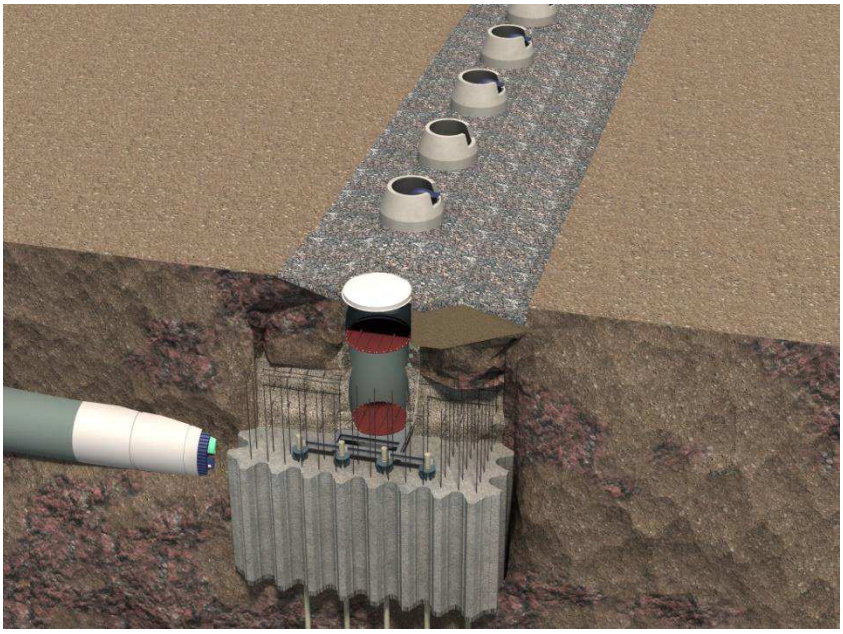
APPENDIX L
HABITAT ASSESSMENT

L.4: DFO Request for Review Supplemental Report

(with Clarification Points)

Annacis Island WWTP New Outfall System

Vancouver Fraser Port Authority
Project and Environmental Review Application



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FISHERIES AND OCEANS CANADA
REQUEST FOR REVIEW SUPPLEMENTAL REPORT

ANNACIS ISLAND WASTEWATER TREATMENT PLANT
NEW OUTFALL - ANNIEVILLE CHANNEL, FRASER RIVER

METRO VANCOUVER
4330 KINGSWAY
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November 15, 2017

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DFO Request for Review Supplemental Report

1.0 Introduction

The Greater Vancouver Sewerage and Drainage District (Metro Vancouver) submitted a Request for Review to Fisheries and Oceans Canada (DFO) on June 8, 2017 related to the Annacis Island WWTP New Outfall System project. On October 4, 2017, DFO responded stating that additional information is necessary to complete their review and determine whether serious harm to fish[1] is likely.

In summary, DFO requested:

1. A detailed construction schedule to assist in understanding what the potential effects to fish and fish habitat may be because of the proposed works and the timing of those works.

2. The schedule/sequencing of works related to the cofferdam installation, as well as, details on the equipment, methodology, materials (e.g. pile materials and diameter), and associated footprints.

3. A copy of the Construction Environmental Management Plan referred to in the Request for Review submission.

4. Further details on the residual effects, and the likelihood of those residual effects, specific to the conversion of the sandy substrate habitat of the Fraser River to hard-armouring (i.e. riprap and diffuser infrastructure).

5. In consideration of DFO's recommendation of a lower risk instream work window from November 1st through February 28th for higher risk in-water works such as dredging and pile-driving, provide a clear quantification and qualification of anticipated serious harm to fish considering the particular species and or life history functions being carried out within, or in the vicinity of the project, during each phase of construction.

Design drawings for the project were included in the original Request for Review and should be referred to for specific details of the planned construction. The design team has prepared an animation of the in-river work that provides a visual depiction of the work and is helpful for understanding what will take place in the river. A copy of the animation is provided with this supplemental report.

This Request for Review supplemental report provides the requested information other than the Construction Environmental Management Plan which is currently being prepared and will be submitted when it has been completed.

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[1] Serious harm to fish is defined as: 1) the death of fish; 2) 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; or 3) 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.

2.0 Construction Effects on Fish and Fish Habitat

2.1 Construction Overview

The proposed construction includes work:

- **On-land construction at the Annacis Island WWTP**: This construction work includes vertical shafts from which tunnels will be driven, tunneling within the plant and between the plant and river (which does not intersect the river bed), and modifications within the plant to the Chlorine Contact Tanks and Level Control Structure.
- **In-river construction within the Fraser River**: This construction work includes installation of a river riser structure within a cofferdam to provide a connection between the tunnel under the river and a diffuser pipe buried in the river bottom, installation of the diffuser pipe in a dredged and backfilled trench in the river bed, and final connection of the tunnel to the diffuser pipe through the riser near the completion of the construction. After the completion of the new outfall system, the existing outfall will be retrofitted with 'duckbill' valves at the top of its riser pipes so it can continue to serve as an emergency influent bypass.

The project design team created a bar chart schedule showing the anticipated relationship and duration of construction activities (see **Attachment 1**) based on a start of construction date in January 2019. The in-river construction activities are shown on this bar chart in purple.

- The first two in-river seasons (river riser and diffuser construction) will be restricted to the June 16th to February 28th, fish window – the period defined as Least Risk to Fish (DFO, 2017a).
- The second two in-river seasons/activities (diffuser connection and existing outfall rehabilitation) do not involve any disturbance to fish or fish habitat at the river bed, other than short-term, temporary anchoring of spud barges. Although it would be preferable to perform these activities later in the fish window when river flows are lowest, the contractor will be allowed to perform these activities outside the in-river work window as necessary to limit the overall duration and impact of the construction work.

Since the on-land activities do not represent any risk of harm to fish, they are not addressed in any more detail in this supplemental report.

2.2 In-River Construction Details

2.2.1 Overview

The following sections describe each in-river construction activity with respect to:

- In-Water Works Windows: Both Least Risk to Fish and Higher Risk In-Water Works
- Work Activity Schedule: Broken down by sequence of work activities
- Nature of Work: Footprint of work, equipment details, methodology, and materials
- Potential Risks for Fish and Fish Habitat: Fish species transiting work area, fish usage of habitat, and anticipated/potential for serious harm to fish.
- Mitigation Measures: Required mitigation measures and additional contractor optional measures
- Residual Risk: Risk of serious harm to fish

The actual activities and sequence of the work will depend on the contractors selected means and methods. However, contractual requirements related to the in-river work windows, environmental management, and the permanent facilities constrain the contractor's options. In describing the work activity schedule for the first two activities, it has been assumed that the construction activities will require the full in-water work window to complete. This is a worst case with respect to the higher risk period identified by DFO within the full in-water work window. It is in the contractor's interest to complete the work over a shorter overall duration with the start of work beginning later in the summer or early fall when river flows are the lowest.

2.2.2 River Riser Construction – Season 1

River riser construction involves mobilization, installation of a cofferdam, excavation of a shaft within the cofferdam, installation of piles within the cofferdam at the base of the shaft, backfilling the shaft and installing the riser pipe, removal of the cofferdam and demobilization. The footprint for the work is shown on **Attachment 2** and a table presenting details on the construction activities, risks, and mitigation measure is presented on **Attachment 3**.

