ESQUIMALT GRAVING DOCK WATERLOT PHASE 2 SOUTH JETTY REMEDIATION DESIGN AND CONSTRUCTION CHALLENGES

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ABSTRACT

The Esquimalt Graving Dock (EGD) is in Esquimalt Harbour on Vancouver Island, British Columbia, and is managed by the federal custodian Public Works and Government Services Canada (PWGSC). The EGD facility has been used for the repair and maintenance of military and civilian vessels since 1927, and it is the largest solid-bottom commercial graving dock on the West Coast of the Americas. Historic contamination includes a broad range of chemicals, such as metals, polychlorinated biphenyls (PCBs), tributyltin (TBT), and polycyclic aromatic hydrocarbons (PAHs).

In support of objectives of the Federal Contaminated Sites Action Plan (FCSAP), PWGSC developed a multiphase remedial action plan and engineering design for cleaning up contaminated sediments in and adjacent to the EGD Waterlot. Phase 1A was completed in 2013 and included installation of a sheetpile perimeter wall around the existing timber jetty structures to prevent recontamination of remediated sediments during subsequent phases of the project. Phase 1B was completed in March 2014 and included 144,000 cubic metres (m^3) of remedial dredging and off-site upland disposal of contaminated sediments. Phase 2 construction was completed in December 2016 and consisted of demolition of the timber-piled South Jetty structures, redriving of the perimeter sheetpile wall to form a resuspension barrier, remedial dredging and off-site upland disposal of approximately 36,000 m^3 of open water and under-pier contaminated sediments, placement of seabed capping materials in open-water and under-pier areas, placement of slope armour, and modifications to the remaining concrete jetty structure.

This paper discusses the key challenges encountered during design and implementation of the Phase 2 remediation project from the perspectives of the design engineer and remediation contractor as well as the innovative technologies and approaches that were used to overcome challenges and complete the construction effort.

Design challenges included sequencing for demolition of the timber jetty structure while meeting operational requirements for the graving dock facility; establishing requirements for recontamination prevention, including the use of floating and anchored silt curtains; maximizing contaminated sediment removal in areas with limited access (e.g., under-pier areas) and limitations due to the presence of structures (e.g., piers and piling and bulkhead walls); sequencing for the removal of hazardous waste; and designing innovative multilayer engineered sediment caps.

Challenges encountered during construction included contractor coordination with third-party designers to meet silt curtain design and bathymetric survey requirements; demolition of timber jetty and removal of asphalt; selection and implementation of innovative dredging technologies, including the use of specialized equipment e.g., Gradall mounted on Flexifloat, chain-drag dredging, and diver-assisted sediment jetting) to remove material from within the dredge prism; management of dredge residuals within a confined sheetpile wall enclosure; removal of historical retaining walls uncovered during dredging; and placement of engineered sediment capping materials in difficult-to-

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access areas using a combination of a purpose-built material conveyor, a mini-excavator, and a Gradall on Flexifloat. Other construction challenges included implementation of revised means and methods to regain the project schedule (including working multiple shifts), sequencing adjustments for completion of construction activities, definition of areas of work for measurement and payment purposes, and completion of concurrent work.

Keywords: dredging, capping, schedule, contingency, cleanup

INTRODUCTION

Background

The EGD Waterlot, located in Esquimalt Harbour, British Columbia, has a long history of naval and industrial activity, within the harbour and on the uplands along the shoreline that dates back to the mid-1800s (Figure 1). The EGD, which has been owned and operated by the federal government since 1927, is managed by the federal custodian PWGSC. The EGD has the largest solid-bottom commercial graving dock on the West Coast of the Americas (Figure 2) and has been used by numerous commercial operators for civilian and military ship repair and construction operations. Contamination of sediments in the project area is primarily due to legacy contaminants from historical sources such as metals, TBT, PCBs, and PAHs. Prior to the open-water remediation conducted in Phase 1B, the highest levels of sediment contamination were located near the mouth of the EGD and beneath the South Jetty. This paper discusses the design and construction implementation challenges associated with the Phase 2 remediation project.

