GRANVILLE ISLAND
MARINE STRUCTURE REPAIRS
OVERVIEW AQUATIC EFFECTS ASSESSMENT

Prepared for:
Parsons Corporation
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Prepared by:
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File: 789-010.01
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HEMMERA

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March 16, 2015
File: 789-010.01

Parsons Corporation
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Attn: Ryan Taylor, P.Eng. – Bridges, Structures and Marine Works

Dear Ryan,

Re: Granville Island Marine Structure Repairs

Hemmera Envirochem Inc. ("Hemmera") is pleased to provide you with this Final Report entitled "Granville Island Marine Structure Repairs: Overview Aquatic Effects Assessment". We have appreciated the opportunity to work with you on this project and trust that this report meets your requirements. Please feel free to contact the undersigned by phone or email regarding any questions or further information that you may require.

Regards,
Hemmera Envirochem Inc.

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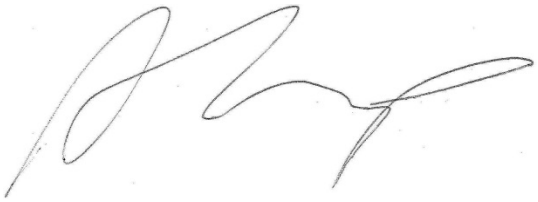

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EXECUTIVE SUMMARY

Parsons Corporation (Parsons) retained Hemmera Envirochem Inc. (Hemmera) to conduct an overview Aquatic Effects Assessment (AEA) to assess impacts associated with the replacement of various marine structures located along Granville Island (the Project). The Project consists of a series of repairs to docks and boardwalks including wooden pile replacements and repairs, concrete reinforcements, cathodic protection, rock slope reinforcement and regrading, a float and mooring system replacement and removal and demolition of select structures.

This report documents the historic and existing site conditions (based on both a literature review and site visit), a description of the proposed works, potential Project effects, mitigation measures to be applied during the implementation phase of the Project, and a self-assessment of the Project using federal Fisheries and Oceans Canada (DFO) guidance.

Based on the AEA, no long-term net loss of functional habitat is anticipated from the Project. The proposed repairs are within the general footprint of the existing marine infrastructure and, provided that the prescribed mitigation measures are implemented, no significant effects to the aquatic environment are expected. As pilings within False Creek and the Project area are used for spawning by Pacific herring (*Clupea pallasii*), a fish of commercial, recreational and Aboriginal (CRA) value, extra precaution must be taken to avoid impacts to this sensitive species. It is in our opinion that the works, as described and with implementation of the prescribed mitigation measures, will not result in “Serious Harm to fish” and as such the works do not require a review by DFO.

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1.0 INTRODUCTION

Parsons Corporation (Parsons), on behalf of the Canadian Mortgage and Housing Corporation (CMHC), retained Hemmera Envirochem Inc. (Hemmera) to conduct an Aquatic Effects Assessment (AEA) to evaluate the potential effects of marine structure repairs and replacements near Granville Island in Vancouver, British Columbia (the Project).

The Project consists of a series of repairs to docks and boardwalks including the removal and replacement of select wooden piles and concrete pedestals, pile repairs, concrete beam reinforcements, rock slope protection and regrading, and installation of cathodic protection on steel supports. In addition, replacement of the existing False Creek Ferry Landing Float and mooring system with a concrete float and steel piles is proposed.

This report describes the results of both a literature review and site visit (conducted on February 21, 2015), to assess potential Project-related effects to the marine environment focussing on an assessment of the existing habitat at and adjacent to the Project area. Mitigation measures to be applied during the Project implementation phase are presented. Existing information and site visit results were used to conduct a self-assessment to determine whether “Serious Harm” to fish would result.

2.0 PROJECT LOCATION

The Project area incudes various sites located along the shores of Granville Island, within False Creek in Vancouver, BC (**Figure 1** and **Figure 2**).

The Project involves repairs and/or upgrades to marine structures located at the Maritime Market Boardwalk, Lions Gate Dock, Bridges Dock, West Dock, the Public Market Wharf and Trestle, the Public Market Boardwalk and Sheet Pile Walls, the Northeast Seawall and Boardwalk, and the False Creek Ferry Landing Float (**Figure 3**). In addition cathodic protection of 161 piles located throughout the island is proposed.

Figure 1 Regional Map Depicting the Project Location on Granville Island, Vancouver, BC

Figure 2 Orthophotograph Depicting the General Project Location on Granville Island

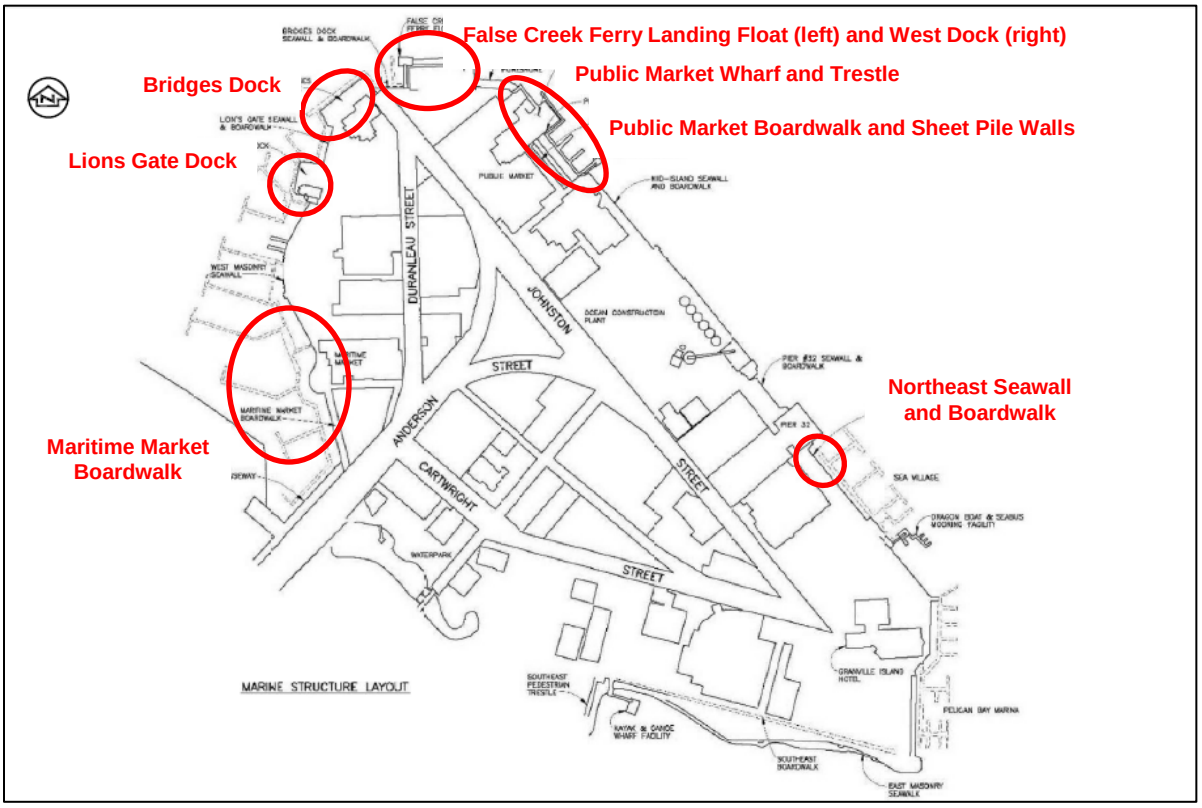


Figure 3 Plan View Showing the Locations of Various Marine Structures Requiring Repairs along Granville Island

3.0 SITE HISTORY

Prior to urbanization and industrialization, False Creek was reported to support an abundance of fish including salmon, eulachon, herring, perch, flounder and rock cod and shellfish including oysters, clams, crabs and mussels (Brauer 2007). The area that would become Granville Island was originally a fertile fishing ground consisting of two sandbars within False Creek (CMHC-Granville Island 2015).