2.2.3 Diffuser Construction – Season 2

Diffuser construction involves mobilization, followed by installation of the diffuser pipe in sections. For the purposes of this report, it is assumed the contractor will elect to install the diffuser in four sections (two on each leg extending out from the river riser). Each diffuser pipe will be installed by dredging a trench, placing pipe bedding material, installing the pipe, and backfilling with native river sand. Following pipe installation, protective caps and the flexible risers will be installed, armor rock will be placed over the entire diffuser, and construction demobilized. The footprint for the work is shown on **Attachment 4** and a table presenting details on the construction activities, risks, and mitigation measure is presented on **Attachment 5**.

2.2.4 Diffuser Connection – Season 3

Diffuser connection involves removal of the internal bulkheads in the 3.8 m diameter riser pipe that isolate the tunnel from the diffuser pipe when the on-land work is completed to the point that the tunnel is flooded. The work is limited to the area shown on **Attachment 6** and is anticipated to take only a week or two to complete. The nature of the work will include:

- **Equipment**: Crane barge for bulkhead removal, worker / diver transport launches.
- **Materials**: None.
- **Construction Methods**: Remove riser cap, remove bulkheads, replace riser cap.

Mobilization of marine equipment for this work is considered in the context of marine traffic. The work will not require specific mitigation measures, but will require adherence and implementation to/of best management practices and the Construction Environmental Management Plan. This construction activity poses no risk of residual serious harm to fish.

2.2.4 Existing Outfall Rehabilitation – Season 3 or 4

Rehabilitation of the exiting outfall involves installation of new flexible valves on the top of the existing 21 vertical steel riser pipes extending above the river bed over about a 60-m diffuser length perpendicular to the navigation channel. The work is limited to the area shown on **Attachment 7** and will take a few weeks to complete. Then nature of the work will include:

- **Equipment**: Work barge, material delivery barge, worker / diver transport launches.
- **Materials**: Flexible rubber risers with steel connection flanges.
- **Construction Methods**: Diver installation of new risers.

Mobilization of marine equipment for this work is considered in the context of marine traffic. The work will not require specific mitigation measures, but will require adherence and implementation to/of best management practices and the Construction Environmental Management Plan. This construction activity poses no risk of residual serious harm to fish.

2.3 Summary of Potential Construction Impacts and Mitigation

All construction related impacts are temporary and mitigated through special measures that would be implemented during construction of the outfall pipe, riser and diffuser manifold.

Dredging required to facilitate construction of the diffuser would impact approximately 12,750 square metres of river bottom fish habitat. Most of this impact is temporary, and would be largely offset through restoration of the affected river bed, outside of the design impact of the outfall, to the pre-impact condition (sediment and elevation).

Temporary impacts associated with the construction of the outfall would not substantively affect fish. Avoidance behaviour would be expressed by fish during installation and removal of the cofferdam, dredging of the river bottom, installation of the diffuser manifold and associated structures, restoration of the river bottom, and the placement of armor rock.

Peak pressures associated with the vibratory hammer installation of the sheet and pipe piles of the cofferdam will be well below those documented to cause injury to or death of fish. Once installed, the cofferdam allows the completion of the river riser structure in isolation of Fraser River waters. This isolates concrete pours and the associated risk to fish.

A clamshell bucket will be utilized to dredge and restore the river bottom, and to place armor rock. The potential to strike fish during the operation of the clamshell bucket is low. With regard to dredging, use of the clamshell bucket is the preferred alternative to hydraulic dredging. Hydraulic dredging readily entrains fish. Mechanical dredging, in this instance defined by clamshell dredging, rarely entrains or strikes fish. Use of the clamshell bucket facilitates the precise placement of armor rock. The bucket will release rock only in proximity to the river bottom. Changes in ambient pressure associated with the operation of the clamshell as it passes through the water column will facilitate detection by fish and instigate avoidance behaviour. The potential to strike fish during the placement of rock is very low.

3.0 Residual Effect of the Completed Outfall

The surface elevation of the completed outfall protective armor rock cover is level with the depth of the navigation channel maintained by the Vancouver Fraser Port Authority (VPFA). The location of the outfall was selected to be in an area where sand accumulation is limited by seasonal scouring and re-deposition of sand. Therefore, dredging to maintain navigation channel depth in this area is rarely required as compared to areas of the channel downstream of the diffuser location where maintenance dredging typically occurs every two years.

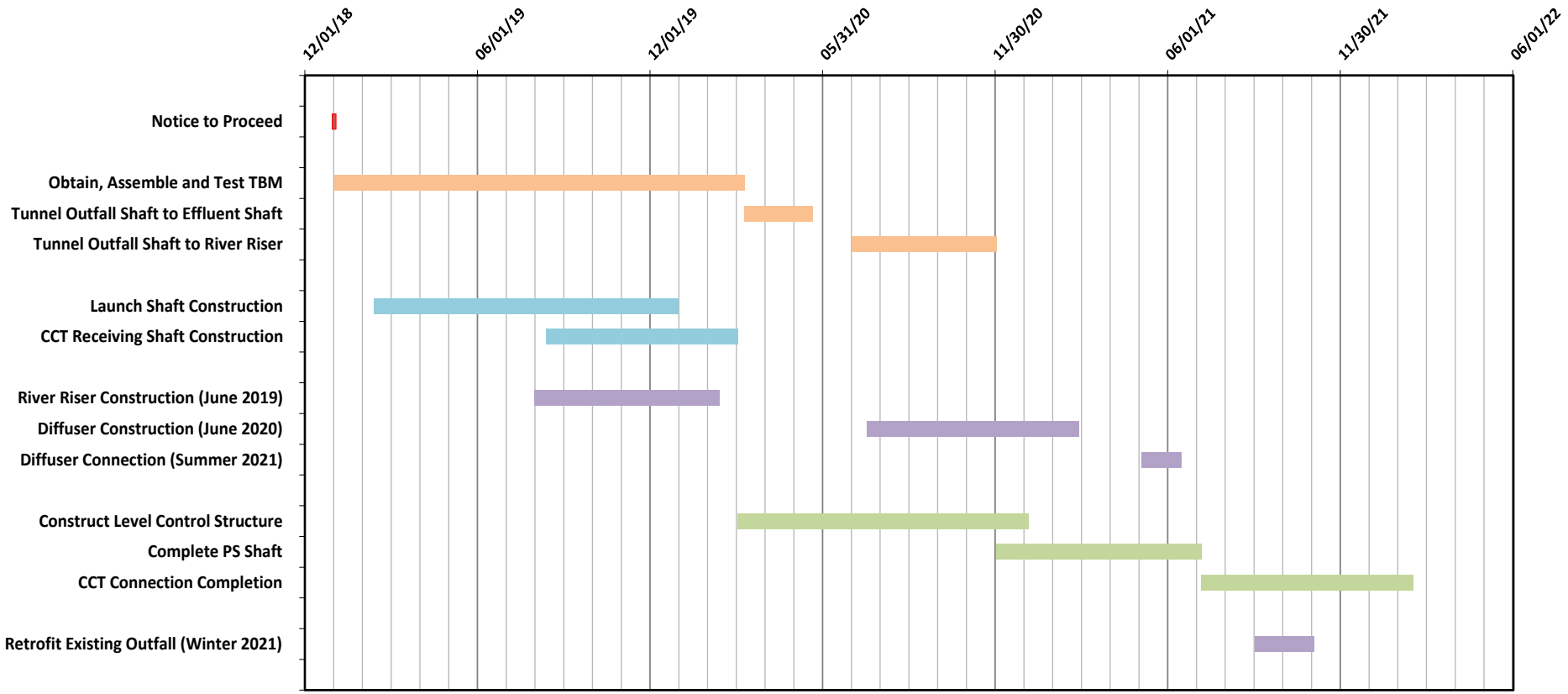
Geomorphological studies performed for the project indicate that sand deposition in this area occurs as low period "sand waves" up to about 1 m in height (see **Attachment 8**). Immediately upon completion of the outfall construction, the river bed will be left at the over-dredged limit used by VFPA when maintenance dredging (about 2 m below the minimum dredge channel depth). The maximum area of exposed armor rock at this point is on the order of 4,100 square metres as shown on Figure 2 in the Request for Review. However, the portion left below the navigation depth will quickly fill in with sand when left to the natural deposition environment. The natural sand waves in the area will re-establish themselves during the first freshet resulting in the armor rock being mostly covered by sand (see **Attachment 9**). The maximum area of exposed armor rock after the river bottom reverts to its natural deposition condition will be considerably less than the 1,100 square metres as shown on Figure 2 in the Request for Review.