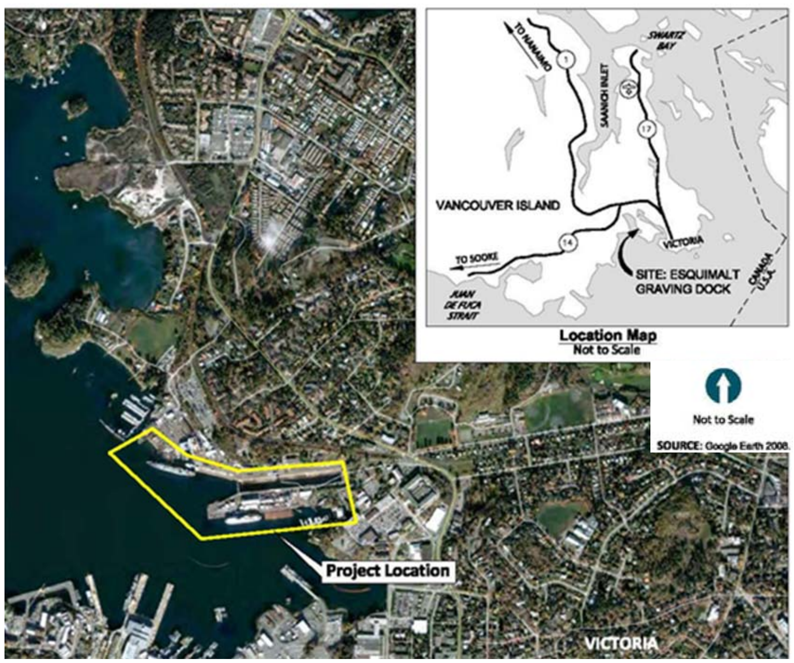

Figure 1. Vicinity map.

Figure 2. Project area and boundaries.

The EGD Waterlot Remediation Project (EGD Project) was conducted as part of the Government of Canada's FCSAP, which is a cost-shared program that supports federal departments, agencies, and consolidated Crown corporations in addressing contaminated sites they are responsible for. The primary objectives of this program are to address the risks these sites pose to human health and the environment and reduce the associated financial liability. Completion of the EGD Project has also established baseline conditions for future site operations, which may support a potential change in facility governance that is under consideration.

General management goals for the EGD Project focus on removing the maximum amount of contamination practicable while allowing graving dock facility operations to resume expeditiously. Removing contamination serves to reduce the Government of Canada's financial liability, establish baseline conditions for future operations, reduce risks to human health and the environment, and achieve FCSAP objectives.

The EGD Project sought to remove the maximum amount of contaminated sediments that exceeded the most stringent numeric criteria for a given contaminant based on the Canadian Council of Ministers of the Environment Probable Effects Level or British Columbia Contaminated Sites Regulation Sediment Quality Criteria for typical contaminated sites. These numeric criteria are referred to as numeric remedial action objectives (NRAOs) and were also used as the basis for cap modeling within the Phase 2 project area and recontamination assessment outside the Phase 2 project area. Figure 3 shows concentrations above NRAOs within the Phase 2 project area prior to remediation.

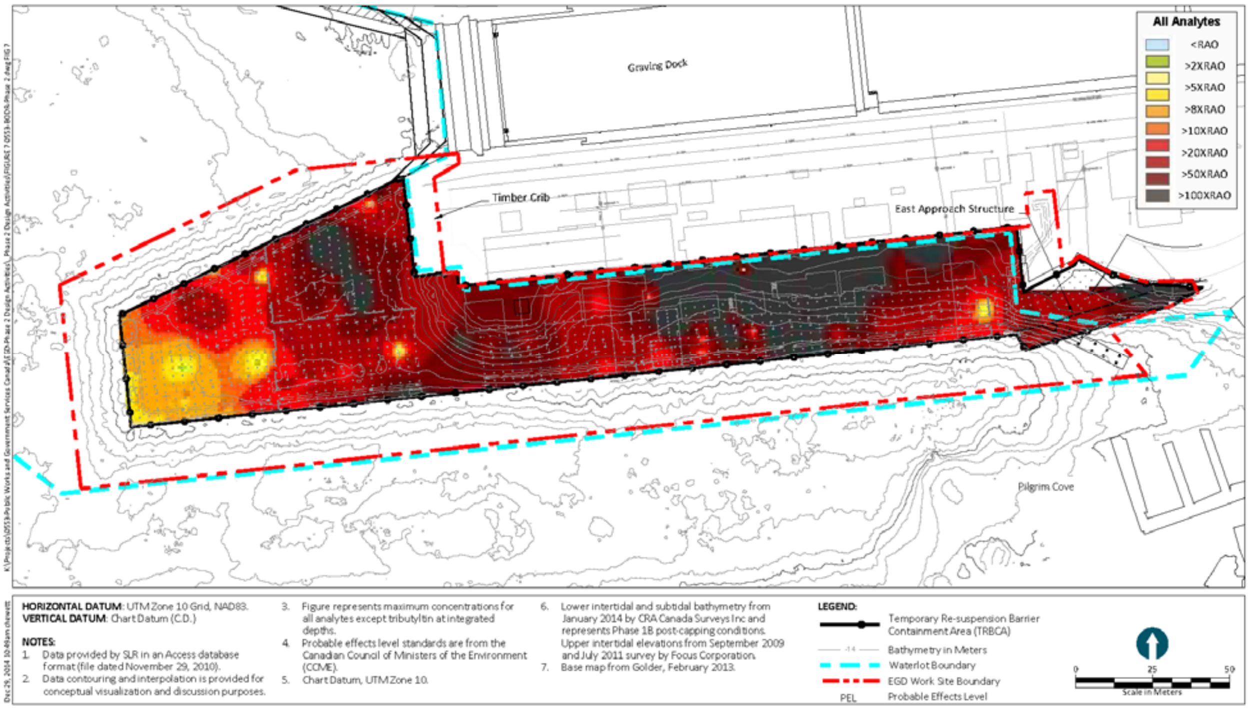

Figure 3. Maximum contaminant concentration at integrated depths.