In the early 1900s the area was transformed when it was infilled with dredged material for industrial land reclamation which resulted in a large loss and alteration of fish habitat. Following the reclamation, tenants from several industries serving the forest, mining, construction and shipping sectors began to establish (**Photo 1**). By 1923, most of the lots on Granville Island were occupied with factories manufacturing industrial goods and machinery (**Photo 2**). Waste and other pollutants were routinely discharged directly into False Creek further degrading the aquatic habitat. However, in the mid-1950s demand for heavy industrial input declined and businesses began relocating out of the inner-city location. By the late 1970s, Granville Island began to change and was converted from a declining 37-acre industrial wasteland to one of the most successful urban redevelopments in North America. Today Granville Island is extensively used as a tourism district and houses numerous facilities including a large public market, theatres, galleries and shopping areas. Marinas and several boat servicing companies are located along the shores of the island. Two companies, False Creek Ferries and Aquabus provide ferry service from Granville Island to other Vancouver waterfront locations (CMHC-Granville Island 2015).

Photo 1 Development of Granville Island in 1917 (City of Vancouver Archives)

Photo 2 View of False Creek and Granville Island in 1939 (City of Vancouver Archives)

4.0 CURRENT ENVIRONMENT

The following description of the existing environment is based on a literature review and information collected during a site visit conducted on February 21, 2015. The site visit was conducted to confirm the current biophysical conditions and habitat values of the area and to assess potential Project-related effects. The site visit included visual observations of the intertidal and shallow subtidal areas during a moderately low tide between 1330h and 1430h (low tide of +1.64 m above Chart Datum at 1353h).

The following sources of information were reviewed prior to the site visit to determine the likelihood of sensitive marine habitats including eelgrass and kelp beds, and commercial and recreational fisheries:

- iMapBC;
- Sensitive Habitat Inventory and Mapping (SHIM);
- Community Mapping Network Fraser River Estuary Management Program (FREMP) – Burrard Inlet Environmental Action Program (BIEAP) Habitat Atlas;
- BC Coastal Resource Information Management System (CRIMS database); and
- BC Conservation Data Centre (CDC) Species and Ecosystem Explorer.

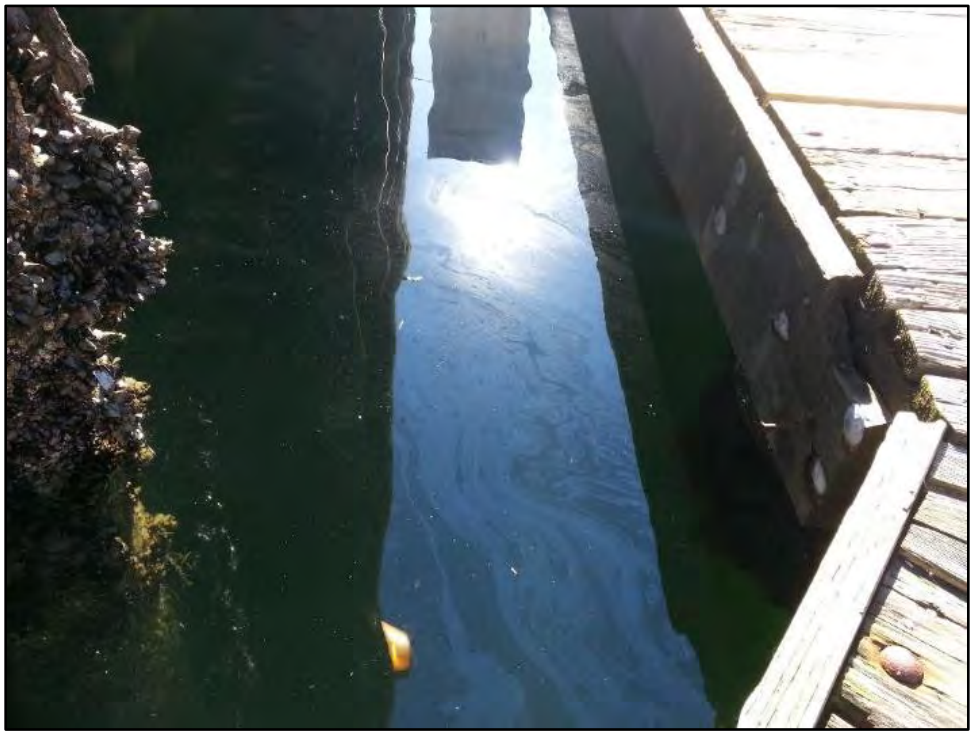
4.1 BIOPHYSICAL CHARACTERISTICS

The Project sites are located in a heavily urbanized area under and adjacent to several wharfs, piers and docks. The shorelines adjacent to all the sites are heavily armoured with rip rap which gives way to cobble, gravel and sand substrates. The intertidal area is littered with urban waste, from upland and marina operations, including woody debris, wires, plastic and rubber (**Photo 3**). Pilings from piers and docks are a common features throughout the Project area.

The Project sites are located near several boat repair businesses in an area with high marina and boat traffic. Storm water run-off and activities such as boat cleaning, fueling operations and hull maintenance all have the potential to negatively affect water quality in False Creek. During the site visit, upland boat cleaning near the edge of the water was observed as well as hydrocarbon sheens around the shoreline (**Photo 4**).

Note: The area was littered with woody debris, wires and other urban waste.

Photo 3 View of the Shoreline and Substrate underneath Lion's Gate Dock



Note: The Project sites are adjacent to heavily used marinas and upland areas. Hydrocarbon sheens, such as this one underneath Lion's Gate Dock, were observed during the site visit.

Photo 4 Hydrocarbon Sheen underneath Lion's Gate Dock

4.2 HABITAT VALUES

The Project sites, being located in an urbanized area, do not support marine riparian vegetation. Most of the immediate backshore associated with the Project sites is paved or covered with boardwalks.

The intertidal zone is steep and narrow at the sites and predominantly consists of rip rap slopes and wooden pilings. There is little marine vegetation along the intertidal shoreline, however the rip rap slopes and wooden piles do provide attachment sites for algal species (e.g., green and brown algae), and invertebrates including barnacles (e.g., acorn barnacles) and mussels (e.g., blue mussels) (**Photos 5** to **7**).