The residual effect of the design condition on the river bottom is the conversion of a limited area armor rock typically covered by up to 1 metre of river sand and the presence of the riser protection caps above the level of sand waves. If future navigation channel maintenance dredging is required in the diffuser area, the upper portion of the armor rock on the dredge channel side of the diffuser will be partially exposed for a short time until covered again by sand during the following freshet. Maintenance dredging has not been required at the planned diffuser location in the last 10 years.

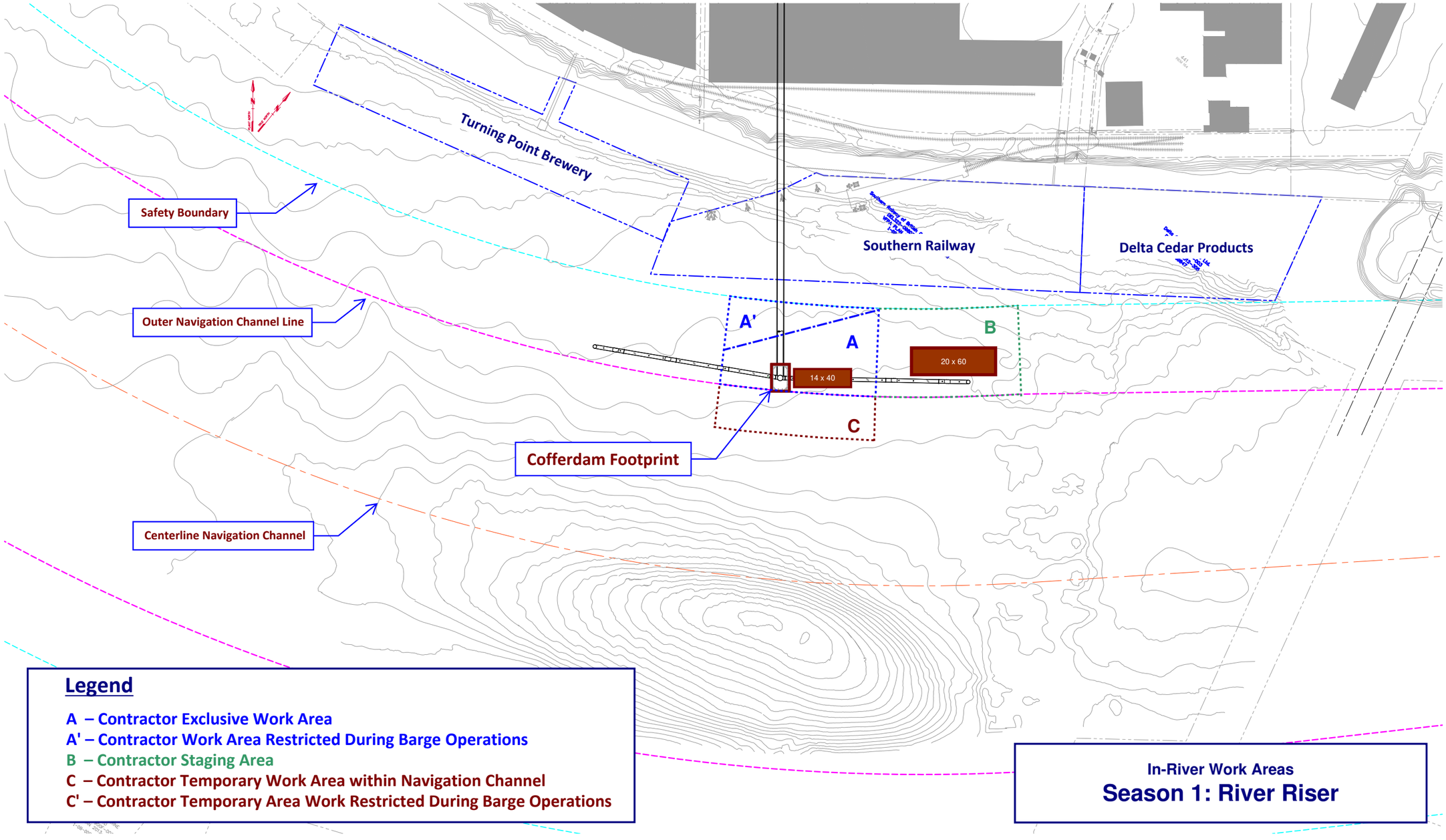
Therefore, the typical bottom condition is characterized by surficial coarse sand that is transitory. This significantly constrains the establishment and persistence of benthic invertebrates. Sieve analysis of 3 samples of surficial sand, each approximately 20 litres in size, did not reveal living invertebrates. Pupal cases of chironomids were the only signs of invertebrates. The apparent absence of invertebrates is compelling, as without such, a food resource for juvenile sturgeon, and for forage fish species that may be prey for adult sturgeon, is absent. In addition, as stated in the Request for Review, the salt wedge extends up with tidal cycles to the outfall location except during freshet flows pre-empting juvenile sturgeon for much of the year.

Affected bottom habitat is represented throughout the Fraser River estuary, including Annieville Channel, Annacis Channel, and other water features associated with Annacis Island (as identified by Fisheries and Oceans Canada's Recovery Strategy for White Sturgeon). The scale of impact is small, with the maximum design footprint of the outfall encompassing approximately 0.01 percent of the 8,156,600 square metres of river bottom identified by DFO's sturgeon polygon for Annacis Island. In consideration of the aforementioned, the limited residual effect on the river bottom does not impair the ability of fish occurring within and about the design location of the outfall to fulfill existing life history functions. In the absence of such impairment, there is no residual serious harm to fish.