Phased Approach

A remedial options assessment was conducted as part of the development of the initial Remedial Action Plan/Risk Management Plan. Various alternatives and technologies were evaluated, and the preferred alternative selected by PWGSC consisted of maximum practicable removal of contaminated sediments through dredging and off-site disposal, to be conducted in two phases to address sediment contamination as soon as possible. Phase 1 consisted of open-water sediment remediation and was completed in March 2014, while Phase 2 addressed remediation of the sediments beneath the South Jetty (Figure 2) and was completed in December 2016.

Phase 1A – Installation of Under-Pier Erosion Protection System

Phase 1A consisted of the installation of an under-pier erosion protection system (sheetpile wall) around the South Jetty structure to prevent resuspension and transport of contaminated under-jetty sediment into the open-water area that was to be remediated as part of Phase 1B. The sheetpile wall provided a barrier against waves and propeller wash (propwash) from vessels operating adjacent to the South Jetty. The sheetpile wall was designed to be protective for selected design vessel operational conditions, with appropriate seabed embedment depths and attachment to the deck of the South Jetty to provide structural integrity. The construction was implemented in three segments along the jetty perimeter to minimize the disruption to EGD operations and accommodate fishery windows, as specified by Fisheries and Oceans Canada. Construction of the Phase 1A sheetpile wall was conducted by Salish Sea Industrial Services from October 2012 to April 2013.

Phase 1B – Open-Water Dredging

Phase 1B consisted of remediation of the open-water area of the Waterlot, with maximum practicable removal of approximately 144,000 m^3 of contaminated sediments (Figure 2). The dredge prism design and overall construction sequencing for remedial dredging were established to maximize contaminant removal, minimize potential for dredge residuals and recontamination, and minimize impact to ongoing EGD operations during construction. A post-construction sand layer was placed at the end of Phase 1B to address dredge residuals and provide a clean post-construction surface. Implementation of the Phase 1B open-water dredging effort was conducted by Frasier River Pile and Dredge and occurred from June 2013 to March 2014.

Phase 1C – Construction of Compensatory Fish Habitat

New intertidal marsh fish habitat was constructed at a separate location in Esquimalt Harbour to compensate for impacts associated with the project, particularly the temporary disruption of habitat underneath the South Jetty due to the installation of the under-pier erosion protection sheetpile wall in Phase 1A. Construction of Phase 1C project was conducted by JJM Construction, Ltd., and occurred from September 2013 to April 2014.

Phase 2 – Under-Pier Remediation

The Phase 2 portion of the project consisted of the demolition of the timber-pile-supported portion of the South Jetty and removal of approximately 37,800 m^3 of contaminated sediments beneath the jetty for disposal at an upland landfill facility. The perimeter sheetpile wall installed in Phase 1A was redriven to serve as a portion of the Temporary Resuspension Barrier (TRB) around the Phase 2 work area. The entire Phase 2 area was capped (following completion of dredging activities) to isolate remaining contamination prior to the removal of the sheetpile wall and final modification of the remaining steel-pile-supported jetty to support ongoing operational use of the EGD facility. Dredge material from the Phase 2 area consisted of fine-grained sediments and fill materials, with contamination extending as deep as 5 metres (m) below the existing mudline. As a result, the Phase 2 design involved several measures to prevent recontamination, maximize the amount of contamination removed, cap any contamination that could not be removed, minimize disturbance to EGD operations, and provide a usable waterfront structure at the end of the construction. Phase 2 remediation was conducted by Malahat Nation-Quantum Murray and occurred from October 2015 to December 2016.

DESIGN AND CONSTRUCTION CHALLENGES

This paper describes the design and construction challenges of the Phase 2 remediation project. Design challenges included development of sequencing requirements for demolition of the timber jetty structure while meeting operational requirements for the facility; developing requirements for recontamination prevention, including performance specifications for floating and anchored silt curtain systems; maximizing contaminated sediment removal in areas with limited access (e.g., under-pier areas) and limitations due to the presence of structures (e.g., piers and piling, bulkhead walls); and innovative design of multilayer engineered sediment caps.

Challenges encountered during construction included timber jetty demolition and asphalt removal; contractor coordination with third-party designers to meet silt curtain design and bathymetric survey requirements; selection and implementation of innovative dredging technologies, including use of specialized equipment (e.g., Gradall mounted on Flexifloat, chain drag dredging, diver-assisted sediment jetting) to remove material from within the dredge prism; management of dredge residuals within a confined sheetpile wall enclosure; removal of historical retaining walls uncovered during dredging; and placement of engineered sediment capping materials in difficult-to-access areas using a combination of a purpose-built material conveyor, a mini-excavator, and a Gradall on Flexifloat.