Although it was difficult to observe the subtidal zone during the site assessment, visual observations suggest that it is largely unvegetated in proximity to the Project sites due to the biophysical conditions and lack of detritus observed along the shoreline. No sensitive habitats, including eelgrass or kelp beds, were observed during the site visit or recorded in any of the databases searched.

Although no fish were observed during the site visit, overhead structures do provide some structure for fish refuge. In addition the Project sites, specifically the submerged wooden piles, provide attachment sites encrusting invertebrates, algae and potentially, herring spawn (see **Section 4.2.2** for more detail).

Note: The rip rap is providing an attachment site for some algal species and invertebrates.

Photo 5 View of the Rip Rap Slope adjacent to the Public Market Boardwalk

Notes: Wooden piles were encrusted with marine life, predominantly barnacles and mussels, such as these piles underneath West Dock.

Photo 6 Wooden Piles underneath West Dock

Photo 7 Close-up View of a Wooden Pile Encrusted with Marine Life, Predominantly Barnacles and Mussels

4.2.1 False Creek Fisheries

The Project sites are located in DFO Area 28 (Lower Mainland/Sunshine Coast) Subarea 8. Recreational crab and finfish fishing within False Creek was previously rated as “moderate” (iMapBC 2015). Although fishing for finfish (including salmon) is allowed during select times of the year, recreational fishing in False Creek is not common. Due to sanitary contamination concerns, no harvesting of bivalve shellfish or crab is allowed in False Creek.

4.2.2 Pacific Herring

Pacific herring are considered a key indicator species for the health of intertidal habitats and play a critical role in the ecosystem by providing a food source for marine mammals (e.g., whales, porpoises, and seals), birds and fish including salmon, lingcod and halibut. For over 100 years, herring have been important economically for commercial fisheries and are important to BC First Nations, both commercially and as a traditional food (EC 2011; DFO 2013; Thompson 2013).

Prior to heavy industrialization of False Creek, Pacific herring were reported to be abundant and spawned annually near the surrounding shores. However as the False Creek foreshore experienced significant development, herring populations were drastically reduced and natural spawning habits for herring (e.g., boulders with rockweed) were replaced with marine structures including wharves and piers. As herring prefer to spawn on smooth, rigid substrates in sheltered intertidal and subtidal environments, herring in False Creek have frequently sought out creosote-treated timber piles as a spawning substrate. However, most herring eggs laid on treated timbers do not survive (Thompson 2013).

While herring appear to have been largely absent throughout False Creek in the nineteenth century, due to factors such as habitat loss, overfishing and poor water quality, herring populations have made a comeback within False Creek in the past five to ten years, with spawning observed in February over the past couple of years. The recent increase in herring abundance can likely be attributed to factors including reduced industrial activity, habitat enhancement (e.g., Habitat Compensation Island) and moderately improved marine and water quality conditions in False Creek (EC 2011). With their increase in population, herring in False Creek are in the public spotlight and several herring enhancement and recovery strategies are currently being implemented by groups such as the Squamish Streamkeepers Society and the False Creek Watershed Society (The Vancouver Sun 2014; Vancouver Courier 2015).

In 2013, DFO and Balanced Environmental Services Inc. conducted an analysis on the survival of Pacific herring spawn on different substrates and found that there was little difference between survival on creosote treated pilings and wrapped (e.g., polyethylene covered) pilings. Nonetheless, the installation of creosote-treated piles in False Creek may not be well received by the public due to the perceived negative effects of creosote piles on herring spawn (The Vancouver Sun 2014).

5.0 PROPOSED WORKS

5.1 PILING REPLACEMENT

The Project will include the removal and replacement of five wooden piles supporting the West Dock (**Photo 8**). These piles are located in the high intertidal zones and replacement will occur within the footprint of the existing structures. The existing wooden piles will be extracted full length from the ground if possible; otherwise they will be cut off at the mud line. These piles are to be replaced with Coastal Douglas-fir timber piles of a minimum 36 cm (14") diameter to a minimum depth of penetration of 6.0 m below mud line or to refusal. The pile will be installed by pile-driving from a barge-mounted crane, except where it may be possible and advantageous to perform the work from the upland. Existing wharf structures may be removed to facilitate the works but will be replaced.

Oil-borne creosote is proposed as a preservative treatment for the piles to be applied in accordance with CSA 080 standards. Any bolts used in the timber piles and the bolt holes are also proposed for treatment with creosote. In addition, any cuts or breaks in the new timber would need to be treated with two coats of the specified treatment (assumed to be creosote).

Note: Five of the wooden piles are to be removed and replaced.

Photo 8 View of the Piles underneath West Dock

5.2 CONCRETE WORKS

Some concrete works are proposed at Lion's Gate Dock, where the concrete and sub-beam will be retro-fit and at Bridges Dock and the Public Market Wharf (**Photo 9**) to fill in areas where the upland concrete abutment has been undermined. Some minor excavation to ensure adequate filling of the voids will be required. All of these concrete structures appear to be located outside of the intertidal zone.