Attachment 1: Overall Construction Schedule



Attachment 2: In-River Work Areas – River Riser, Season 1

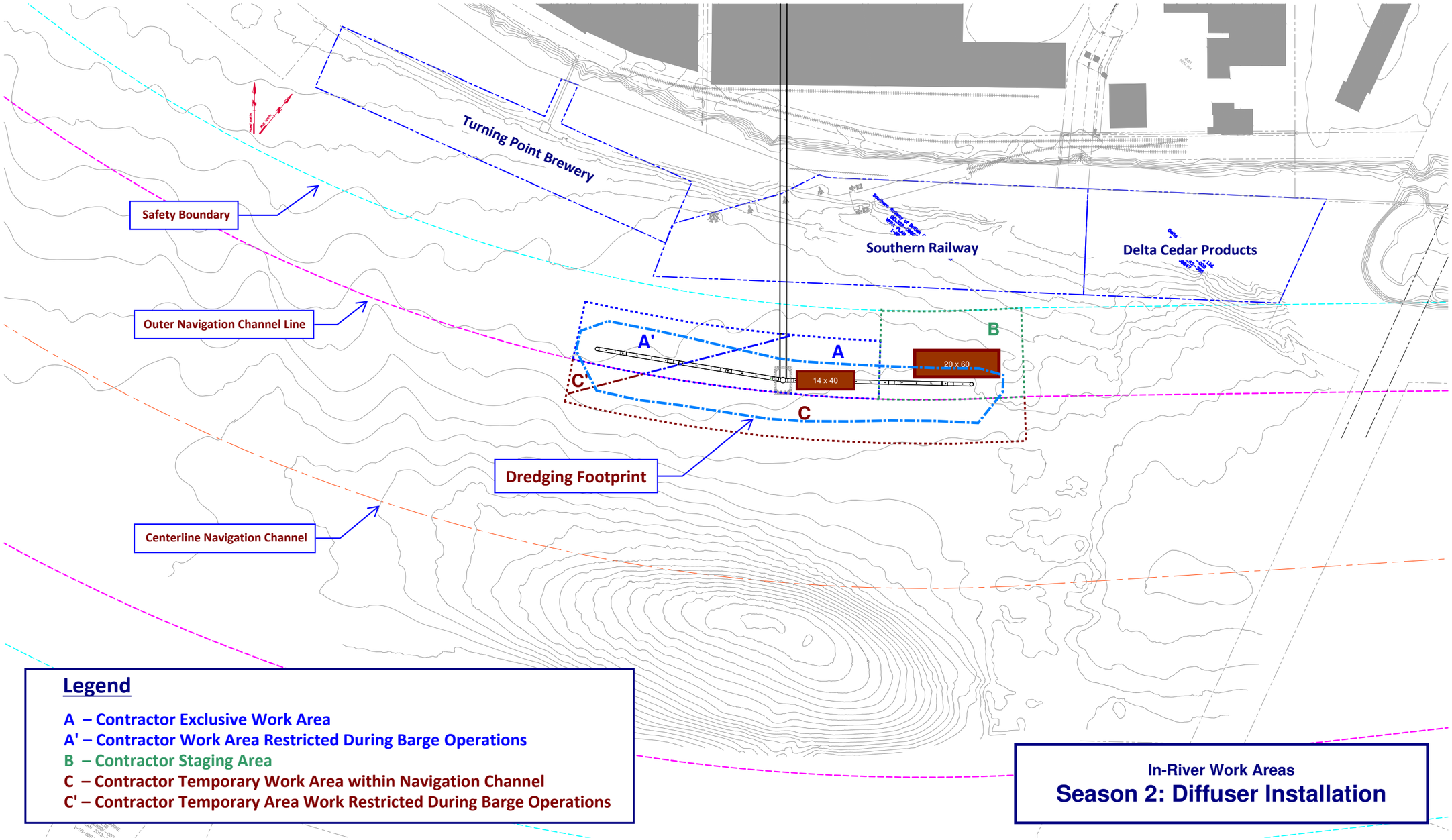


Attachment 3: Activities, Risks and Mitigation – River Riser, Season 1

Construction Week	06/16/2019	06/23/2019	06/30/2019	07/07/2019	07/14/2019	07/21/2019	07/28/2019	08/04/2019	08/11/2019	08/18/2019	08/25/2019	09/01/2019	09/08/2019	09/15/2019	09/22/2019	09/29/2019	10/06/2019	10/13/2019	10/20/2019	10/27/2019	11/03/2019	11/10/2019	11/17/2019	11/24/2019	12/01/2019	12/08/2019	12/15/2019	12/22/2019	12/29/2019	01/05/2020	01/12/2020	01/19/2020	01/26/2020	02/02/2020	02/09/2020	02/16/2020	02/23/2020	03/01/2020
In-Water Works Windows																																						
Least Risk to Fish (DFO, 2017a)	DFO's marine/estuarine timing window for the protection of fish and fish habitat from June 16, 2019 to February 28, 2020																																				
Higher Risk In-Water Works (DFO, Proposed)																				DFO's recommendation for higher-risk in-water works from November 1, 2019 to February 28, 2020																	
Work Activity Schedule																																					
Mobilize for In-River Work	Mobilize for In-River Work																																				
Install Cofferdam						Install Cofferdam																																
Excavate Shaft										Excavate Shaft																												
Install Piles in Base of Shaft																Install Piles in Base of Shaft																					
Backfill Shaft and Install Riser																				Backfill Shaft and Install Riser																
Remove Cofferdam and Demobilize																														Remove Cofferdam and Demobilize							

Nature of Work	Mobilize for In-River Work	Install Cofferdam	Excavate Shaft	Install Piles in Base of Shaft	Backfill Shaft and Install Riser	Remove Cofferdam and Demobilize
Footprint of Work	Refer to Attachment 2: In-River Work Areas – River Riser, Season 1. Cofferdam is approximately 12 m by 20 m in plan dimension.					
Equipment Details	Equipment during all activities will include a crane spud-barge or jack-up barge, a support barge, material delivery barges, and worker / diver transport launches.					
Methodology	In-River mobilization	Vibratory driving of piles and sheeting	Excavation using clamshell bucket	Pile driving of piles within cofferdam	Placement of rebar and concrete, installation of pre-cast fabricated riser pipe	Vibratory removal of cofferdam
Materials	None	Steel pipe piles and formed steel sheet piles	Internal steel bracing and excavated sand	24 - 762 mm x 25.40 mm steel pipe piles	Self-consolidating concrete, steel riser	None
Potential Risks for Fish and Fish Habitat	Mobilize for In-River Work	Install Cofferdam	Excavate Shaft	Install Piles in Base of Shaft	Backfill Shaft and Install Riser	Remove Cofferdam and Demobilize
Fish Species Transiting Work Area	The mobilization of marine equipment in preparation of in-river work is not constrained by DFO's marine/estuarine timing window for the protection of fish and fish habitat. Mobilization of marine equipment is considered in the context of marine traffic. Salmon, char, eulachon and sturgeon transiting the work area will not be affected.	Juvenile sturgeon may occur intermittently at and about the location of the cofferdam; however, during low flows within the Fraser River that occur during the timing window, the salt wedge will commonly be at the location of the cofferdam, pre-empting juvenile white sturgeon. Adult white sturgeon may occur at and about the location of the cofferdam. Upstream migrating adult salmon move through the main channel; the location of the cofferdam is along the northern margin of the main channel; little to no interaction with upstream migrating adult salmon.	The shaft will be excavated within the confines of the cofferdam. Excavation will be conducted in isolation of Fraser River waters. The specific activity of excavation will not interact with fish.	The installation of piles will be conducted within the confines of the cofferdam. The installation of piles will be conducted in isolation of Fraser River waters. The specific activity of pile installation will not interact with fish.	The backfill of the shaft and installation of the riser will be conducted within the confines of the cofferdam. The backfill of the shaft and installation of the riser will be conducted in isolation of Fraser River waters. The specific activities of shaft backfill and riser installation will not interact with fish.	The removal of the cofferdam and the demobilization of marine equipment is not constrained by DFO's window for the protection of fish and fish habitat. Sheet and pipe piles will be removed directly by crane, with or without vibration. De-mobilization of marine equipment is considered in the context of marine traffic. Salmon, char, eulachon and sturgeon transiting the work area will not be affected.
Fish Usage of Habitat	The mobilization of marine equipment in preparation of in-river work will not affect fish habitat. It will not affect use of fish habitat by salmon, char, eulachon or sturgeon.	The cofferdam extends from the river bottom through the water column. The cofferdam will not impede local movements of fish nor will it impede the upstream migration of adult salmon. The construction footprint of the cofferdam occupies a small portion of the design footprint of the outfall. The cofferdam will not markedly affect use of the river bottom by white sturgeon.	The shaft will be excavated within the confines of the cofferdam. Excavation will be conducted in isolation of Fraser River waters. The specific activity of excavation will not interact with fish habitat.	The installation of piles will be conducted within the confines of the cofferdam. The installation of piles will be conducted in isolation of Fraser River waters. The specific activity of pile installation will not interact with active fish habitat.	The backfill of the shaft and installation of the riser will be conducted within the confines of the cofferdam. The backfill of the shaft and installation of the riser will be conducted in isolation of Fraser River waters. The specific activities of shaft backfill and riser installation will not interact with active fish habitat.	The removal of the cofferdam and the demobilization of marine equipment will not affect the use of habitat by fish.
Anticipated / Potential for Serious Harm to Fish or Fish Habitat	Serious harm to fish is highly unlikely.	A vibratory hammer will be used to install sheet and pipe piles that comprise the cofferdam; underwater peak pressures will be less that 30kPa, the threshold utilized by DFO in determining harm to fish. The potential for strikes of fish, in particular white sturgeon, is extremely low. Serious harm to fish is unlikely. Impacts to river bottom are categorically temporary; construction related impacts only occur within the cofferdam footprint.	Serious harm to fish is highly unlikely.			
Mitigation Measures	Mobilize for In-River Work	Install Cofferdam	Excavate Shaft	Install Piles in Base of Shaft	Backfill Shaft and Install Riser	Remove Cofferdam and Demobilize
Required Mitigation Measures	Adherence and implementation to/of best management practices. Adherence and implementation to/of Construction Environmental Management Plan.					
Additional Contractor Optional Measures	The Construction Environmental Management Plan is explicit with regard to the obligations of the Contractor. Little discretion is afforded to the Contractor with regard to implementation of the Construction Environmental Management Plan. Implementation of the Contractor's Health and Safety Plan will reduce the potential for accidents and malfunctions, and hence, will confer additional mitigation of the potential of events that may cause serious harm to fish.					
Residual Risk	Mobilize for In-River Work	Install Cofferdam	Excavate Shaft	Install Piles in Base of Shaft	Backfill Shaft and Install Riser	Remove Cofferdam and Demobilize
Risk of Serious Harm to Fish	There is no risk of residual serious harm to fish.	There is a very low risk of residual serious harm to fish attributable to the installation of the cofferdam.	There is no risk of residual serious harm to fish.			

