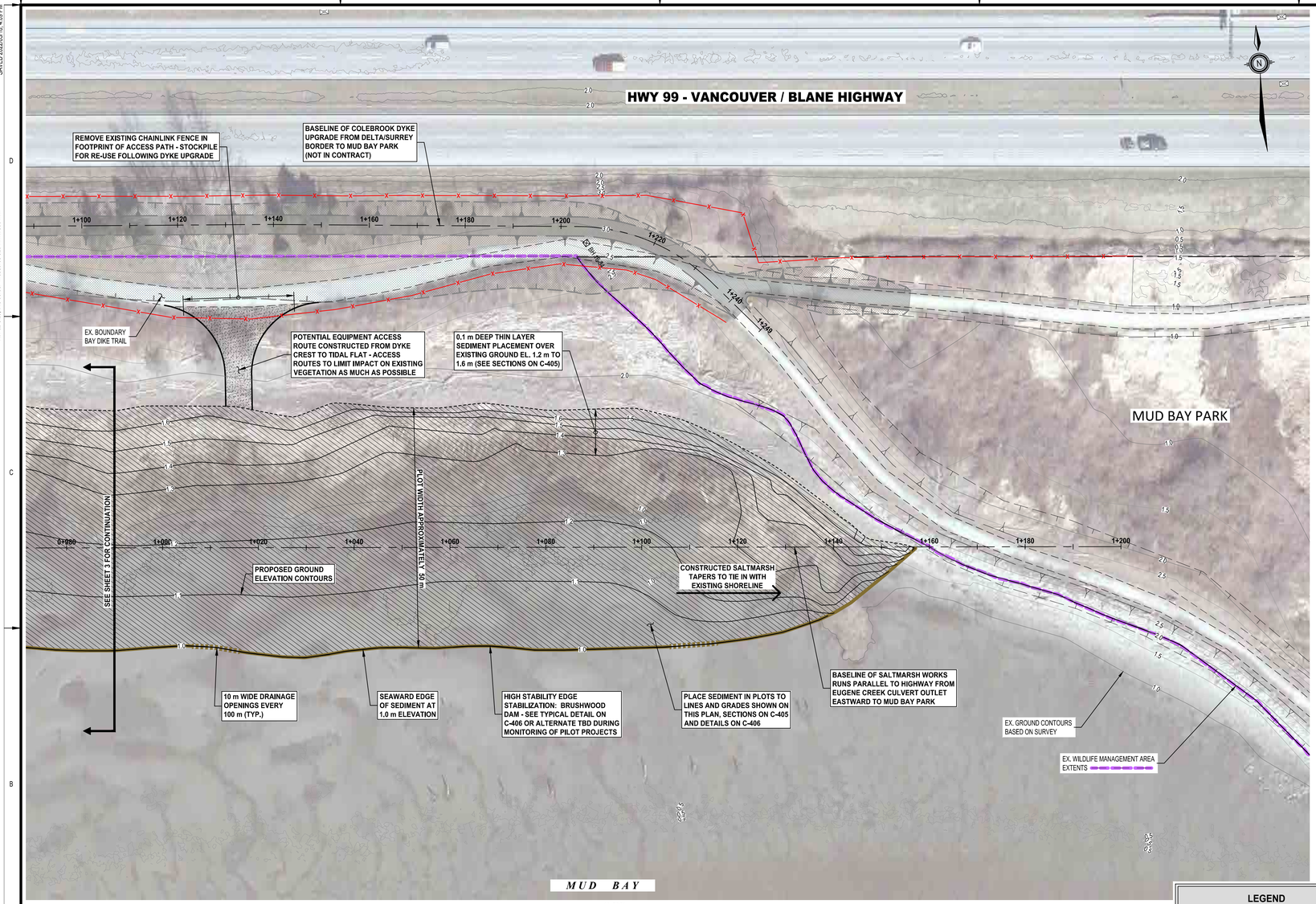
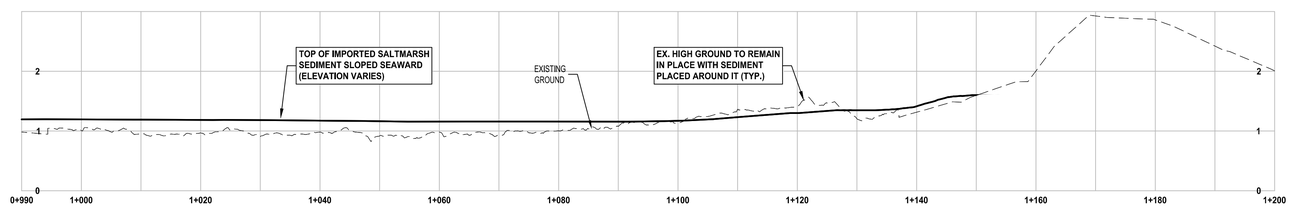
CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
SITE S2
GRADING PLAN - SHEET 3

Project No.	Drawing No.	Rev.
0471-336	C-403	C
Group: CIVIL		





SITE S2 SALTMARSH PROFILE

0 5 (H 1:500) 25m
0 0.5 (V 1:50) 2.5m

LEGEND

- SALTMARSH SEDIMENT
- BRUSHWOOD DAM
- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL

KERR WOOD LEIDAL
consulting engineers

PRELIMINARY
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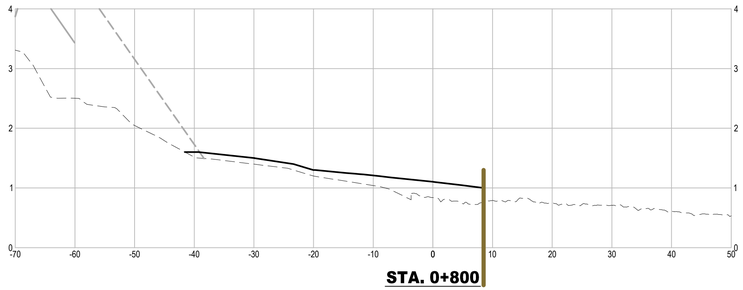
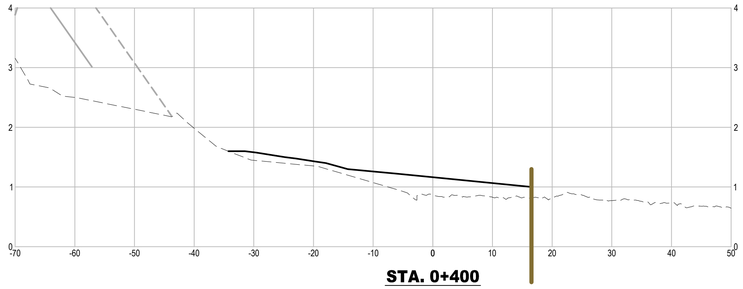
CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
SITE S2
GRADING PLAN - SHEET 4

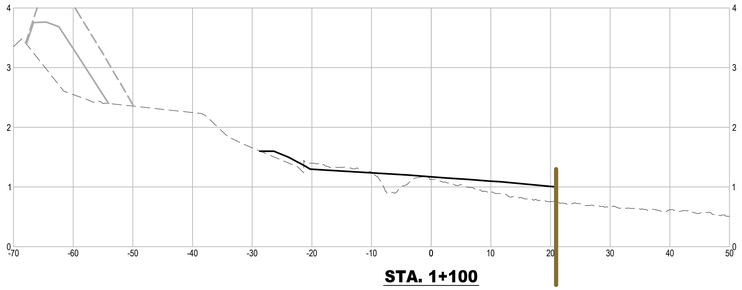
Project No.	Drawing No.	Rev.
0471-336	C-404	C
Group: CIVIL		