South Jetty Demolition Construction Sequencing

The EGD Phase 2 design documents allowed the contractor flexibility for construction sequencing regarding demolition of the timber jetty structure. The jetty was divided into two areas. The West Jetty area included the section of structure west of the concrete deck and steel-pile-supported crane pad, and the South Jetty area extended to the eastern end of the project area in Pilgrim Cove, as shown in Figure 4.

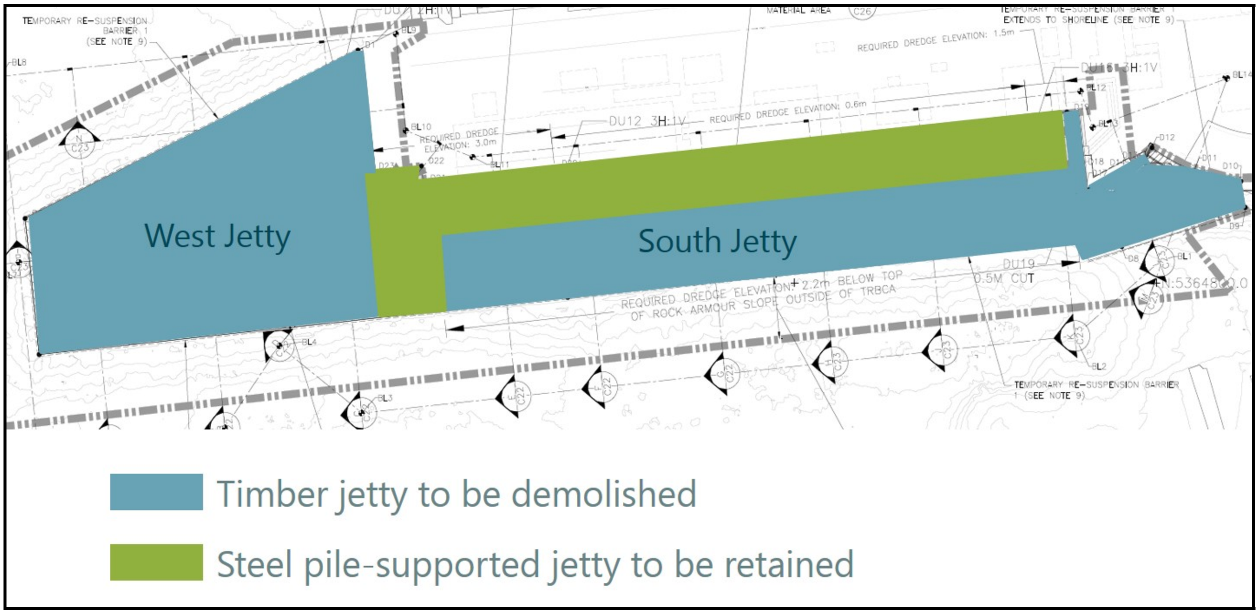

Figure 4. West Jetty and South Jetty areas.

The engineering design allowed the contractor to select how they would complete the jetty demolition activities in a manner that not only met facility operational requirements (e.g., vessel berthing, access to mouth of graving dock, and upland tenant coordination) but also provide flexibility so that multiple construction activities, such as structure demolition and dredging, could be performed at one time to maximize schedule efficiency. The design team evaluated several potential scenarios for restricting areas that could be worked in at different times to maintain operational flexibilities at the graving dock facility; however, the final design criteria favored schedule efficiency, and the contractor was ultimately allowed to access the jetty area in accordance with the sequencing allowances that best fit their means and methods for completion of the jetty demolition activities.

The contractor selected a demolition sequence that involved removal of the asphalt sections above the timber jetty deck first, followed by removal of decking, pile caps and stringers, and timber support piles. Reference Drawings were made available to the contractor to describe the layout of structural components and were considered sufficient to represent anticipated conditions for the completion of the structure demolition activities. The contractor elected to remove the asphalt sections for removal from the site and reuse at a recycling facility, followed by removal of the timber structure elements for transport to an upland landfill facility for disposal.

Construction challenges were encountered immediately as the contractor began asphalt section removal in the South Jetty area of the project site. The asphalt section did not peel back from the timber decking easily due to the presence of tack coat material that was applied between the bottom of asphalt and top of the timber jetty deck, and as a result, some treated timber decking was mixed into the asphalt material stockpiles, as shown in Figure 5.

Figure 5. Asphalt demolition challenges.

The presence of the tack coat material was not identified in the Reference Drawings provided in the project tender, which resulted in slower production rates and led to the mobilization of specialized equipment to complete removal of the asphalt material. Additionally, the mixing of treated timber debris into the demolished asphalt material resulted in the asphalt not being accepted at the recycling facility for reuse. The demolished asphalt and timber debris needed to be disposed of at a landfill facility, which resulted in the need to utilize contingency funding to cover the added costs for time used to remove and dispose of the demolition debris.