Attachment 4: In-River Work Areas – Diffuser Construction, Season 2

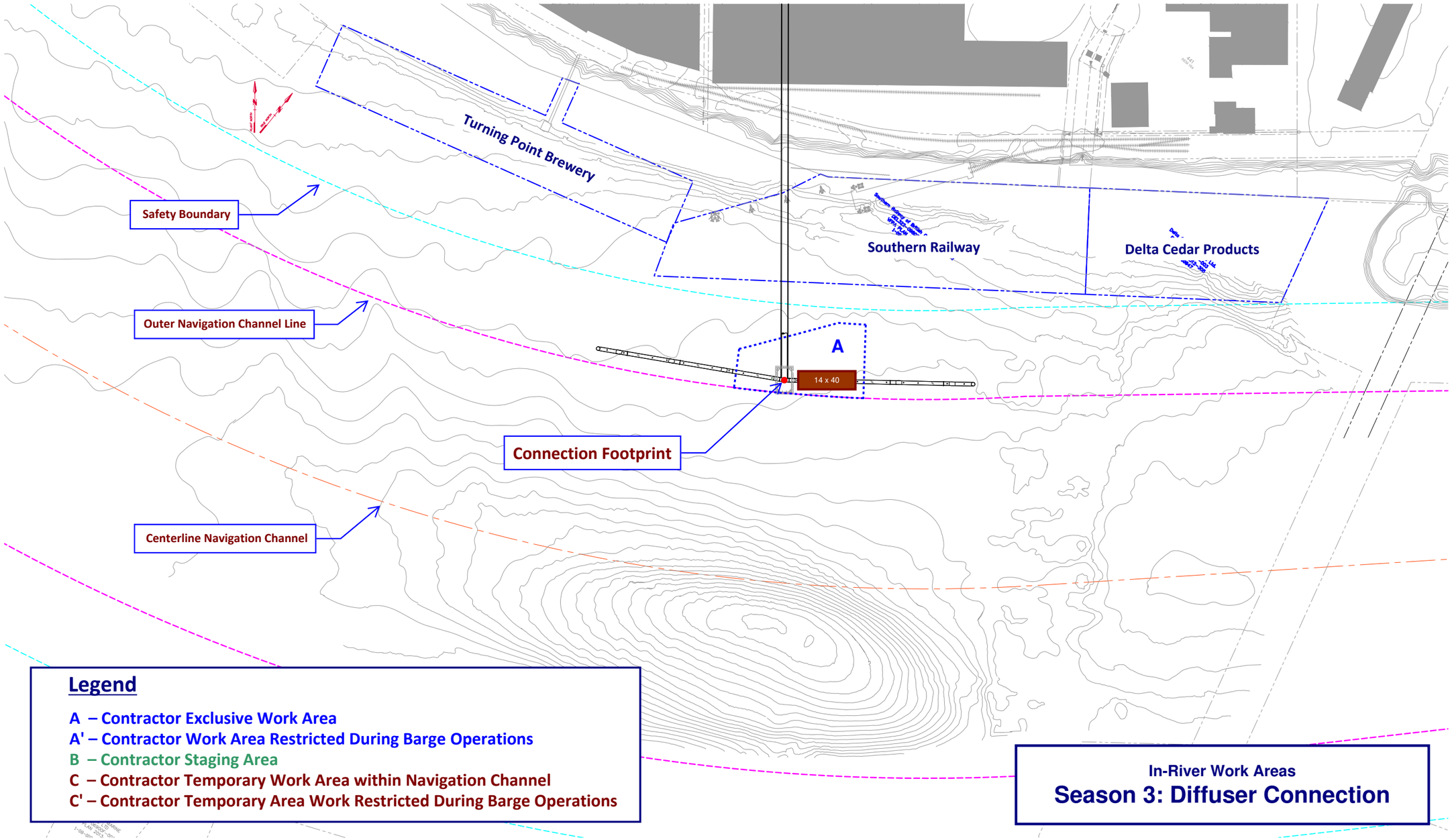


Attachment 5 Activities, Risks and Mitigation – Diffuser Construction, Season 2

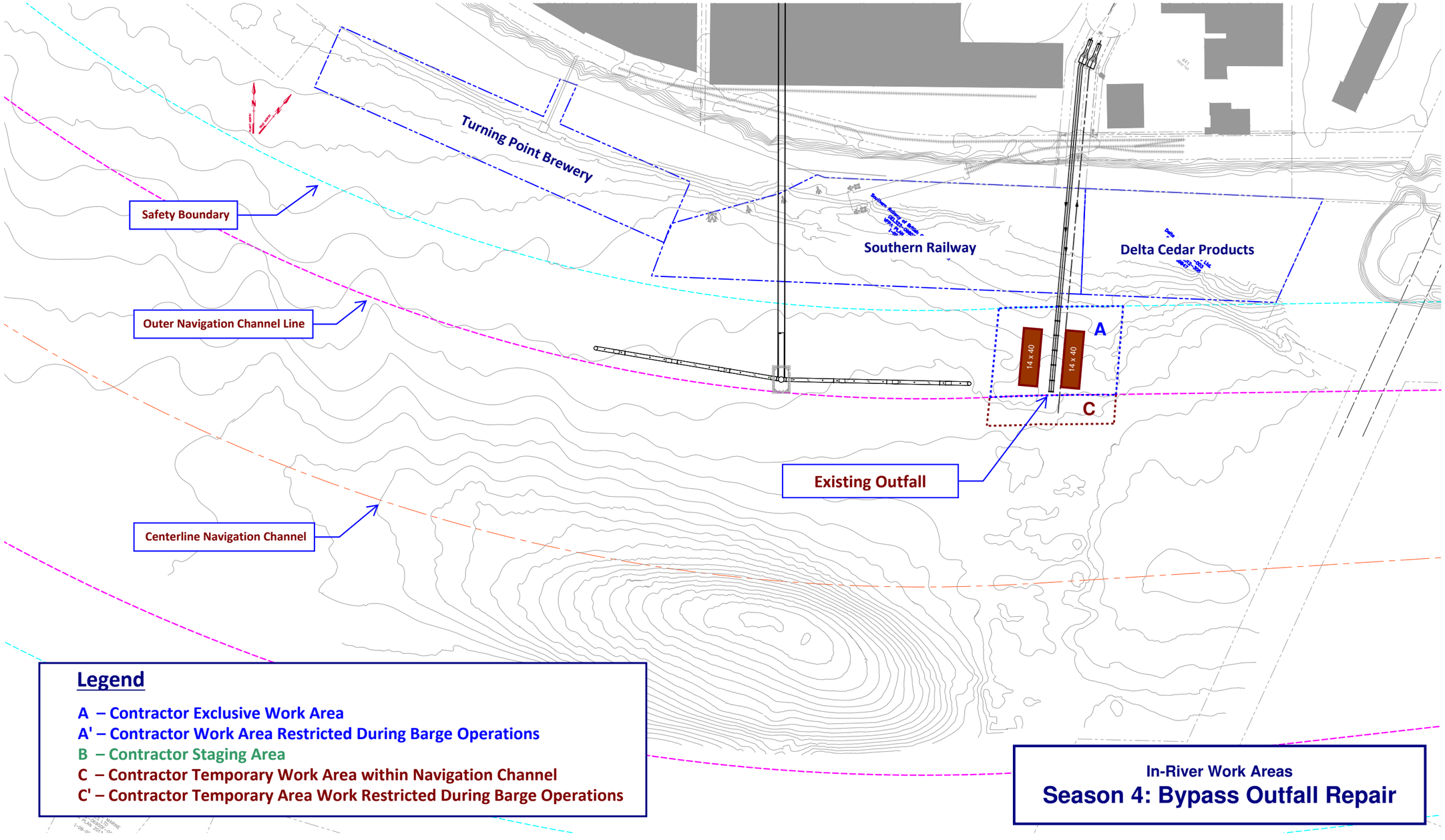
Construction Week	06/16/2020	06/23/2020	06/30/2020	07/07/2020	07/14/2020	07/21/2020	07/28/2020	08/04/2020	08/11/2020	08/18/2020	08/25/2020	09/01/2020	09/08/2020	09/15/2020	09/22/2020	09/29/2020	10/06/2020	10/13/2020	10/20/2020	10/27/2020	11/03/2020	11/10/2020	11/17/2020	11/24/2020	12/01/2020	12/08/2020	12/15/2020	12/22/2020	12/29/2020	01/05/2021	01/12/2021	01/19/2021	01/26/2021	02/02/2021	02/09/2021	02/16/2021	02/23/2021	03/02/2021
In-Water Works Windows																																					
Least Risk to Fish (DFO, 2017a)	DFO's marine/estuarine timing window for the protection of fish and fish habitat from June 16, 2019 to February 28, 2020																																				
Higher Risk In-Water Works (DFO, Proposed)																					DFO's recommendation for higher-risk in-water works from November 1, 2019 to February 28, 2020																
Work Activity Schedule																																					
Mobilize for In-River Work	Mobilize for In-River Work																																				
Dredge Section 1 and Place Bedding						Dredge Section 1																															
Install Diffuser Pipe Section 1 and Backfill									Install Pipe																												
Dredge Section 2 and Place Bedding											Dredge Section 2																										
Install Diffuser Pipe Section 2 and Backfill														Install Pipe																						
Dredge Section 3 and Place Bedding																Dredge Section 3																				
Install Diffuser Pipe Section 3 and Backfill																			Install Pipe																	
Dredge Section 4 and Place Bedding																					Dredge Section 4															
Install Diffuser Pipe Section 4 and Backfill																								Install Pipe													
Install Riser Protection Caps																											Install Riser Caps									
Place Armor Rock over Diffuser and Backfill																													Place Armor Rock and Backfill							
Secure Site and Demobilize																																	Secure and Demobilize		