STA. 0+800

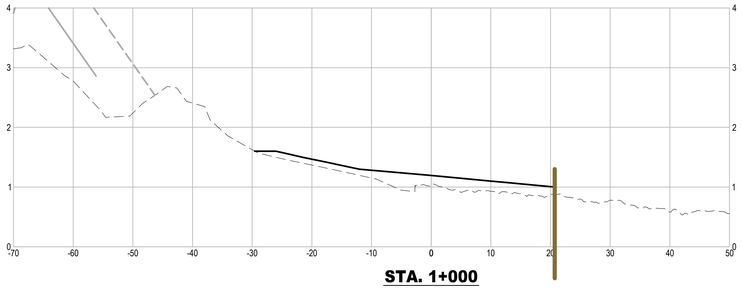


STA. 0+400

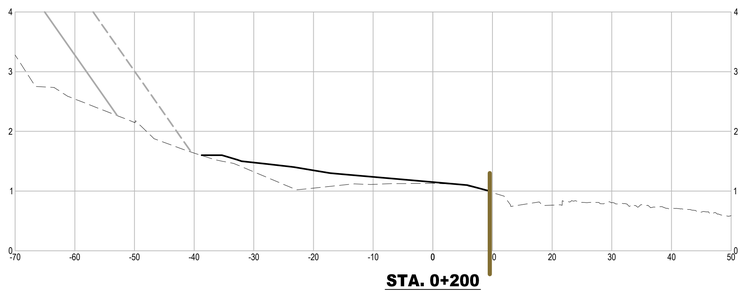


STA. 1+100

STA. 0+300
SITE S2 TYPICAL SECTION



STA. 1+000



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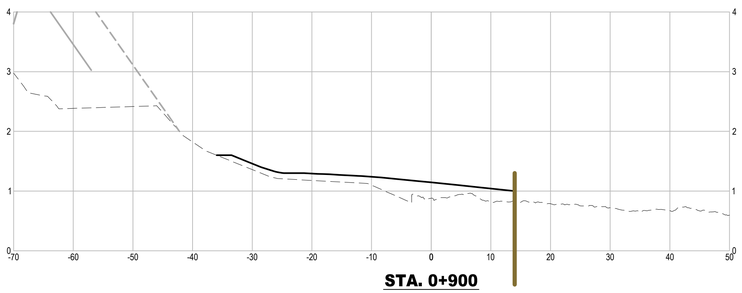

STA. 0+900

0 5 (H 1:500) 25m
0 0.5 (V 1:50) 2.5m

KERR WOOD LEIDAL
consulting engineers

PRELIMINARY
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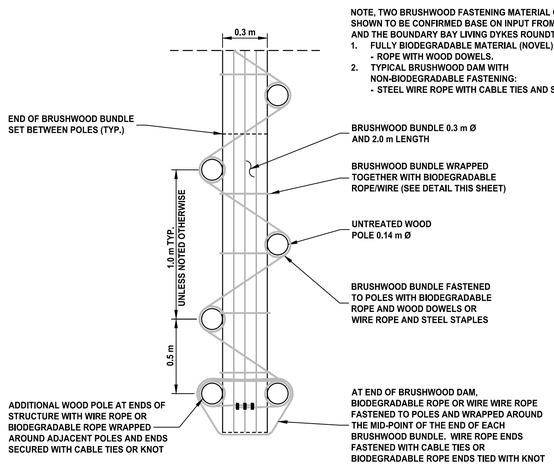
CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
SITE S2
CIVIL SECTIONS

Project No. 0471-336
Drawing No. C-405
Rev. C
Group CIVIL

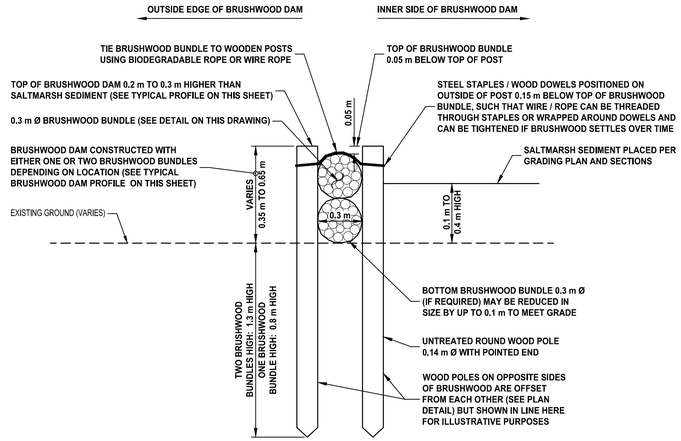


NOTE, TWO BRUSHWOOD FASTENING MATERIAL OPTIONS SHOWN TO BE CONFIRMED BASE ON INPUT FROM CLIENT AND THE BOUNDARY BAY LIVING DYKES ROUNDTABLE:

1. FULLY BIODEGRADABLE MATERIAL (NOVEL):
   - ROPE WITH WOOD DOWELS.
2. TYPICAL BRUSHWOOD DAM WITH NON-BIODEGRADABLE FASTENING:
   - STEEL WIRE ROPE WITH CABLE TIES AND STAPLES.

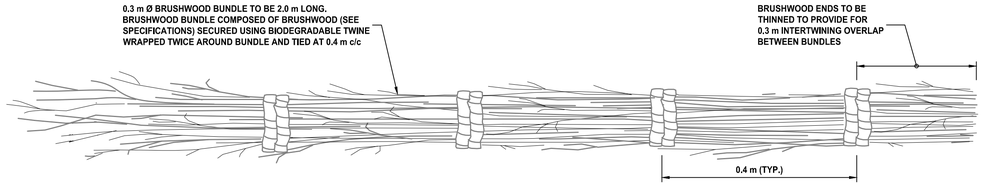
BRUSHWOOD DAM - PLAN DETAIL

Scale 1:20



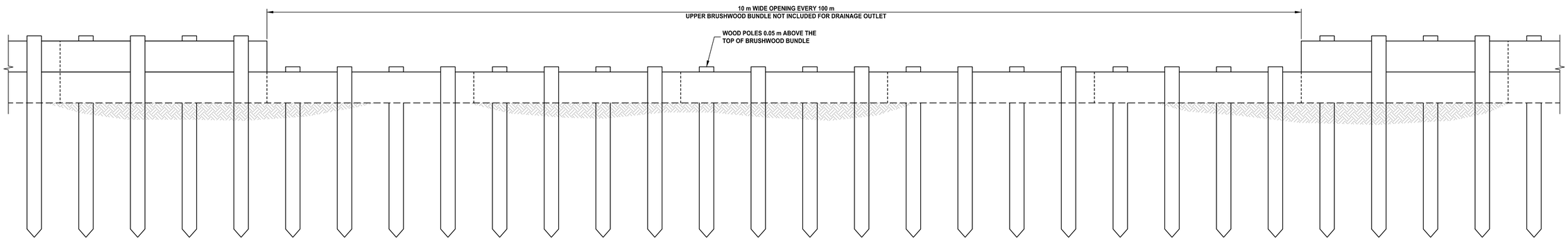
BRUSHWOOD DAM - TYPICAL SECTION

Scale 1:20



BRUSHWOOD BUNDLE DETAIL - PLAN

N.T.S.