Requirements for Prevention of Recontamination

Preventing recontamination of the adjacent Phase 1B area was one of the primary challenges for Phase 2. The original design of the perimeter sheetpile wall was intended to continue to isolate under-pier contamination as part of the TRB system during Phase 2 construction, but several risks regarding recontamination to the Phase 1B area remained. These risks included the failure of the TRB, a spill of contaminated sediment from the derrick or dredge material barge, or deposition of suspended sediments with elevated contaminant concentrations associated with opening the TRB for vessel movement into and out of the work area. Design elements intended to address these risks and prevent and mitigate potential recontamination resulted in the need for an effective barrier to keep suspended sediments (generated as part of Phase 2 construction activities) within the TRB Containment Area (TRBCA).

Temporary Resuspension Barrier Containment Area

The design required a TRB system, which was to be designed by the contractor's third-party engineer, to address the potential for recontamination of the Phase 1B area due to migration of suspended sediments,. The design of the TRB system was guided by performance specifications provided in the engineering design and required the contractor to prepare and provide an Aquatic Water Quality Control Plan that included third-party engineer design details for the design, procurement, installation and maintenance of the TRB system throughout implementation of the Phase 2 project. The TRB included a floating silt curtain that overlapped with the top of the redriven sheetpile wall. The redriven sheetpile wall (installed as part of Phase 1B project activities) served as the lower portion of the TRB system. The area inside the TRB was designated as the TRBCA.

The objective of the TRB was to create a physical barrier around the jetty perimeter (and dredge equipment) to prevent the spread of suspended sediment generated during dredging operations. The TRB extended around the entire Phase 2 work area (Figure 6) and included an area along the eastern side where a full-length silt curtain was necessary because sheetpile could not be installed during Phase 1A due to the presence of shallow bedrock (Figure 7). The contractor partitioned the work area using additional "intermediate" TRBs to physically isolate contractor-defined subareas and thereby prevent recontamination during construction.

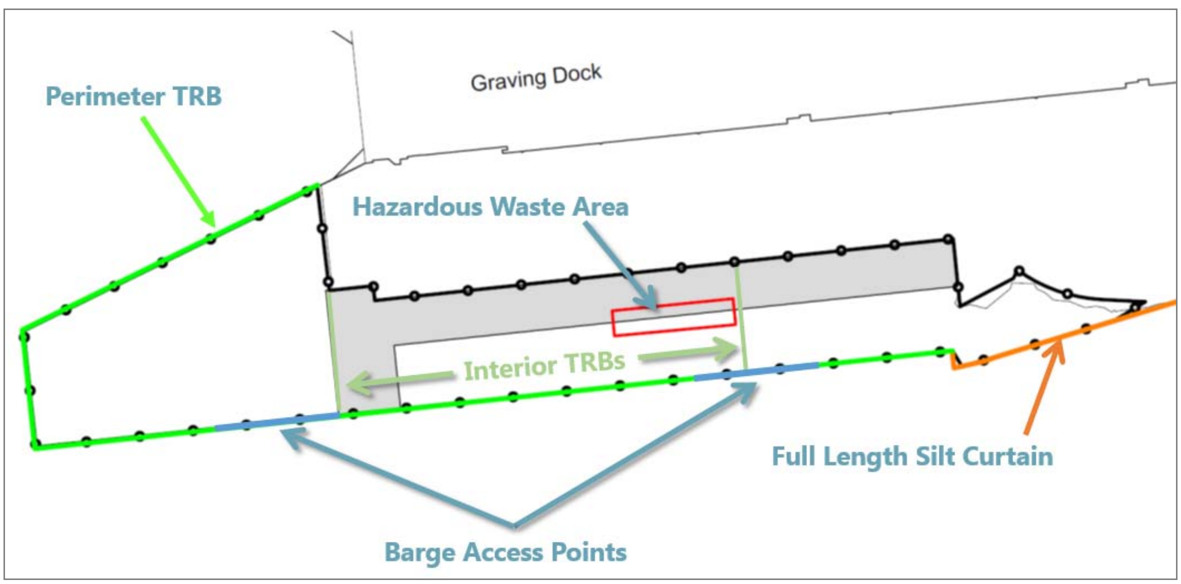

Figure 6. Perimeter and interior temporary resuspension barriers.