Nature of Work	Mobilize for In-River Work	Dredge Section and Place Bedding	Install Diffuser Pipe and Backfill	Install Riser Protection Caps	Place Armor Rock and Backfill	Secure and Demobilize
Footprint of Work	Refer to Attachment 4: In-River Work Areas – Diffuser Installation, Season 2. Each leg of the 2.5 m diameter diffuser pipe is about 120 m long.					
Equipment Details	Equipment during all activities will include a crane spud-barge or jack-up barges for pipe installation, a dredge barges, excavated material and backfill material barges, and worker / diver transport launches.					
Methodology	In-River mobilization.	Vibratory pile driving, clamshell bucket dredging.	Pipe installation via slings, backfill placement via clamshell bucket or skip.	Foundation rock skip, protective caps with crane.	Armor rock and backfill placement via clamshell bucket or skip.	Geophysical and sonar surveys of installed diffuser final location.
Materials	None.	Temporary steel sheeting and excavated sand.	Bedding material, pre-assembled steel diffuser pipe sections, and sand backfill.	Foundation rock and pre-cast concrete protective covers, flexible rubber risers.	Armor rock.	None.
Potential Risks for Fish and Habitat	Mobilize for In-River Work	Dredge Section and Place Bedding	Install Diffuser Pipe and Backfill	Install Riser Protection Caps	Place Armor Rock and Backfill	Secure and Demobilize
Fish Species Transiting Work Area	The mobilization of marine equipment in preparation of in-river work is not constrained by DFO's marine/estuarine timing window for the protection of fish and fish habitat. Mobilization of marine equipment is considered in the context of marine traffic. Salmon, char, eulachon and sturgeon transiting the work area will not be affected.	Juvenile sturgeon may occur intermittently at and about the location of dredge area; however, during low flows within the Fraser River that occur during the timing window, the salt wedge will commonly engage the location of works, pre-empting juvenile white sturgeon. Adult white sturgeon may occur at and about the location of the dredge area. Upstream migrating adult salmon move through the main channel; the location of the dredge area is along the northern margin of the main channel; little to no interaction with upstream migrating adult salmon.	Juvenile sturgeon may occur intermittently at and about the location of work area; however, during low flows within the Fraser River that occur during the timing window, the salt wedge will commonly engage the location of the cofferdam, pre-empting juvenile white sturgeon. Adult white sturgeon may occur at and about the location of the work area. Upstream migrating adult salmon move through the main channel; the location of the work area is along the northern margin of the main channel; little to no interaction with upstream migrating adult salmon.	The installation of riser protection caps is of low risk to fish and fish habitat. However, the installation will occur within DFO's marine/estuarine timing window for the protection of fish and fish habitat due to sequencing of overall works. The installation will not markedly affect Dolly Varden, bull trout, resident cutthroat trout or white sturgeon. Upstream migrating adult salmon will not be affected.	Juvenile sturgeon may occur intermittently at and about the location of material placement; however, during low flows within the Fraser River that occur during the timing window, the salt wedge will commonly engage the location of material placement, pre-empting juvenile white sturgeon. Adult white sturgeon may occur at and about the location of material placement. Upstream migrating adult salmon move through the main channel; the location of the dredge area is along the northern margin of the main channel; little to no interaction with upstream migrating adult salmon.	The demobilization of marine equipment in preparation of in-river work is not constrained by DFO's timing window for the protection of fish and fish habitat. Mobilization of marine equipment is considered in the context of marine traffic. Salmon, char, eulachon and sturgeon transiting the work area will not be affected.