BRUSHWOOD DAM DRAINAGE OPENING DETAIL

SCALE 1:20

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

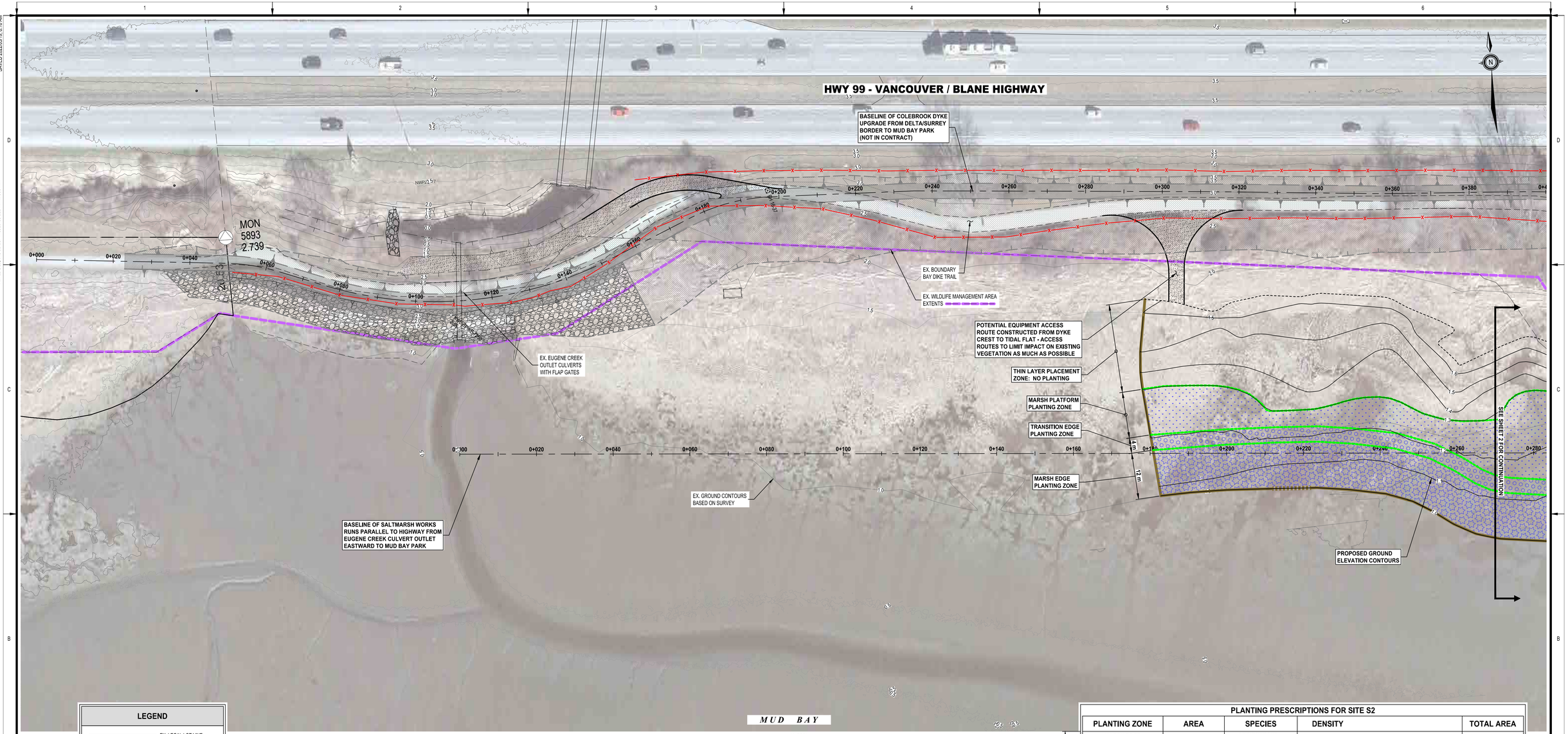
Rev	Date	Des	Dwn	Chk	Description
A	2021-02-26	MS	MAR		ISSUED FOR CLIENT REVIEW
B	2022-02-11	ARM	LA	DNM	ISSUED FOR 50% DESIGN
C	2022-02-25	ARM	SB	EM	UPDATED 50% DESIGN BASED ON CLIENT REVIEW
D	2022-05-18	ARM	SB	DNM	ISSUED FOR 70% DESIGN

Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S2
TYPICAL DETAILS

Project No. 0471-336
Drawing No. C-406
Rev. D
Group CIVIL



LEGEND

- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL

PLANTING STRATEGY (SPACED SINGLE PLUGS OR GROUPS OF THREE PLUGS) TO BE SELECTED BASED ON MONITORING OF D1 AND S1 PILOT PROJECTS

PLANTING PRESCRIPTIONS FOR SITE S2

PLANTING ZONE	AREA	SPECIES	DENSITY	TOTAL AREA
MARSH EDGE SPACED GROUPED	12 m WIDE BAND AT EDGE OF MARSH	• ARROWGRASS • PICKLEWEED • SEACOAST BULRUSH • SALTGRASS • SEA MILKWORT	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	7,767 m²
TRANSITION MARSH SPACED GROUPED	4 m WIDE BAND LANDWARDS OF THE MARSH EDGE	• ARROWGRASS • PICKLEWEED • SALTGRASS	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	2,499 m²
MARSH PLATFORM SPACED GROUPED	REMAINDER OF MARSH AREA, EXCEPT THE THIN LAYER PLACEMENT ZONE	• ARROWGRASS • PICKLEWEED • PACIFIC ALKALI GRASS • SALTGRASS • SEA MILKWORT • FOXTAIL BARLEY • BALTIC RUSH • SEASIDE PLANTAIN	• EVENLY SPACED PLUGS: PLUGS SPACED 1.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 2.5 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD). • WIDER SPACING TO ENCOURAGE NATURAL RECRUITMENT.	10,489 m²
THIN LAYER PLACEMENT: NO PLANTING	OVER EXISTING MARSH PLATFORM AS SHOWN ON DWGS.	• NA - NO PLANTING	• NA - NO PLANTING	

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

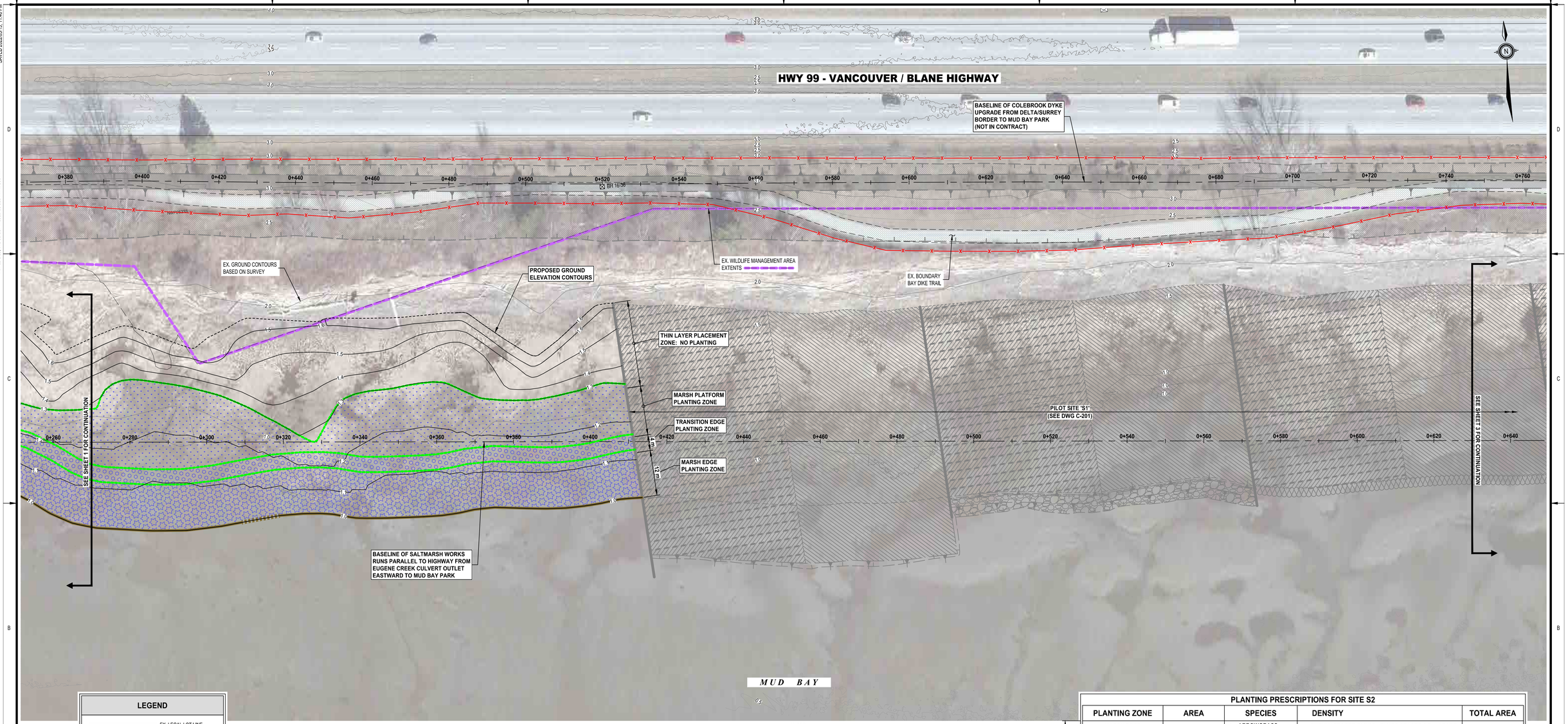
Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2022-05-18	ARM	SB	GW	ISSUED FOR 70% DESIGN