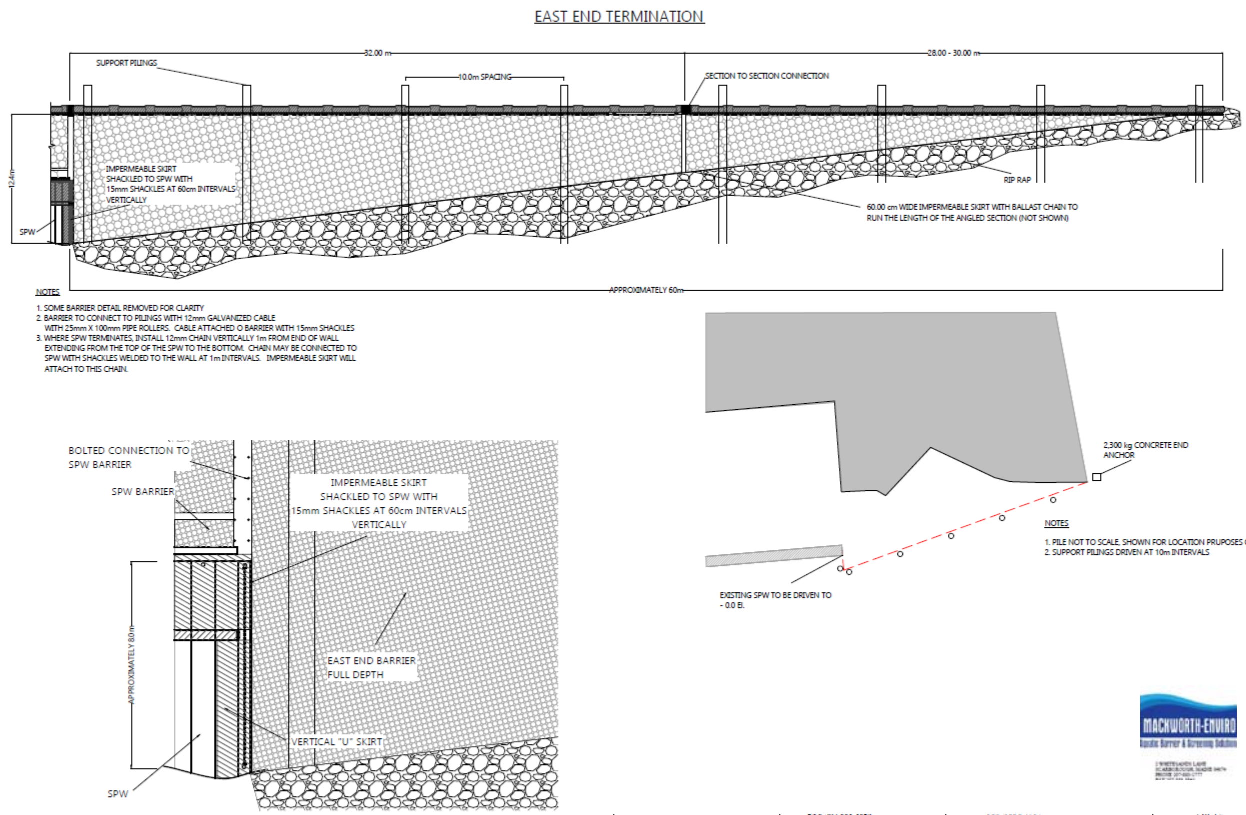

Figure 7. East end profile – full length curtain.

The TRB system was designed and stamped by the contractor's third-party engineer, Mackworth-Enviro. The contractor was required to develop a system that was capable of withstanding forces from wind waves and currents, as well as forces from its vessel movements.

The silt curtains used for the TRBs were made of flexible, reinforced, thermoplastic material, including a tri-layer filter media (FW402 – 10 ounces [oz]), suspended from a 2.5-centimetre flotation hood constructed of 36-oz CoolThane-coated nylon (Figure 8). The bottom of the curtain was constructed with an impermeable layer U-skirt, which overlapped on both sides of the top of the sheetpile wall that was anchored with a 12-millimetre chain ballast (Figure 9). TRBs are most effective on projects where they are not opened and closed to allow equipment access to the dredging or disposal area; however, for Phase 2 of the project, it was necessary to allow several openings of the TRB to facilitate ingress and egress of the contractor's equipment into and out of the TRBCA.