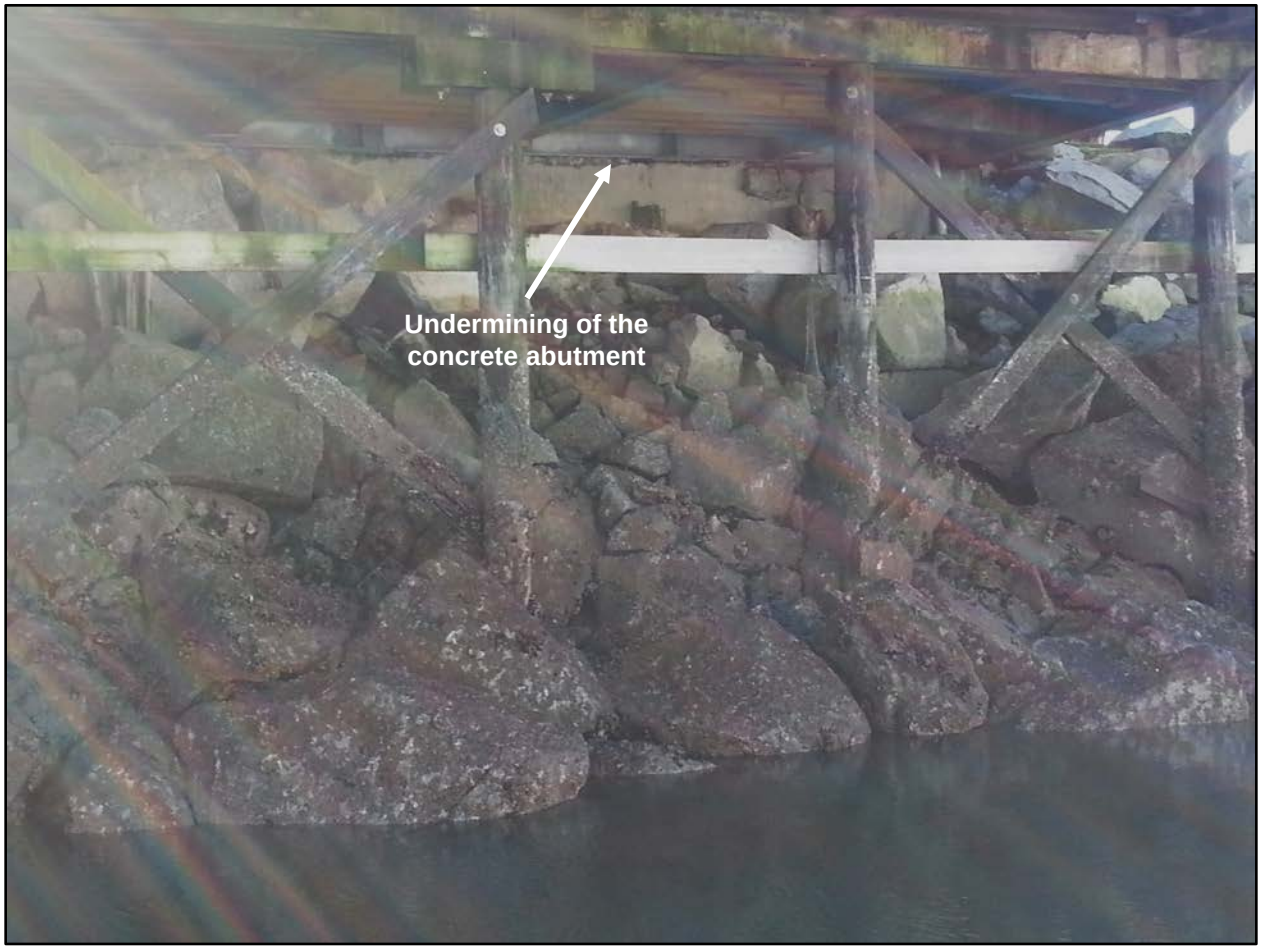


Photo 9 Concrete Undermining Observed by the Public Market Wharf

5.3 ROCK SLOPE PROTECTION AND REGRADING

Downslope of the Public Market Boardwalk, some of the rip rap armouring on the steep intertidal zone has been failing (**Photo 10**). To reinforce the rock slope, additional placement of rip rap is proposed.

In addition, regrading of a 3 m long rock slope spanning 20 m adjacent to the Maritime Market Boardwalk is required to prevent the floating docks from stranding at low tide (**Photo 11** and **Photo 12**). The regarded bank will change from 3:1 to a 1.75:1 slope and will terminate at least 0.5 m before the edge of the floating dock at a depth of 1.5 m (relative to the lowest yearly tide elevation).

Photo 10 Rock Slope Protection to be Repaired along the Public Market Boardwalk

Photo 11 View of a Stranded Floating Dock at Low Tide Adjacent to the Maritime Market Boardwalk (Photo Courtesy of Parsons)

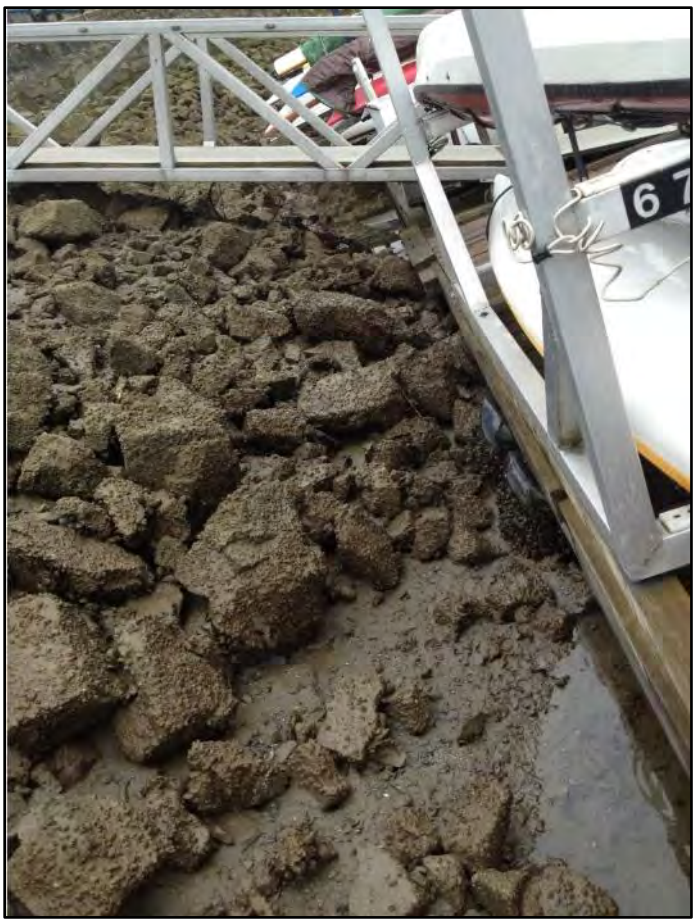


Photo 12 View of the Rock Slope and a Gangway Leading to a Stranded Floating Dock at Low Tide adjacent to the Maritime Market Boardwalk (Photo Courtesy of Parsons)

5.4 FLOAT REPLACEMENT

The existing timber False Creek Ferry Landing Float, adjacent to West Dock (**Photo 13**), is proposed for replacement with a new buoyancy foam filled concrete float. Although the design has not been finalized, the creosote-treated wooden mooring system is anticipated to be replaced with steel pipe piles (**Photo 14**).

The existing landing is approximately 7.43 m wide by 11.1 m long (82.5 m^2) and the new float will be designed to meet the minimum dimensions of 7.5 m by 11.2 m (84 m^2). It is not anticipated that the float will be much larger than the minimum design criteria. The float will be constructed of reinforced concrete with internal compartments filled with polystyrene foam. The float will be constructed offsite. Concrete will be cured for a minimum of seven days prior to installation and will have a silane sealer applied after the curing period.

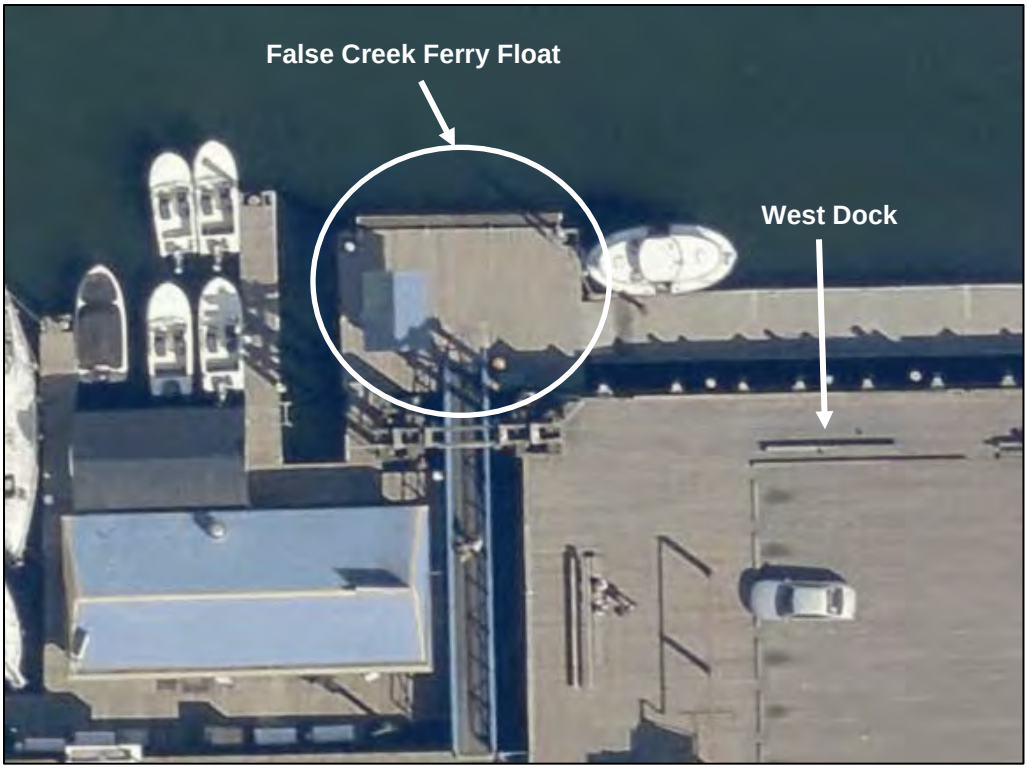


Photo 13 Aerial View of the False Creek Ferry Landing Float (VanMap 2013)