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT
PILOT SITE S2
PLANTING PLAN - SHEET 1

Project No. 0471-336
Drawing No. L-401
Rev. A
Group CIVIL



LEGEND

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- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL

PLANTING STRATEGY (SPACED SINGLE PLUGS OR GROUPS OF THREE PLUGS) TO BE SELECTED BASED ON MONITORING OF D1 AND S1 PILOT PROJECTS

PLANTING PRESCRIPTIONS FOR SITE S2

PLANTING ZONE	AREA	SPECIES	DENSITY	TOTAL AREA
MARSH EDGE (SPACED / GROUPED)	12 m WIDE BAND AT EDGE OF MARSH	• ARROWGRASS • PICKLEWEED • SEACOAST BULRUSH • SALTGRASS • SEA MILKWORT	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	7,767 m²
TRANSITION MARSH (SPACED / GROUPED)	4 m WIDE BAND LANDWARDS OF THE MARSH EDGE	• ARROWGRASS • PICKLEWEED • SALTGRASS	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	2,499 m²
MARSH PLATFORM (SPACED / GROUPED)	REMAINDER OF MARSH AREA, EXCEPT THE THIN LAYER PLACEMENT ZONE	• ARROWGRASS • PICKLEWEED • PACIFIC ALKALI GRASS • SALTGRASS • SEA MILKWORT • FOXTAIL BARLEY • BALTIC RUSH • SEASIDE PLANTAIN	• EVENLY SPACED PLUGS: PLUGS SPACED 1.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 2.5 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD). • WIDER SPACING TO ENCOURAGE NATURAL RECRUITMENT.	10,489 m²
THIN LAYER PLACEMENT: NO PLANTING	OVER EXISTING MARSH PLATFORM AS SHOWN ON DWGS.	• NA - NO PLANTING	• NA - NO PLANTING	

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

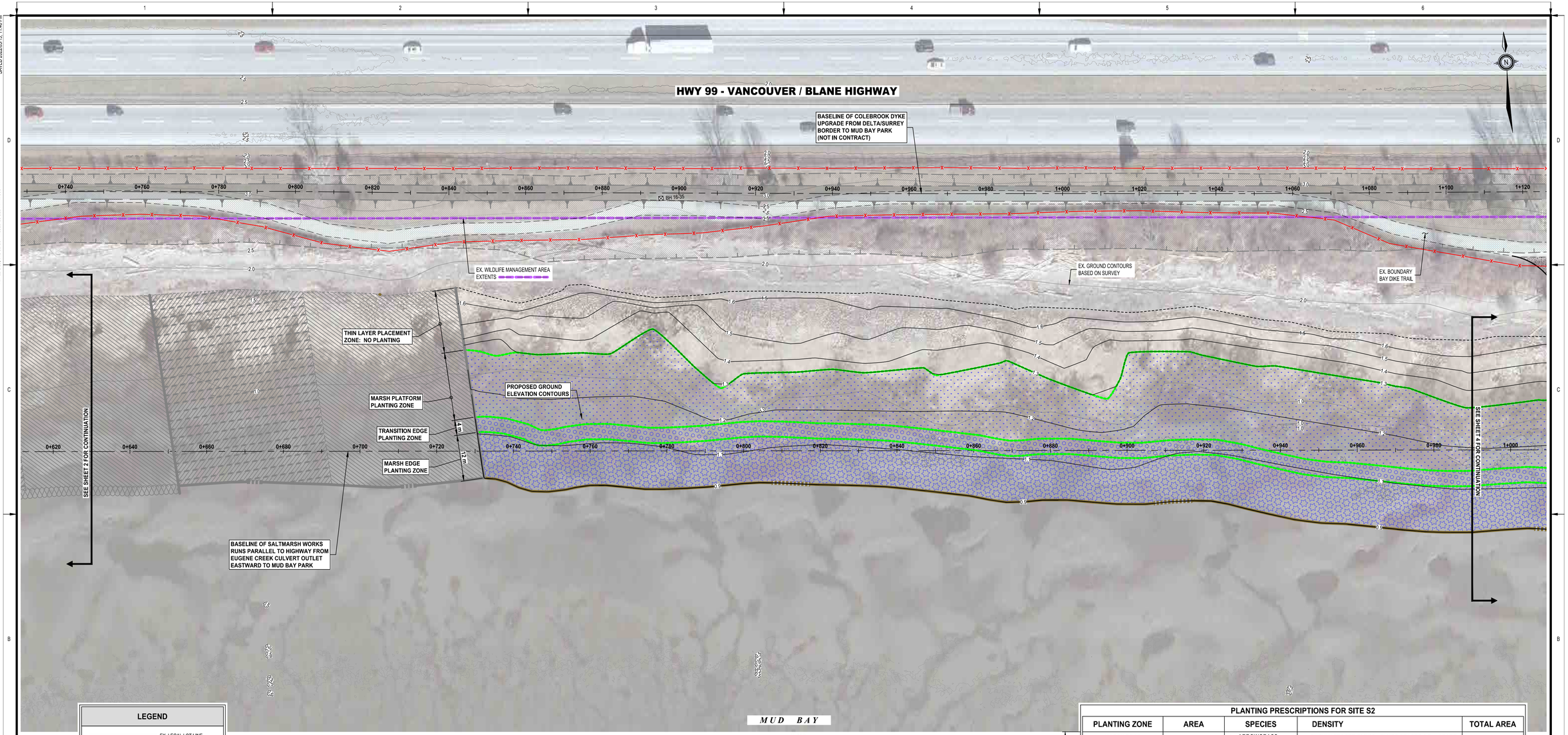
Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2022-05-18	ARM	SB	GW	ISSUED FOR 70% DESIGN

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT SITE S2
PLANTING PLAN - SHEET 2

Project No. 0471-336
Group CIVIL
Drawing No. L-402
Rev. A



LEGEND

- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL

PLANTING STRATEGY (SPACED SINGLE PLUGS OR GROUPS OF THREE PLUGS) TO BE SELECTED BASED ON MONITORING OF D1 AND S1 PILOT PROJECTS