Fish Usage of Habitat	The mobilization of marine equipment in preparation of in-river work will not affect fish habitat. It will not affect use of fish habitat by salmon, char, eulachon or sturgeon.	Dredging and the placement of bedding will not impede the upstream migration of adult salmon. Dredging and the placement of bedding will temporarily pre-empt the use of the affected area and associated water column by Dolly Varden, bull trout, resident cutthroat trout, and white sturgeon.	The installation of the diffuser and placement of backfill will not impede the upstream migration of adult salmon. Installation of the diffuser will temporarily limit use of the work area by white sturgeon. The placement of backfill will temporarily pre-empt the use of the affected water column by Dolly Varden, bull trout, resident cutthroat trout, and white sturgeon.	The installation of the riser protection caps is of low risk to fish and fish habitat. The installation will not affect upstream migrating adult salmon. The installation will not markedly affect use of the work area by Dolly Varden, bull trout, resident cutthroat trout or white sturgeon. Upstream migrating adult salmon will not be affected.	The placement of armor rock and backfill will not impede the upstream migration of adult salmon. The work area at the time of material placement is already in an active state of disturbance;impacts to use by Dolly Varden, bull trout, resident cutthroat trout, and white sturgeon are not markedly greater than existing at the time of material placement.	The mobilization of marine equipment in preparation of in-river work will not affect fish habitat. It will not affect use of fish habitat by salmon, char, eulachon or sturgeon.
Anticipated / Potential for Serious Harm to Fish	Serious harm to fish is highly unlikely.	Effects on fish use are temporary; no potential for serious harm to fish attributable to temporary effects. Dredging would be conducted using a clamshell dredge. A clamshell dredge has the potential to strike or entrain white sturgeon. Clam shell dredging is mechanical dredging. US Army Corps of Engineers data spanning 18 years documented only 4 sturgeon entrained by mechanical dredging; this represents 0.2 sturgeon per year entrained by mechanical dredging. As such, potential of serious harm to fish, in particular white sturgeon, is low.	Effects on fish use are temporary; no potential for serious harm to fish attributable to temporary effects. Installation of diffuser pipe has no potential for serious harm to fish; installation slow and methodical; fish can easily avoid works. Placement of fill has a similar potential as mechanical dredging to strike white sturgeon. As for mechanical dredging, however, the potential of strikes is low; risk of serious harm to fish, in particular white sturgeon, is low.	Serious harm to fish is highly unlikely.	Effects on fish use are temporary; no potential for serious harm to fish attributable to temporary effects. Placement of armor rock and backfill has a similar potential as mechanical dredging to strike white sturgeon. As for mechanical dredging, however, the potential of strikes is low; serious harm to fish, in particular white sturgeon, is low.	Serious harm to fish is highly unlikely.
Mitigation Measures	Mobilize for In-River Work	Dredge Section and Place Bedding	Install Diffuser Pipe and Backfill	Install Riser Protection Caps	Place Armor Rock and Backfill	Secure and Demobilize
Required Mitigation Measures	Adherence and implementation to/of best management practices. Adherence and implantation to/of Construction Environmental Management Plan.					
Additional Contractor Optional Measures	The Construction Environmental Management Plan is explicit with regard to the obligations of the Contractor. Little discretion is afforded to the Contractor with regard to implementation of the Construction Environmental Management Plan. Implementation of the Contractor's Health and Safety Plan will reduce the potential for accidents and malfunctions, and hence, will confer additional mitigation of the potential of events that may cause serious harm to fish.					
Residual Risk	Mobilize for In-River Work	Dredge Section and Place Bedding	Install Diffuser Pipe and Backfill	Install Riser Protection Caps	Place Armor Rock and Backfill	Secure and Demobilize
Risk of Serious Harm to Fish	There is no risk of residual serious harm to fish.	There is a low risk of residual serious harm to fish.				

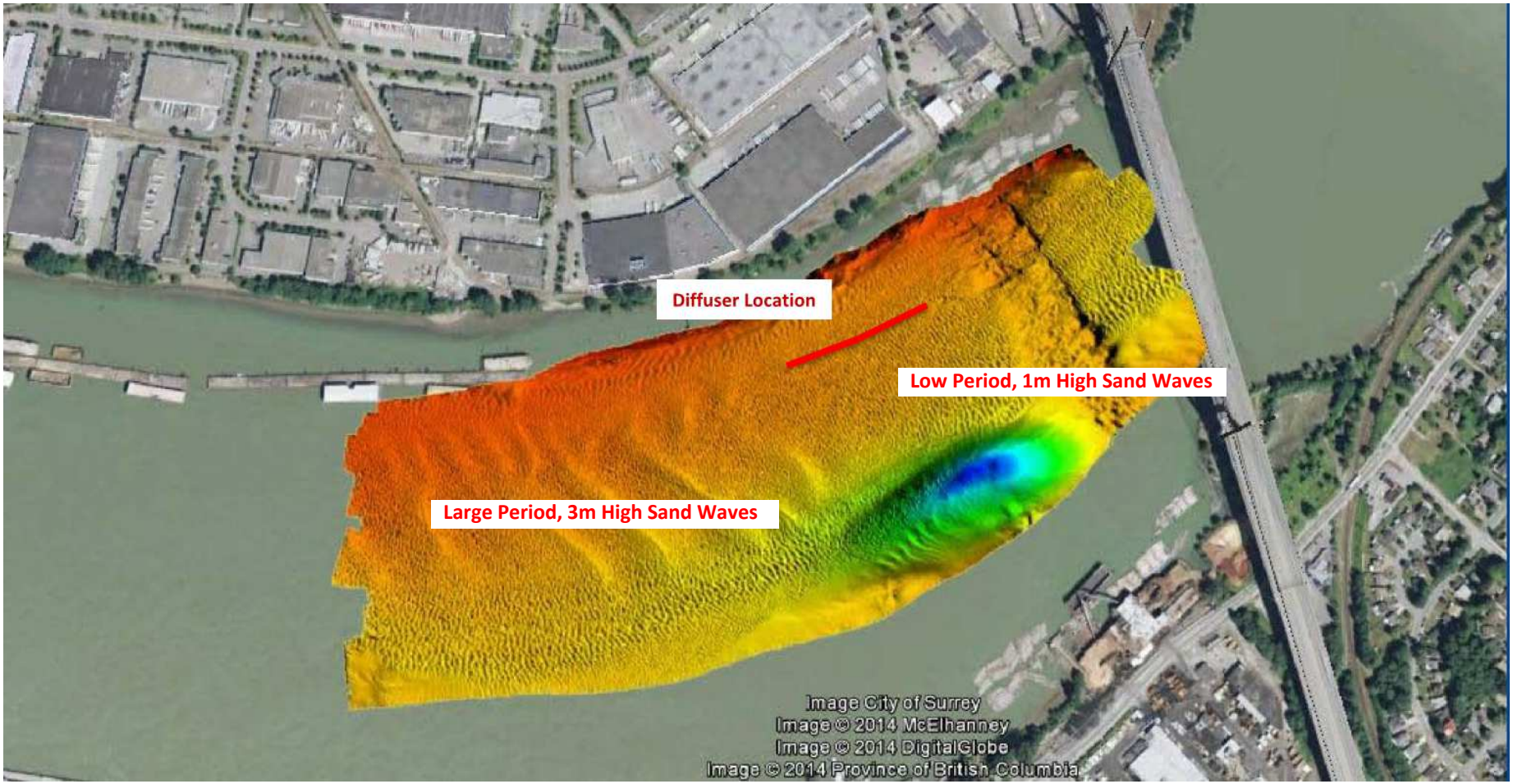
Attachment 6: In-River Work Areas – Diffuser Connection, Season 3