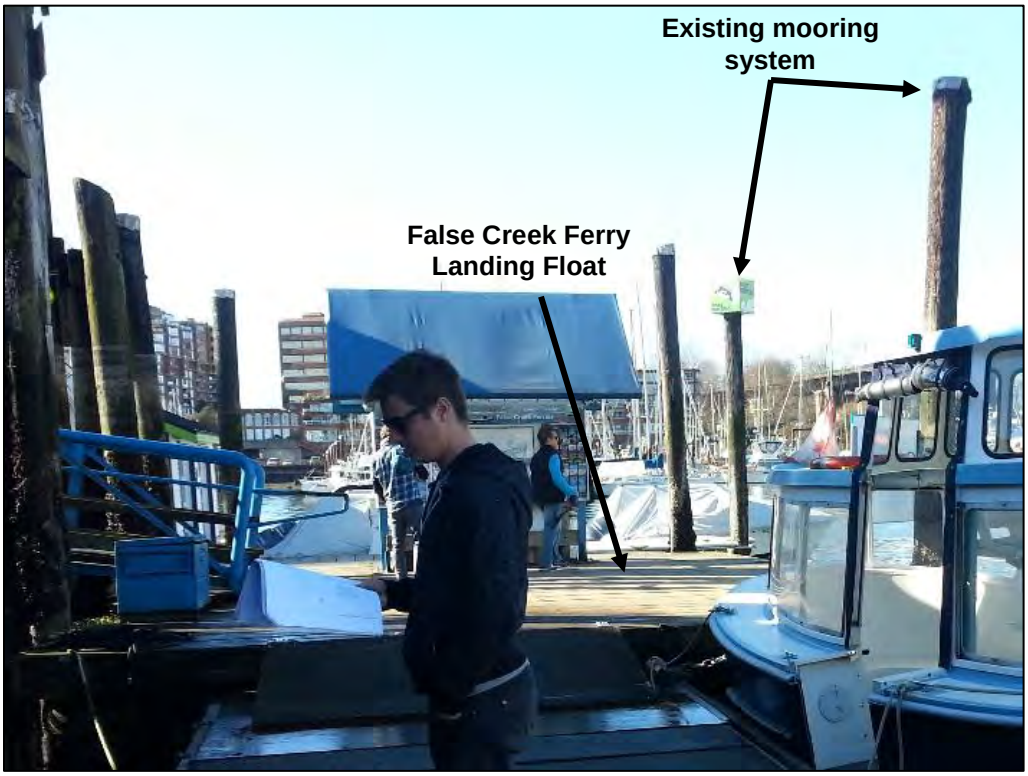
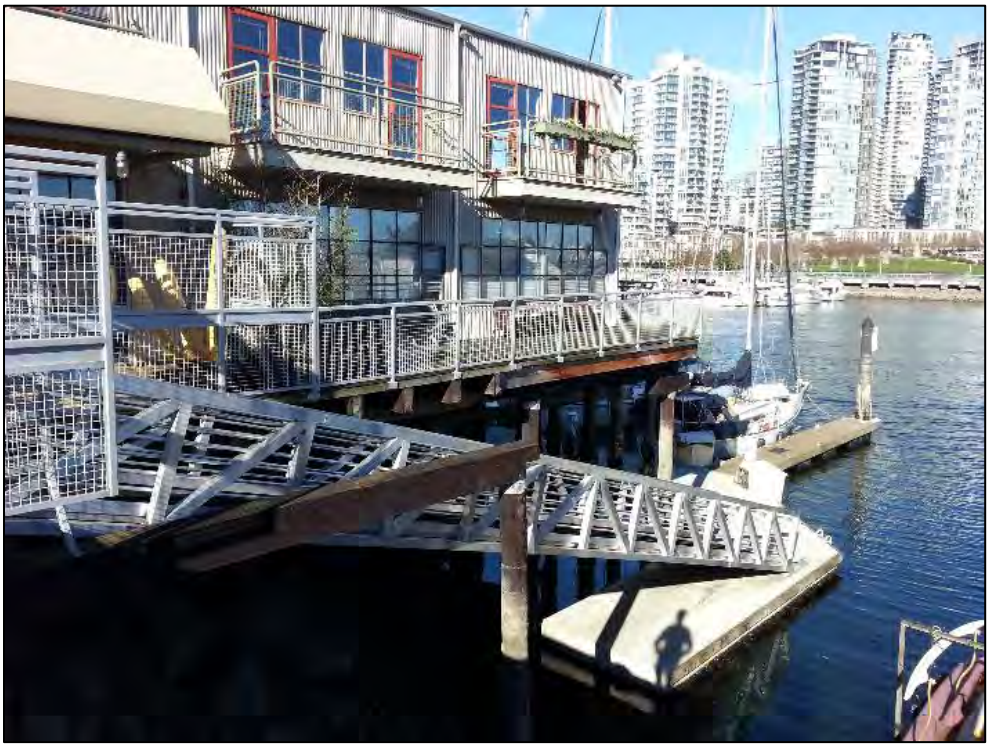


Photo 14 False Creek Ferry Landing Float with Wooden Mooring Piles

5.5 CATHOIDIC PROTECTION

Cathodic protection (aluminum anodes) on outboard piles and installation of steel plate patches are proposed to prevent further corrosion and deterioration of piles (e.g., at the Northeast Seawall and Boardwalk (**Photo 15**) along the shoreline). Anodes will be installed on 161 piles along Granville Island at or below 0.0 m (chart datum) by a diver.



Note: Some minor works involving steel plate patching and cathodic protection on the steel piles is proposed.

Photo 15 Wharf adjacent to Pier 32

5.6 OTHER MINOR WORKS

At Lion's Gate Dock (**Photo 16**), Bridges Dock, West Dock and the Public Market Trestle, installation of steel bands is proposed around wooden piles that have been compromised (e.g., due to cracks and fissures in the wooden piles). No in-water works are anticipated.

Fresh heading of piles and installation of corbel blocks and or sub-caps is proposed for a select number of piles at Lion's Gate Dock (**Photo 17**), West Dock, and the Public Market Wharf. These works will affect the top ends of the piles and no in-water works are anticipated.