PLANTING PRESCRIPTIONS FOR SITE S2

PLANTING ZONE	AREA	SPECIES	DENSITY	TOTAL AREA
MARSH EDGE (SPACED / GROUPED)	12 m WIDE BAND AT EDGE OF MARSH	• ARROWGRASS • PICKLEWEED • SEACOAST BULRUSH • SALTGRASS • SEA MILKWORT	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	7,767 m^2
TRANSITION MARSH (SPACED / GROUPED)	4 m WIDE BAND LANDWARDS OF THE MARSH EDGE	• ARROWGRASS • PICKLEWEED • SALTGRASS	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	2,499 m^2
MARSH PLATFORM (SPACED / GROUPED)	REMAINDER OF MARSH AREA, EXCEPT THE THIN LAYER PLACEMENT ZONE	• ARROWGRASS • PICKLEWEED • PACIFIC ALKALI GRASS • SALTGRASS • SEA MILKWORT • FOXTAIL BARLEY • BALTIC RUSH • SEASIDE PLANTAIN	• EVENLY SPACED PLUGS: PLUGS SPACED 1.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 2.5 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD). • WIDER SPACING TO ENCOURAGE NATURAL RECRUITMENT.	10,489 m^2
THIN LAYER PLACEMENT: NO PLANTING	OVER EXISTING MARSH PLATFORM AS SHOWN ON DWGS.	• NA - NO PLANTING	• NA - NO PLANTING	

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PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

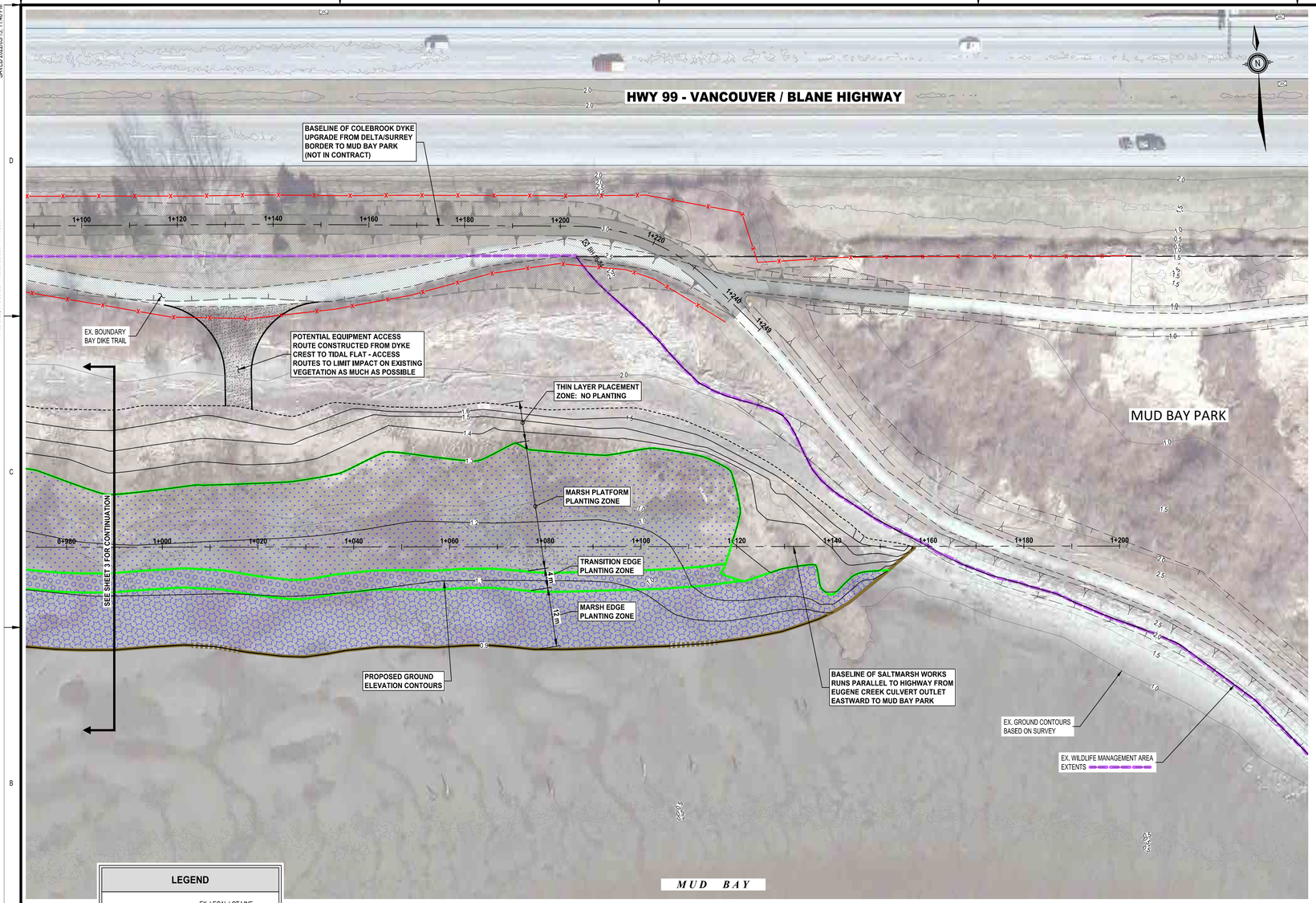
Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2022-05-18	ARM	SB	GW	ISSUED FOR 70% DESIGN

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT SITE S2
PLANTING PLAN - SHEET 3

Project No. 0471-336
Group CIVIL
Drawing No. L-403
Rev. A



LEGEND

- EX. LEGAL LOT LINE
- EX. LEGAL EASEMENT LINE
- EX. CONTOUR AND LABEL
- EX. FENCE LINE
- EX. TOP OF BANK SLOPE
- EX. TOE OF BANK SLOPE
- EX. PAVED ROAD / TRAIL
- EX. GRAVEL ROAD / TRAIL

PLANTING STRATEGY (SPACED SINGLE PLUGS OR GROUPS OF THREE PLUGS) TO BE SELECTED BASED ON MONITORING OF D1 AND S1 PILOT PROJECTS

PLANTING PRESCRIPTIONS FOR SITE S2

PLANTING ZONE	AREA	SPECIES	DENSITY	TOTAL AREA
MARSH EDGE SPACED GROUPED	12 m WIDE BAND AT EDGE OF MARSH	• ARROWGRASS • PICKLEWEED • SEACOAST BULRUSH • SALTGRASS • SEA MILKWORT	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	7,767 m^2
TRANSITION MARSH SPACED GROUPED	4 m WIDE BAND LANDWARDS OF THE MARSH EDGE	• ARROWGRASS • PICKLEWEED • SALTGRASS	• EVENLY SPACED PLUGS: PLUGS SPACED 0.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 1.0 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD).	2,499 m^2
MARSH PLATFORM SPACED GROUPED	REMAINDER OF MARSH AREA, EXCEPT THE THIN LAYER PLACEMENT ZONE	• ARROWGRASS • PICKLEWEED • PACIFIC ALKALI GRASS • SALTGRASS • SEA MILKWORT • FOXTAIL BARLEY • BALTIC RUSH • SEASIDE PLANTAIN	• EVENLY SPACED PLUGS: PLUGS SPACED 1.5 m APART. • GROUPED PLUGS: 3 PLUGS PLANTED TOGETHER AND SPACED 2.5 m FROM ADJACENT GROUP. • ALTERNATING ROWS MOVING SHOREWARD (CHECKERBOARD). • WIDER SPACING TO ENCOURAGE NATURAL RECRUITMENT.	10,489 m^2
THIN LAYER PLACEMENT: NO PLANTING	OVER EXISTING MARSH PLATFORM AS SHOWN ON DWGS.	• NA - NO PLANTING	• NA - NO PLANTING	

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consulting engineers

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

Info:

Seal:

Rev	Date	Des	Dwn	Chk	Description
A	2022-05-18	ARM	SB	GW	ISSUED FOR 70% DESIGN

Rev	Date	Des	Dwn	Chk	Description

CITY OF SURREY
DMAF NATURE-BASED COASTAL CLIMATE ADAPTATION

COASTAL FORESHORE ENHANCEMENT PROJECT SITE S2
PLANTING PLAN - SHEET 4

Project No.	Drawing No.	Rev.
0471-336	L-404	A
Group: CIVIL		

Appendix A4

Mud Bay Wildlife Species at Risk

Table A4.1 Wildlife Species Observed in Mud Bay Which Are Provincially or Federally at Risk (CDC 2022; GBIF 2022).