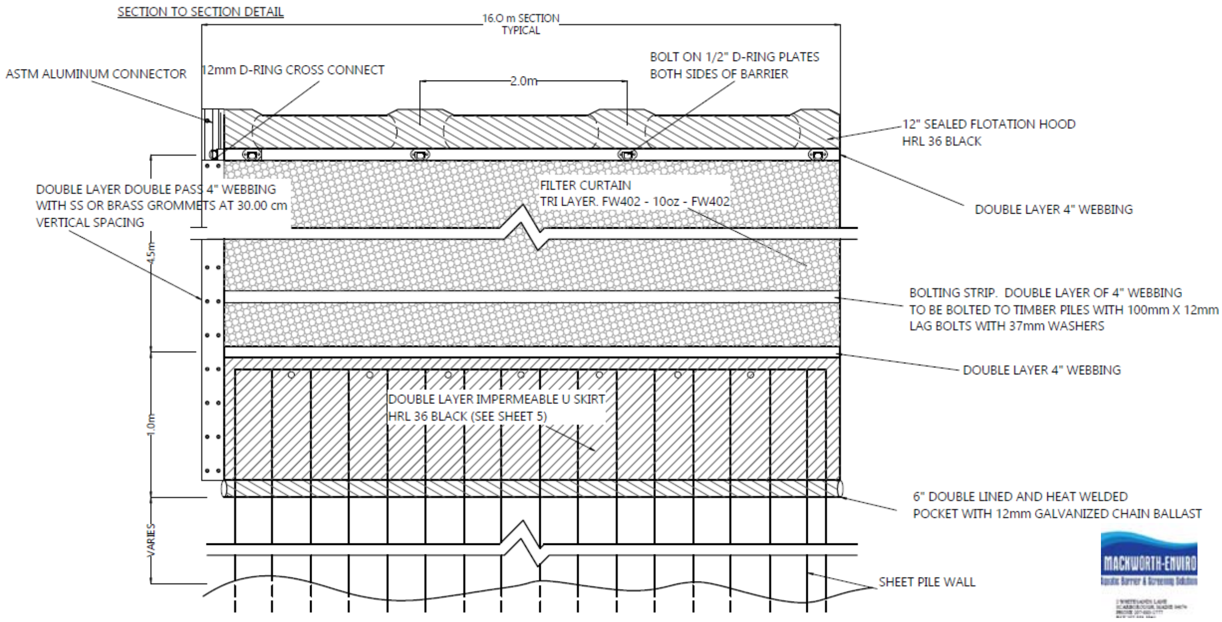

Figure 8. Typical perimeter temporary resuspension barrier curtain.

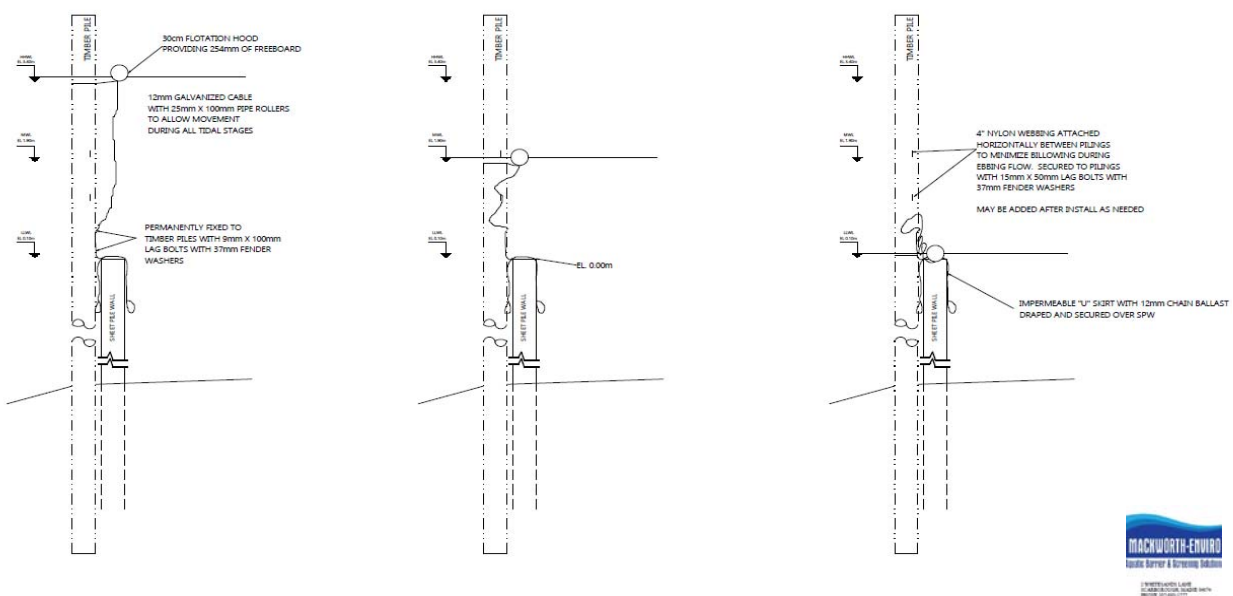

Figure 9. High/low water perimeter temporary resuspension barrier profile.

The TRB system was procured and installed prior to the extraction of timber piling completed as part of South Jetty demolition activities for the project. Schedule delays were realized during design and fabrication of the silt curtain system which resulted in delay in delivery of the system materials to the project site. Installation challenges included deploying the TRB system and anchoring it to temporary mooring piles and the seabed in accordance with the requirements of the third-party engineer design. Additionally, fabrication of the full-length curtain shown on Figure 7 and the interior TRB sections (Figure 6) did not match the seabed profile, and in-field modifications to the system were required during installation to better fit the curtain to the bathymetry profile for the project site (Figure 8).