A large boulder (**Photo 18**), currently resting on a wooden pile under Bridges Dock, will be removed to prevent further shifting of the pile. The boulder is located in the intertidal zone but is exposed at low tide.

Replacement of concrete pedestals, forming the Public Market Boardwalk, and wooden posts along the upland of Lions Gate Dock is also proposed. These concrete pedestals (**Photo 19**) and wooden posts are located outside the intertidal zone. No in-water works are anticipated.

Note: Steel bands are proposed to be installed in areas where the structural integrity of the wooden piles has been compromised, such as under the Lion's Gate Dock.

Photo 16 Example of Wooden Piles with Compromised Structural Integrity, under the Lion's Gate Dock

Note: Some minor works, involving fresh heading and installation of corbel blocks, are proposed such as under Lion's Gate Dock

Photo 17 Location of Proposed Installation of Corbel Blocks under Lion's Gate Dock

Note: A large boulder will also be removed.

Photo 18 View underneath Bridges Dock Facing Southwest Showing the Concrete Abutment (left) and Piles where Steel Bands will be Installed

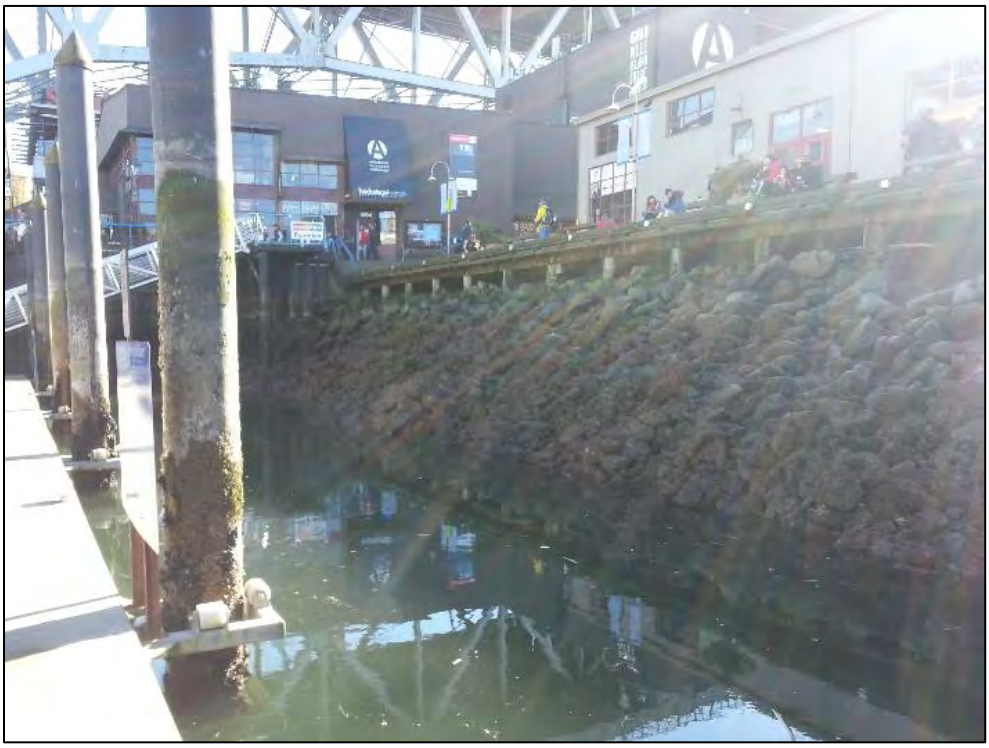


Photo 19 View of the Concrete Pedestals (right side of photo) to be Replaced adjacent to the Public Market Boardwalk

6.0 POTENTIAL EFFECTS

The Project's footprint will be within the general footprint of the existing infrastructure. The installation of the floating dock is expected to result in a footprint increase of approximately 2 m^2, and there may be some minor increases in the footprint associated with the reinforcement of the rip rap slope. While overwater structures, such as docks and floats, can adversely affect the physical characteristics that sensitive species and habitat may rely on, including light penetration, wave energy, substrates and water quality, this marginal increase in footprint is not expected to result in any significant effect to nearshore habitat or its use by fish.

6.1 EFFECTS OF INSTALLATION AND REPLACEMENT OF STRUCTURES IN THE MARINE ECOSYSTEM

6.1.1 Pile Replacements

Chemical preservation of timber piles is intended to prevent structural damage from marine borers. However, the use of oil-borne preservatives, such as creosote, in aquatic environments can introduce toxins that can harmfully alter fish habitat. Subsection 36(3) of the *Fisheries Act* prohibits the deposit of a deleterious substance of any type in water frequented by fish. The risk of release of a deleterious substance from creosote-treated piles (e.g., polycyclic aromatic hydrocarbons (PAHs)) is increased when they are abraded or damaged or if the piles are not properly treated and maintained. Removal of creosote pilings can result in the release of creosote into the environment, especially if the pile is broken at or below the mud line.

The potential environmental effects resulting from the proposed installation of new creosote-treated piles is considered low for the following reasons:

- Timber piles will be treated with creosote in accordance with CSA 080 standards;
- The works involve the removal of creosote-treated piles (potentially pre-CSA 080 standards);
- The piles to be replaced are all located on the shoreward end of West Dock predominantly within the high intertidal zone where there will be reduced exposure to the marine environment and where the use of piles by herring for spawning would be limited;
- The Project sites are located in False Creek, a marine environment where creosote treated piles are very common. The Project will involve the replacement of five piles under West Dock where there are currently 122 wooden creosote-treated piles.

The piles are located in an areas such that they are rarely subject to direct sunlight and hence are less likely to leach due to solar degradation.In addition, piles are often encrusted with marine invertebrates and removal of the piles may result in shell hash (debris from attached shellfish and barnacles that dislodge and drop to the seabed) that can affect benthic habitats when "pile communities" develop. The noise generated from pile driving may also have a temporary effect on fish and other marine life in the immediate vicinity of the Project site as discussed in **Section 6.2**. However, provided that the mitigation measures and Best Management Practices (BMPs) outlined in **Section 7.0** below are followed, there is a low risk that piling installation will result in Serious Harm to fish.

6.1.2 Concrete Works

The lime in concrete easily dissolves in water and is toxic to aquatic life. If concrete leachate enters waters frequented by fish it can alter the pH by increasing the alkalinity of the water which can be lethal to fish and other aquatic life.

This Project involves filling voids within some of the concrete footings to prevent further undermining. All sites where concrete fill is proposed are located outside the intertidal zone and are not likely to be wetted by regular tides. The primary environmental concerns associated with the use of concrete near the marine environment is associated with concrete wastewater entering the marine environment. Provided that the mitigation measures and BMPs outlined in **Section 7.0** are followed, there is a low risk that concrete works will result in Serious Harm to fish.

6.1.3 Rock Slope Protection and Regrading

The additional rock slope protection proposed along the Public Market Boardwalk may result in a marginal increase in the footprint of the Project if rip rap is placed past the existing edge of the rock slope. However, the addition of rip rap to the existing shoreline may be beneficial by providing new attachment sites for algal species and marine invertebrates.