Group	Common Name	Scientific Name	BC List	SARA	General Habitat	Comments
Insects	Audouin's Night-stalking Tiger Beetle	*Omus audouini*	Red	T	Coniferous forests, forest-meadow transitions, coastal bluffs, and beaches. Open or shaded ground; often hard-packed, moist or dry soil consisting of clay or loamy sand and covered with needles or grassy vegetation. Larval habitat: inclined slopes, burrows (20-35 cm deep) dug into hard-packed soil. Adults often hiding under logs, stones, dead leaves, etc., during the day. Source: Larochelle and Lariviere (2001).	Larvae may occur year-round; adults active late spring and summer.
Insects	Blue Dasher	*Pachydiplax longipennis*	Blue	-	Ponds and lakes with abundant vegetation in the water and along the shore.	
Owls	Short-eared Owl	*Asio flammeus*	Blue	SC	Broad expanses of open land with low vegetation for nesting and foraging are required. Habitat types frequently mentioned as suitable include fresh and saltwater marshes, bogs, dunes, prairies, grassy plains, old fields, tundra, moorlands, river valleys, meadows, savanna, open woodland, and heathland. Nests on ground, generally in slight depression, often beside or beneath a bush or clump of grass.	Breeds and overwinters in the area.
Passerines	Lark Sparrow	*Chondestes grammacus*	Blue	-	Nonbreeding habitats include agricultural areas, suburban gardens, oak woodlands, chaparral, and mesquite/acacia grassland.	Not expected to occur.
Passerines	Bank Swallow	*Riparia*	Yellow	T	Open and partly open situations, near flowing water. Nests in burrows in steep sand, dirt, or gravel banks. Individuals tend to return to same nesting area in successive years.	May occur during migration.
Passerines	Barn Swallow	*Hirundo rustica*	Blue	T	Open habitats, frequently near water. Nests in barns or other buildings, under bridges, in caves or cliff crevices, usually on vertical surface close to ceiling. Commonly reuses old nests. Usually returns to same nesting area in successive years.	May occur in breeding season.
Passerines	Purple Martin	*Progne subis*	Blue	-	Open and partly open habitats, frequently near water or around towns. Nests in tree cavities, abandoned woodpecker holes, crevices in rocks, bird-houses, and other human-made structures.	May occur in breeding season.
Passerines	Olive-sided Flycatcher	*Contopus cooperi*	Blue	T	Breeds in various forest and woodland habitats. Most nesting sites contain dead standing trees, which are used as singing and feeding perches. Nests are placed most often in conifers.	May occur in breeding season.

BC List: Red = at risk of being lost (extirpated, endangered or threatened), Blue = of special concern, Yellow = apparently secure or secure; SARA-Schedule 1: E = endangered, T = threatened, SC = Special Concern; table excludes species of Special Concern which are yellow-listed (not at risk) in BC.

Table A4.1 (Cont'd.)

Group	Common Name	Scientific Name	BC List	SARA	General Habitat	Comments
Pigeons and doves	Band-tailed Pigeon	*Patagioenas fasciata*	Blue	SC	In coastal British Columbia (BC), breeds from sea level to 760 m elevation in natural and human-made habitats including edges and openings in mature coniferous, mixed and deciduous forests, city yards and parks, wooded groves, open bushland, golf courses and orchards.	May occur in breeding season.
Raptors	Rough-legged Hawk	*Buteo lagopus*	Blue	-	Nonbreeding habitat in grasslands, fields, marshes, sagebrush flats, and open cultivated areas; sometimes rat-infested garbage dumps. Breeds in the arctic and subarctic.	May occur in non-breeding season.
Shorebirds and allies	Marbled Murrelet	*Brachyramphus marmoratus*	Blue	T	Coastal areas, mainly in salt water within 2 km of shore; not uncommon up to 5 km offshore; occasionally also on rivers and lakes usually within 20 km of ocean, especially during breeding season. Nests often are in mature/old growth coniferous forests near the coast: on large mossy horizontal branches, mistletoe infection, witches broom, or other structures providing a platform high in mature conifer (e.g., Douglas-fir, mountain hemlock). Most nesting occurs in large stands of old growth.	May occur in non-breeding season, but suitable nesting habitat not available.
Shorebirds and allies	Common Murre	*Uria aalge*	Red	-	Pelagic and along rocky seacoasts. Nests in the open or in crevices on cliff ledges, cliff tops, and flat, rocky, low-lying islands; less commonly nests under boulders or in caves; usually nests in same site in successive years.	May occur year-round.
Shorebirds and allies	American Golden-Plover	*Pluvialis dominica*	Blue	-	Short grasslands, pastures, golf courses, mudflats, sandy beaches, and flooded fields.	May occur during migration.
Shorebirds and allies	California Gull	*Larus californicus*	Blue	-	Seacoasts, bays, estuaries, mudflats, marshes, irrigated fields, lakes, ponds, dumps, cities, and agricultural lands. In autumn migration, the most abundant gull in pelagic waters off the BC.	May occur during migration.
Shorebirds and allies	American Avocet	*Recurvirostra americana*	Blue	-	Lowland marshes, mudflats, ponds, alkaline lakes, and estuaries.	
Shorebirds and allies	Hudsonian Godwit	*Limosa haemastica*	Red	-	Non-breeding habtiat is marshes, beaches, flooded fields, tidal mudflats, and lake and pond shores.	May occur during migration.
Shorebirds and allies	Parasitic Jaeger	*Stercorarius parasiticus*	Red	-	During non-breeding period, mostly pelagic, less frequently along seacoasts, casually on large inland bodies of water.	May occur during migration.
Shorebirds and allies	Red Knot	*Calidris canutus*	Red	T	Primarily seacoasts on tidal flats and beaches, less frequently in marshes and flooded fields. On sandy or pebbly beaches, especially at river mouths; feeds on mudflats.	May occur during migration.

BC List: Red = at risk of being lost (extirpated, endangered or threatened), Blue = of special concern, Yellow = apparently secure or secure; SARA-Schedule 1: E = endangered, T = threatened, SC = Special Concern; table excludes species of Special Concern which are yellow-listed (not at risk) in BC.

Table A4.1 (Cont'd.)