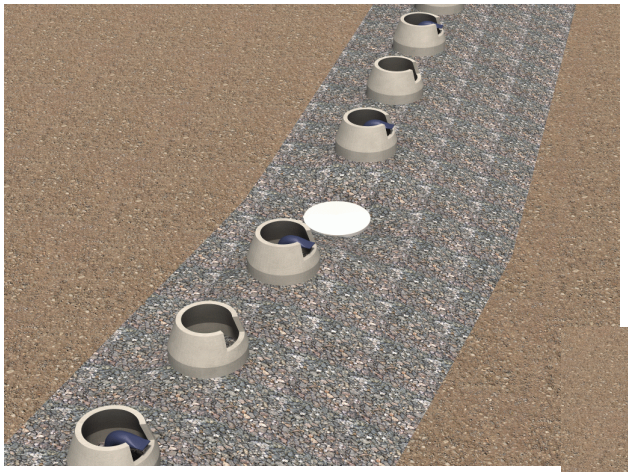
Attachment 7: In-River Work Areas – Existing Outfall Rehabilitation, Season 3/4



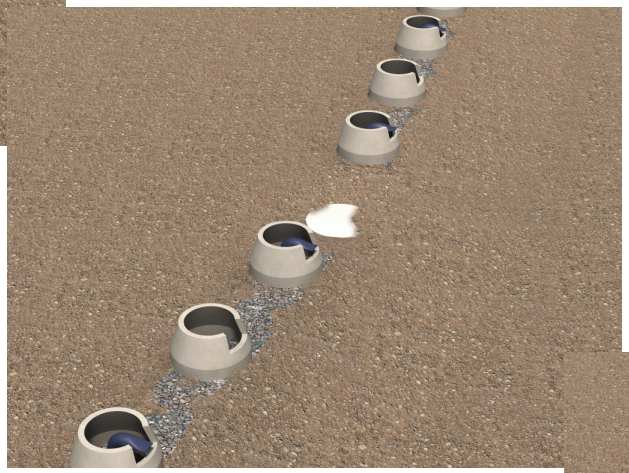
Attachment 8: River Bottom Relief Image



Attachment 9: Evolution of Final Constructed Condition



Condition immediately following construction



Condition after first freshet

Condition after bottom stabilizes

Clarification Points

Fisheries and Oceans Canada
Request for Review Supplemental Report (November 15, 2017)
Sand Migration and Accumulation in the Completed Outfall Area
December 6, 2017

1. An important distinction for the new Annacis outfall armor rock protection is that its purpose differs from that where armor rock is placed over a hydraulic structure in an area of on-going scour and erosion. For the latter, most of the armor rock surface remains exposed since sediments do not have an opportunity to accumulate over the armor rock. For the Annacis Outfall, the armor rock is primarily intended to provide a barrier to limit the extent to which future maintenance dredging can encroach upon the outfall pipe and diffuser ports. It will also help protect the outfall as localized areas of erosion develop over time along the diffuser length as described below.

2. Sediment transport along the channel bottom in this area are characterized as medium to coarse sands moving along the river bed in 'sand waves'. These sand waves are analogous to sand dunes which migrate laterally due to erosion on the windward side and deposition on the lee side.

3. On page 5, paragraph 1 of the November 15th Supplemental Report, where we state that "*the location of the outfall was selected to be in an area where sand accumulation is limited by seasonal scouring and re-deposition of sand*", the intent was to distinguish the outfall location from the inside of the Mungo Bend immediately downstream of the planned outfall location where the sand waves do not reach dynamic equilibrium. In this area, the sand waves continue to grow in height, building up to several metres over a period of one to two years. The port authority is required to regularly perform maintenance dredging to maintain the navigation channel depth. Upstream, where the outfall is planned, bathymetric soundings over the last 10 years indicate that river bed elevation is more stable and has fluctuated less than one metre from its average elevation. The shallow, short amplitude sand waves moving through this area reach a dynamic equilibrium and do not continue to build up over time.

4. On page 5, paragraph 2 of the November 15th Supplemental Report where we state that "*the portion left below the navigation depth will quickly fill in with sand when left to the natural deposition environment*", the intent was to indicate that any areas left deeper than the average depth of the river bed in this area would tend to trap and accumulate sand until the bottom elevation is returned a stable, relatively level average depth. This process will begin immediately after construction and be complete no later than the next freshet. Thereafter, sand would again move through the area in waves and not accumulate significantly.

5. The current average elevation of the river bed at the outfall location varies by slightly over one metre with the upstream end being slightly below the navigation channel minimum depth and the downstream end being at the navigation channel minimum depth. The diffuser arms need to be level for the best hydraulic performance. The diffuser elevation has been designed such that the top of the armor rock will be level at the navigation channel minimum depth, therefore it will be at the current average river bed elevation at the downstream end and up to one metre above the current average river bed elevation at the upstream end.

6. Studies of potential alterations to local deposition and erosion resulting from installation of the new diffuser in the outfall area indicate that area will remain relatively stable with some potential for localized additional sediment deposition in the immediate vicinity of the downstream diffuser leg due a reduction in local overall downstream flow velocity caused by the horizontal discharge from the new diffuser ports. The armor rock will also limit lateral migration of sediment along the upstream diffuser leg where it is above the current average river bed elevation, tending to raise the normal river bed elevation. In summary, installation of the new outfall will tend to locally increase and flatten the average river bed elevation along which the sand waves will migrate.

7. We anticipate that sediment migration will soon revert to its typical condition of scouring and re-deposition in the form of sand waves up to one metre in height migrating in dynamic equilibrium along the future average river bed elevation. This condition will be established by the first spring following construction, as the greatest amount of sand deposition and migration occurs during the freshet. At the upstream end of the diffuser, it is likely that the armor rock would be periodically exposed as the sand waves traverse the area. The armor rock is less likely to be exposed as sand waves migrate along the river bed at the downstream end.

8. There is no practical way to make an accurate prediction of the amount of armor rock that will be exposed for an extended period; however, it will be considerably less than the total area of armor rock (1,100 m^2) at the navigation channel bottom elevation.

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