The regrading of the rock slope adjacent to the Maritime Market Boardwalk will result in the temporary disturbance to approximately 60 m^2 of rip rap and result in a steeper slope. As the target depth by the floating docks is -1.5 m (chart datum) some in-water works will be required that may result in the release of sediment-laden waters.

The rock slope works will also temporarily disturb algal species and marine invertebrates. However recolonization is anticipated to occur rapidly following rock slope protection and regrading works. Provided that the mitigation measures and BMPs outlined in **Section 7.0** are followed, there is a low risk that rock slope protection works will result in Serious Harm to fish.

6.1.4 Float Replacement

The False Creek Ferry Landing Float proposed for replacement adjacent to the West Dock is anticipated to result in a net benefit due to the removal of a deteriorating timber landing float and treated creosote moorage infrastructure and replacement with steel and concrete infrastructure. The marginal increase in the footprint of the dock (approximately 2 m^2) is not anticipated to result in any significant effects to the marine environment. Provided that the mitigation measures and BMPs outlined in **Section 7.0** are followed, there is a low risk that rock slope protection works will result in Serious Harm to fish.

6.2 EFFECTS OF ACOUSTIC PRESSURE ON FISH AND MARINE MAMMALS

Pile driving can generate pressure waves that have the potential to cause auditory tissue damage or temporary hearing loss to fish if they are exposed to low levels of sound for a relatively long period of time or exposed to higher levels of sound for shorter periods of time. Indirect effects of hearing loss in fish may relate to the fish's reduced fitness, which may increase the animal's vulnerability to predators and result in the fish's inability or reduced success in locating prey, communicating or sensing their physical environment.

However the five small diameter wooden piles proposed for installation with this Project have relatively good energy absorbing qualities and pose little threat of sound pressure impacts to fish and their habitat when driving timber piles. However, sound during installation of steel piles associated with a new moorage system for the False Creek Ferry Landing Float should be monitored to ensure that operations do not generate sound that could affect fish or marine mammals during pile driving operations.

7.0 MITIGATION MEASURES

The proposed guidelines and recommendations presented in this section are intended to address potential effects to the marine habitat that may result from the Project. The recommendations presented below are intended to be used as a guide to mitigate potential effects to marine habitat, fish and marine mammals.

7.1 GENERAL CONSTRUCTION BMPS

The following mitigation measures should be followed to minimize the potential impacts to fish and fish habitat that may result from in-water or high-risk nearshore activities related to the Project:

- During the course of the Project, a Qualified Environmental Professional (QEP), shall be available to be on site in case incidents with the potential to affect the environment occur.
- In-water and high-risk nearshore works should be scheduled when the timing windows of least risk are open in order to avoid or limit adverse effects to fish and marine mammals during sensitive life history phases (e.g., reproduction and migration). Granville Island is located within the “Burrard Inlet” DFO Fisheries Management Area 28 where in-water and high risk nearshore marine activities should be conducted between **August 16 and February 28**.
- If in-water works are to take place outside of the appropriate marine timing window, then an environmental monitor (QEP) should be available to supervise the works. If in-water works are to take place during herring spawning season, typically in the spring, monitoring for spawning herring is to take place.
- An appropriate, up-to-date spill prevention, containment, and cleanup contingency plan for hydrocarbon products (e.g., fuel, oil, hydraulic fluid, lubricants), and all other deleterious substances that may be used in association with the Project, shall be put in place prior to work commencing. Appropriately sized spill kits must be maintained on site in case of spills.
- All machinery working in the marine and nearshore environment is to be inspected and must be free of contaminants and be in good working condition.
- Hydraulic fluids used in machinery on site is to be non-petroleum vegetable oil based.
- Concrete leachate, hydrocarbon products (e.g., fuel, oil, hydraulic fluid, and lubricants), and any other deleterious substances shall be prevented from entering into the marine environment at the site at any time during the Project construction and operation. Re-fueling and maintenance of machines is to be conducted at a distance of at least 30 m from any waterway
- All debris and deleterious substances generated by demolition and construction associated with the Project shall be appropriately contained in the immediate work area, collected, and appropriately disposed of in accordance with all applicable legislation, guidelines and BMPs.
- The shoreline surrounding the sites has been heavily armoured with rip rap and poses a low erosion risk. However general erosion and sediment control BMPs should be in place during construction. A silt containment plan is to be supplied to the engineer for approval.

- Notification is to be given to the engineer as to when any and all in-water work is to be completed. The contractor is to provide a construction and access plan to the engineer for review and approval prior to commencing construction.
- Prior to the start of work, contractors working on the Project shall be provided with a copy of these Mitigation Measures, which shall be explained to the Project Supervisor and shall be retained at the site and made available to contractors for their reference throughout the duration of the Project.

Mitigation measures specific to the different Project components have been provided in **Sections 7.2** to **7.5** below.

7.2 PILE REPLACEMENTS

The Project requires removal of existing creosote-treated piles and replacement with new creosote-treated piles (Bridges Dock) or steel pipe piles (False Creek Ferry Landing Float). To prevent impacts to the marine environment associated with piling installation, the following mitigation measures are recommended:

- Ensure all treated wood adheres to CSA 080 criteria and industry standard BMPs for creosote use in the marine environment to ensure that appropriate treatment and post-treatment measures have been employed (MOTI and MFLNRO 2013, MFLNRO 2014). Piles are also to be visually inspected before installation to ensure that there are no excessive preservative deposits or signs of bleeding of creosote.
- A reasonable attempt should be made to remove the entire length of creosote-treated piles. Piles should be removed by a slow, steady pull to minimize disturbance of surface habitats and to avoid bringing creosote-contaminated sediments to the surface. Pile-driving is not anticipated to result in the generation of drill castings, however the amount of sediment disturbed during the removal and installation of piles shall be minimized.
- To the extent possible, avoid in situ application of creosote or other wood-treatment chemicals. However, some creosote may need to be applied after the timber piles are cut and to bolt holes once installed. This application must happen with containment in place to prevent discharge of creosote to the marine environment with the use of booms or socks for extra precaution.
- If feasible, cutting and boring of treated wood should take place in upland areas and all waste materials must be contained (e.g., with plastic containers) and kept out of the aquatic environment to be properly disposed of upland.
- Splintering during pile driving can deposit PAHs into the aquatic environment. To prevent the release of PAHS, all construction debris must be contained and recovered.
- Removal and disposal of treated wood components from existing structures should be done in a manner that reduces impact on the environment. Landfilling at facilities approved to accept treated wood waste is the primary option for disposal within BC (MOTI and MFLNRO 2013).
- In the event of a spill of creosote or any deleterious substance, the spill must be immediately contained and reported to the Provincial Emergency Program Environmental Emergency Management Plan Incident Reporting Hotline 1-800-663-3456 and DFO's Observe, Record and Report Hotline 1-800-465-4336.