Group	Common Name	Scientific Name	BC List	SARA	General Habitat	Comments
Shorebirds and allies	Caspian Tern	*Hydroprogne caspia*	Blue	-	Seacoasts, bays, estuaries, lakes, marshes, and rivers. Nests on sandy or gravelly beaches and shell banks along coasts or large inland lakes; sometimes with other waterbirds. Pacific coast populations formerly nested mainly in inland marshes, now mainly on human-created habitats (e.g., dikes).	May occur during breeding/migration.
Shorebirds and allies	Short-billed Dowitcher	*Limnodromus griseus*	Blue	-	Nonbreeding habitats include mudflats, estuaries, shallow marshes, pools, ponds, flooded fields and sandy beaches. Prefers shallow salt water with soft muddy bottom, but visits various wetlands during migration.	May occur during migration.
Shorebirds and allies	Long-billed Curlew	*Numenius americanus*	Blue	SC	In migration and winter occurring on beaches and mudflats. Breeding in prairies and grassy meadows, generally near water.	May occur during migration.
Shorebirds and allies	Whimbrel	*Numenius phaeopus*	Red	-	Uses beaches, tidal mudflats, marshes, estuaries, edges of tidal creeks, sandy or rocky shores, flooded fields and pastures during non-breeding season. Roosts on salt pond flats and dikes.	May occur during migration.
Shorebirds and allies	Red-necked Phalarope	*Phalaropus lobatus*	Blue	SC	In winter, primarily pelagic, sometimes occurring in migration on ponds, lakes, open marshes, estuaries, and bays, costal lagoons, salinas, sewage ponds.	May occur during migration.
Swifts and hummingbirds	Black Swift	*Cypseloides niger*	Blue	E	Aerial; forages over forests and in open areas. Nests behind or next to waterfalls and wet cliffs, on sea cliffs, in sea caves, and occasionally in limestone caves.	May occur during breeding period; suitable nesting habitat not available.
Waterbirds	Brant	*Branta bernicla*	Blue	-	In winter, this species occurs primarily in marine situations that are marshy, along lagoons, estuaries, shallow bays, and often in areas with eelgrass.	May occur during migration and non-breeding period.
Waterbirds	Long-tailed Duck	*Clangula hyemalis*	Blue	-	Coastal waters (e.g., rocky coasts, calm bays and coves), large inland lakes, and (less commonly) rivers during non-breeding period.	May occur during migration and non-breeding period.
Waterbirds	Tundra Swan	*Cygnus columbianus*	Blue	-	Lakes, sloughs, rivers, sometimes fields, in migration. Shallow lakes, ponds, and estuaries in winter.	May occur during migration and non-breeding period.
Waterbirds	Black Scoter	*Melanitta americana*	Blue	-	Mostly coastal waters, less commonly on large inland lakes and rivers when not breeding.	May occur during non-breeding period.
Waterbirds	Surf Scoter	*Melanitta perspicillata*	Blue	-	Primarily marine littoral areas, less frequently in bays or on freshwater lakes and rivers during non-breeding season.	May occur during non-breeding period.
Waterbirds	Yellow-billed Loon	*Gavia adamsii*	Blue	-	Non-breeding habitat is not well known. Generally near shore, in protected waters. Spend roughly eight months exclusively in marine environments. During migration, prefer open-water leads for resting and refueling.	May occur during non-breeding period.

BC List: Red = at risk of being lost (extirpated, endangered or threatened), Blue = of special concern, Yellow = apparently secure or secure; SARA-Schedule 1: E = endangered, T = threatened, SC = Special Concern; table excludes species of Special Concern which are yellow-listed (not at risk) in BC.

Table A4.1 (Cont'd.)

Group	Common Name	Scientific Name	BC List	SARA	General Habitat	Comments
Waterbirds	American Bittern	*Botaurus lentiginosus*	Blue	-	Nests primarily in inland freshwater wetlands, sometimes in tidal marshes or in sparsely vegetated wetlands or dry grassy uplands. Breeding occurs primarily in wetlands with tall emergent vegetation. Sparsely vegetated wetlands and dry grassy uplands are sometimes used, as are tidal marshes.	May occur in breeding season.
Waterbirds	American White Pelican	*Pelecanus erythrorhynchos*	Red	-	Habitat includes rivers, lakes, reservoirs, estuaries, bays, and open marshes, sometimes inshore marine habitats. Pelicans rest/roost on islands and peninsulas. Habitats used in winter are mainly coastal but also include also inland waters and rivers with open water. Suitable sand bars for roosting or loafing are important components of winter habitat.	Rarely occurs during migration.
Waterbirds	Great Blue Heron, fannini subspecies	*Ardea herodias*	Blue	SC	Freshwater and brackish marshes, along lakes, rivers, bays, lagoons, ocean beaches, mangroves, fields, and meadows. Nests commonly high in trees in swamps and forested areas, less commonly in bushes, or on ground, rock ledges, and coastal cliffs, often with other herons. Generally nests close to foraging habitat.	May occur year-round.
Waterbirds	Green Heron	*Butorides virescens*	Blue	-	Swamps, mangroves, marshes, and margins of ponds, rivers, lakes, and lagoons. Eggs are laid in platform nest in tree, thicket, or bush over water or sometimes in dry woodland or orchard; nests in both freshwater and brackish situations.	May occur during breeding season.
Waterbirds	Western Grebe	*Aechmophorus occidentalis*	Red	SC	Marshes, lakes, and bays; in migration and winter also sheltered seacoasts, less frequently along rivers. Nests on large inland bodies of water.	May occur in migration and wintering periods.
Waterbirds	Eared Grebe	*Podiceps nigricollis*	Blue	-	Marshes, ponds and lakes; in migration and winter also salt lakes, bays, estuaries and seacoasts. Some migrate to coast in fall, some remain inland in loose flocks on large bodies of freshwater during winter.	May occur in migration and wintering periods.
Waterbirds	Double-crested Cormorant	*Nannopterum auritum*	Blue	-	Lakes, ponds, rivers, lagoons, swamps, coastal bays, marine islands, and seacoasts; usually within sight of land. Nests on the ground or in trees in freshwater situations, and on coastal cliffs.	May occur year-round.
Waterbirds	Brandt's Cormorant	*Urile penicillatus*	Red	-	Mainly inshore coastal zone, especially in areas having kelp beds; offshore islands; less commonly, inshore on brackish bays. In winter, sheltered inlets and other quiet waters. Nests on flat or gently sloping surfaces on tops of rocky islands.	May occur year-round.

BC List: Red = at risk of being lost (extirpated, endangered or threatened), Blue = of special concern, Yellow = apparently secure or secure; SARA-Schedule 1: E = endangered, T = threatened, SC = Special Concern; table excludes species of Special Concern which are yellow-listed (not at risk) in BC.

Appendix A5

Summary of Preliminary Engagement with Public and Stakeholder Groups

Table A5.1 Summary of preliminary engagement with Public and Stakeholder Groups.

Event	Date	Notes
Lowland Dyking Stakeholder AGM	27/1/2016	Introduced CFAS and sought feedback around flood management interests and values in and around Mud Bay planning area.
Green Shores Workshop	10/11/2016	Not specifically CFAS, but informed the section of dyke now part of the “Mud Bay Foreshore Enhancements Project”
CFAS Agricultural Focus Group	3/2/2017	Introduced CFAS and sought feedback around flood management interests and values in and around Mud Bay planning area.
CFAS Residential Focus Group	7/2/2017	Introduced CFAS and sought feedback around flood management interests and values in and around larger study area, including Mud Bay.
CFAS Environmental Focus Group	8/3/2017	Introduced CFAS and sought feedback around flood management interests and values in and around larger study area with a particular focus on Mud Bay.
CFAS Open House – April 26	26/4/2017	Presentation of summary interests and concerns in and around larger study area, including Mud Bay. Participants invited to prioritize sub-values in general thematic areas.
Mud Bay Infrastructure Flood Vulnerability Assessment Workshop (PIEVC)	28/3/2017	Workshop targeted at infrastructure owners and emergency service providers using Engineers Canada PIEVC approach. The workshop was attended by 66 participants representing 28 organizations.
CFAS Survey – Phase 1	1/04/2017	CitySpeaks (the City’s survey platform) panel survey focusing on flood management values and interests in and around larger area, including Mud Bay.
Green Shores Shoreline Design workshop	11/7/2017	Early design exploration of green shores/living dyke concepts for Mud Bay. Participant interests and values around potential green shores approaches in Mud Bay.
CFAS Advisory group workshop	25/7/2017	Summary presentation of community values and interests. Exploration of Advisory Group values and interests in and around larger study area, including Mud Bay.
Regulators Meeting	17/10/2017	Presented potential directions for three study areas, with emphasis on Mud Bay. Sought feedback on agricultural concerns and interests for Mud Bay.
Coastal Land Stewards Meeting	17/11/2017	Technical workshop to identify co-benefits and provide technical rankings for several preliminary options for the Mud Bay area. The purpose of the workshop was to assess early options based on potential co-benefits. Priority benefits were identified. Habitat benefits ranked as the highest priority, followed by ecosystem service benefits and community benefits.
ALC Presentation	7/12/2017	Presented potential directions for three CFAS study areas, including Mud Bay. Sought feedback on agricultural concerns and interests for Mud Bay direction.