- Timber piling is normally driven using a drop hammer, a diesel/air impact hammer or a small vibratory hammer. Because of the relatively small diameter of the timber piles, and its energy absorbing qualities, there is little threat of sound pressure impacts to fish and their habitat while driving timber piles.
- While it is has not been confirmed what size the steel pile moorings will be for the False Creek Ferry Landing Float, it is anticipated that the piles will be less than 24 inches in diameter. Given this relatively small diameter, the use of a hydrophone is not required, however the site should be visually monitored for shock waves.
- If during pile installation a fish kill is observed or the sound pressure exceeds 30 kPa, works will stop immediately and appropriate mitigation measures including deployment of a bubble curtain over the full length of the wetted pile will be implemented. If fish kills or disturbance to marine life is observed despite implementation of appropriate mitigation measures, the works will stop immediately and the methods will be reviewed and corrected.
- Works should be conducted in adherence to the "Best Management Practices for Pile Driving and Related Operations – BC Marine and Pile Driving Contractors Association" (BC Marine and Pile Driving Association Contractors 2003) and to "Guidelines to Protect Fish and Fish Habitat From Treated Wood Used in Aquatic Environments in the Pacific Region" (Hutton and Samis 2000).

Note: While sleeves, wrapping and coatings are options that may reduce the release of creosote preservatives from a treated wood pile, the wrapping may allow creosote to accumulate under the covering and move into the aquatic environment in a significant pulse if it is breached (Hutton and Samis 2000). The use of sleeves, wrappings and coatings are not recommended for this Project.

7.3 CONCRETE WORKS

Works involving the curing of concrete are to adhere with the Ministry of Environment's "General BMPs and Standard Project Considerations" for Concrete Works. These BMPs include:

- Ensure that concrete is isolated from water until it has had time to cure (approximately 48-72 hours).
- Ensure a carbon dioxide (CO_2) tank with regulator, hose and gas diffuser is readily available during concrete work to neutralize pH levels should a spill occur.
- If equipment has been in contact with concrete, provide containment facilities to wash-down equipment and contain waste water. Hand tools, buckets and chutes are not to be washed in areas where waste water may enter fish-bearing waters.
- Any spills of sediments, debris, concrete fines, wash or contact water of reportable quantities must be immediately reported to the Provincial Emergency Program Environmental Emergency Management Plan Incident Reporting Hotline and DFO's Observe, Record and Report Hotline. Emergency mitigation and clean-up measures (such as use of CO_2 and immediate removal of the material) must be implemented.

7.4 ROCK SLOPE PROTECTION AND REGRADING

- Excavation and placement of rip rap and shoreline armouring should take place during low tide.
- The rip rap used must be free of any fines (e.g., fine sand, silt, clay, and organics) or deleterious substances prior to placement in the water.
- If rip rap is to be moved or added, wherever reasonably possible, existing rip-rap with marine life shall be salvaged and set aside to be incorporated into new rip-rap armouring at the same orientation (e.g., algae upright) and similar tidal elevations to the positions they were removed from. This will allow for quicker propagation of marine life.

7.5 FLOAT REPLACEMENT

While a design for the timber False Creek Ferry Landing Float has not yet been developed, it is anticipated the structure will be composed of pre-cast concrete, and that the replacement will involve the removal of wooden piles and installation of steel piles. These works may generate debris. Relevant BMPs as described above should be applied during these works.

8.0 PERMITTING REQUIREMENTS

Under the *Fisheries Act*, proponents are responsible for avoiding and mitigating Serious Harm to fish that are part of or support commercial, recreational or Aboriginal fisheries:

> 35. (1) No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery (DFO 2012).

Serious harm to fish is defined as "the death of fish or any permanent alteration to, or destruction of, fish habitat". Only when proponents are unable to completely avoid or mitigate serious harm to fish will projects require authorization under section 35 (2) of the Fisheries Act in order for the project to proceed (DFO 2012).

The Fisheries Protection Policy Statement (2013) defines Serious Harm to fish as:

- The **death of fish**;
- A **permanent alteration** to fish habitat of a spatial scale, duration or intensity that limits or diminishes the ability of fish to use such habitats as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes;
- The **destruction of fish habitat** of a spatial scale, duration, or intensity that fish can no longer rely upon such habitats for use as spawning grounds, or as nursery, rearing, or food supply areas, or as a migration corridor, or any other area in order to carry out one or more of their life processes.

The Project, as described, will not result in Serious Harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery.

In addition, Environment Canada is responsible for the administration and enforcement of pollution prevention provisions of the *Fisheries Act*. Subsection 36(3) of the *Fisheries Act* prohibits the deposit of a deleterious substance of any type in water frequented by fish. Provided that the recommended mitigation measures are implemented, the Project is not expected to result the release of deleterious substances to fish-bearing waters.

9.0 DISCUSSION AND CONCLUSION

Marine structure repairs, including the removal and replacement of piles, will cause temporary disruption to the Project area. However, replacement of the deteriorating infrastructure with new infrastructure that meets today's standards will improve the marine habitat and quality. With implementation of the mitigation measures described in this document, no adverse residual effects are likely to result. As such, the proposed Project is not likely to result in Serious Harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery; therefore, no *Fisheries Act* Authorization will be required.

Hemmera sincerely appreciates the opportunity to have assisted you with this project and if there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

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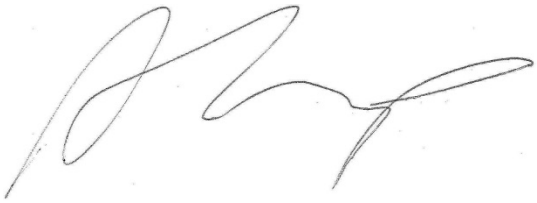

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10.0 STATEMENT OF LIMITATIONS

This report was prepared by Hemmera Envirochem Inc. (“Hemmera”), based on fieldwork conducted by Hemmera, for the sole benefit and exclusive use of Parsons Corporation. The material in it reflects Hemmera’s best judgment in light of the information available to it at the time of preparing this Report. Any use that a third party makes of this Report, or any reliance on or decision made based on it, is the responsibility of such third parties. Hemmera accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this Report.

Hemmera has performed the work as described above and made the findings and conclusions set out in this Report in a manner consistent with the level of care and skill normally exercised by members of the environmental science profession practicing under similar conditions at the time the work was performed.

This Report represents a reasonable review of the information available to Hemmera within the established Scope, work schedule and budgetary constraints. It is possible that the levels of contamination or hazardous materials may vary across the Site, and hence currently unrecognised contamination or potentially hazardous materials may exist at the Site. No warranty, expressed or implied, is given concerning the presence or level of contamination on the Site, except as specifically noted in this Report. The conclusions and recommendations contained in this Report are based upon applicable legislation existing at the time the Report was drafted. Any changes in the legislation may alter the conclusions and/or recommendations contained in the Report. Regulatory implications discussed in this Report were based on the applicable legislation existing at the time this Report was written.

In preparing this Report, Hemmera has relied in good faith on information provided by others as noted in this Report, and has assumed that the information provided by those individuals is both factual and accurate. Hemmera accepts no responsibility for any deficiency, misstatement or inaccuracy in this Report resulting from the information provided by those individuals.

The liability of Hemmera to Parsons Corporation shall be limited to injury or loss caused by the negligent acts of Hemmera. The total aggregate liability of Hemmera related to this agreement shall not exceed the lesser of the actual damages incurred, or the total fee of Hemmera for services rendered on this project.

11.0 REFERENCES

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