Event	Date	Notes
CFAS Options Survey	20/12/2017	City-wide survey. Presented potential directions for CFAS three study areas, including Mud Bay. Sought public feedback on directions.
CFAS Advisory Group Options Workshop	9/3/2018	Presented emerging directions for three study areas, including Mud Bay. Sought feedback on directions.
CFAS Open House	10/4/2018	Presented emerging directions for three study areas, including Mud Bay. Sought public feedback on directions.
Boundary Bay Living Dike Roundtable Meeting	6/6/2018	Meeting to discuss potential “Living Dike” Project and other infrastructure projects to manage flood risks and promote community resilience in Boundary Bay. Semiahmoo First Nation and Lower Fraser Fisheries Alliance participated in meeting.
Boundary Bay Living Dike Roundtable Meeting	5/7/2018	Introduced DMAF and proposed to include two Nature-Base Foreshore Enhancements Pilot Studies as part of application.
Boundary Bay Living Dike Roundtable Meeting	18/7/2018	Further discussed potential for including two Nature-Base Foreshore Enhancements Pilot Studies as part of DMAF application.
Boundary Bay Living Dike Roundtable Meeting	20/11/2018	Provided an update on Surrey’s DMAF application. Surrey requests letters of support from participants, including Tsawwassen First Nation and MOF.
Ecosystem Vulnerability Workshop	27/11/2018	Convened Boundary Bay environmental partners, agency representatives and subject matter experts to provide an update on CFAS, gather feedback on a framework for ecosystem risk assessment to prioritize issues for short to medium term adaptation and communications materials.
CFAS Advisory Group Meeting	16/5/2019	Presented final CFAS strategy and strategic directions. Introduced 13 DMAF projects including the Project.
Boundary Bay Living Dike Roundtable Meeting	25/6/2019	Continued exploration of living dike Project concept, including research goals. Presented latest information on CFAS.
Boundary Bay Living Dike Roundtable Meeting	4/9/2019	Reviewed draft Terms of Reference for Living Dike Roundtable.
CFAS Wrap-up Event	28/11/2019	Introduced 13 DMAF projects including the Project. Invited public input and feedback.
Agricultural Land Commission Endorsement	7/1/2020	Letter endorsing CFAS. Support does note that 5 metre setback that prohibits agricultural activity on expanded dykes may not be consistent with the purposes of the *Agricultural Land Commission Act.*
Boundary Bay Living Dike Roundtable Meeting	3/2/2020	Updates on the Project and procurement process, continued development of Project concept with collaborators and partners, including Semiahmoo First Nation. Chief Chappell from Semiahmoo First Nation attended meeting.
Boundary Bay Living Dike Roundtable Meeting	25/9/2020	Project discussion attended by Semiahmoo First Nation and Tsleil-Waututh First Nation.

Event	Date	Notes
Boundary Bay Living Dike Roundtable Meeting	14/10/2020	Project discussion. Chief Chappell from Semiahmoo First Nation attended meeting.
Boundary Bay Living Dike Roundtable Meeting	28/1/2021	Review of work done to date, progress, and schedule.
Boundary Bay Living Dike Roundtable Meeting	12/3/2021	Formation of Living Dike Roundtable Technical Working Group. Attended by Semiahmoo First Nation.
Boundary Bay Living Dike Roundtable – Technical Working Group Meeting	17/3/2021	Review of work done to date, progress, and schedule.
Boundary Bay Living Dike Roundtable Meeting	29/3/2021	Review of work done to date, progress, and schedule. Chief Chappell from Semiahmoo First Nation attended meeting.
Boundary Bay Living Dike Roundtable – Core Team Meeting	13/5/2021	Review of work done to date, progress, and schedule. Chief Chappell from Semiahmoo First Nation attended meeting.
Boundary Bay Living Dike Roundtable – Core Team Meeting	10/7/2021	Review of work done to date, progress, and schedule.
Boundary Bay Living Dike Roundtable – Site Tour	23/9/2021	Project site field visit hosted by Semiahmoo First Nation.
Boundary Bay Living Dike Roundtable – Core Team Meeting	7/10/2021	Review of memos and Kerr Wood Leidal Associates Ltd. (KWL) progress. Attended by Semiahmoo First Nation staff and leadership.
Boundary Bay Living Dike Roundtable – Core Team Meeting	22/10/2021	Feedback provided to memos. Attended by Semiahmoo First Nation staff and leadership.
Boundary Bay Living Dike Roundtable – Core Team Meeting	4/11/2021	Update on schedule and progress towards Project options, and logistics. Attended by Semiahmoo First Nation staff and leadership.
Boundary Bay Living Dike Roundtable – Core Team Meeting	2/12/2021	Review of work to date, progress, and schedule. Attended by Semiahmoo First Nation staff and leadership.
Boundary Bay Living Dike Roundtable – Core Team Meeting	6/1/2022	Review of work to date, progress, and schedule. Attended by Semiahmoo First Nation staff and leadership.
Boundary Bay Living Dike Roundtable – Technical Working Group Meeting	10/1/2022	Review of Project options by Technical Working Group. Attended by Semiahmoo First Nation staff and leadership.
Boundary Bay Living Dike Roundtable Meeting	28/1/2022	Review of Technical Working Group feedback, progress review, and TOR. Attended by Semiahmoo, Tsawwassen, and Tsleil-Waututh First Nations.
Boundary Bay Living Dike Roundtable – Core Team Meeting	4/2/2022	Review of work done to date, progress, schedule, and review of proposed 50% Design.
Boundary Bay Living Dike Roundtable – Core Team Meeting	3/3/2022	Review of work to date. Attended by Semiahmoo First Nation staff and leadership.
Boundary Bay Living Dike Roundtable – Technical Working Group Meeting	4/3/2022	Review of proposed 50% Design. Attended by Semiahmoo First Nation staff and leadership.

Event	Date	Notes
Boundary Bay Living Dike Roundtable Meeting	23/3/2022	Review of progress to date. Attended by Semiahmoo, Tsawwassen, and Musqueam Indian Band.
Boundary Bay Living Dike Roundtable – Core Team Meeting	28/3/2022	Indigenous plants discussion. Attended by Semiahmoo First Nation staff and leadership.
Boundary Bay Living Dike Roundtable – Core Team Meeting	4/4/2022	Partnership discussion and archaeology follow-up.
Boundary Bay Living Dike Roundtable Meeting	2/5/2022	Meeting with Semiahmoo First Nation to discuss EAC Exemption Order process options and third-party review.
Boundary Bay Living Dike Roundtable – Core Team Meeting	5/5/2022	Review of work done to date, progress, and schedule.