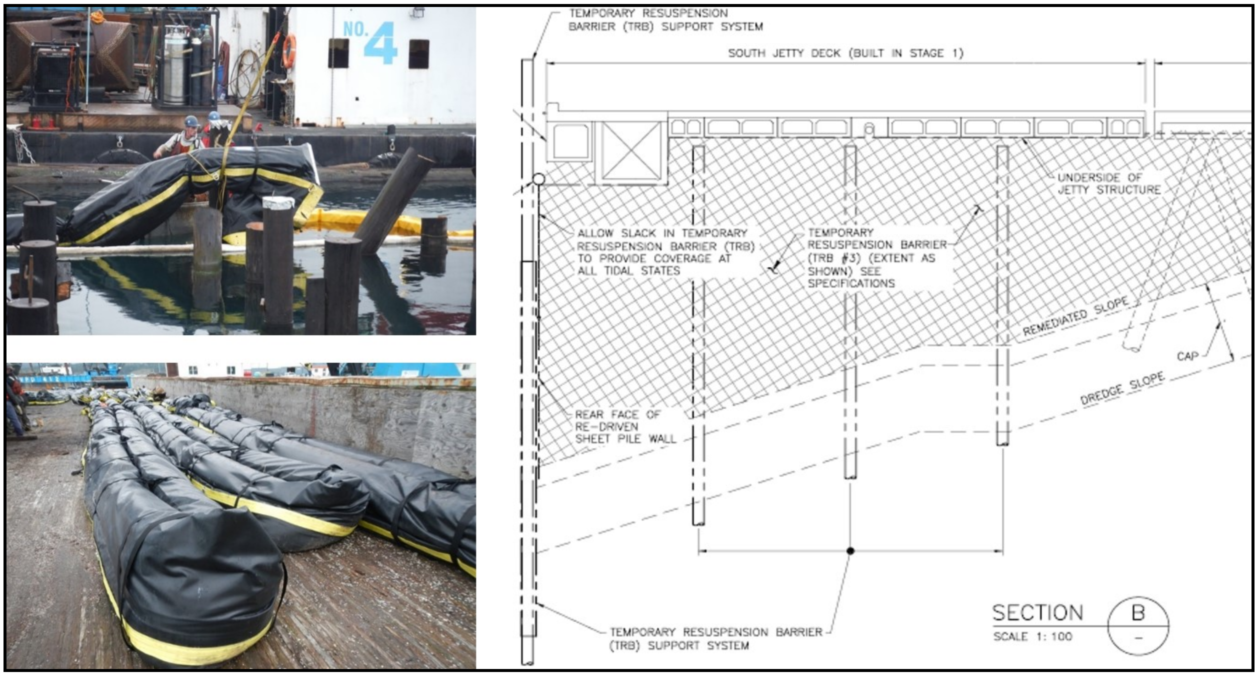

Figure 10. TRB system deployment and bathymetry profile fitting.

After deployment of the TRB system and during completion of dredging activities for the project, several maintenance issues were discovered that required routine repair to the TRB system so that it could meet water quality requirements for the project. Maintenance issues were attributed to the operation of vessels in and around the graving dock facility and normal wear and tear on the TRB system materials associated with the marine environment and the operation of marine construction equipment close to the TRB.

Overall, the TRB system proved to effectively prevent recontamination of the remediated area outside of the TRBCA; however, the results of water quality monitoring and confirmatory sediment sampling conducted throughout the duration of the project identified that some recontamination of surface sediments did occur in the eastern portion of the project site, and the contractor was required to place a thin layer (approximately 0.3 m thick) of clean sand material as residuals management cover to mitigate the effects of the recontamination that occurred.

Maximizing Sediment Removal – Dredging Approach

Dredge Prism Design

The dredge prism identified the minimum horizontal and vertical extents of required dredging for the contractor as part of the Phase 2 project and is shown in Figure 11. The dredge prism has two components: the required dredge prism and the allowable overdredge. The required dredge prism represents the elevation, grades, and horizontal extent of sediment that a dredging contractor is required to remove. The allowable overdredge is a constant thickness of sediment below the required dredge prism that design engineers typically allow to account for equipment inaccuracies and tolerances. The design of the dredge prism accounts for the fact that it is not possible for any dredge to excavate to an exact surface and that the dredge ends up removing excess material below the required dredge prism.

A major consideration during the design of the dredge prism for the Phase 2 project was the presence of creosote-treated timber piles throughout most of the project area. Predesign sediment borings drilled through the jetty deck identified the presence of elevated PAH concentrations up to 5 m below mudline in several areas. Per the remediation objectives for the project, the dredge design was developed to remove the highest concentrations of these PAHs and other contaminants that exceeded the cleanup criteria. However, due to structural and geotechnical limitations, not all sediment that exceeded the cleanup objectives could be removed, and engineered sediment caps had to be constructed to address remaining contamination left behind following completion of dredging activities.

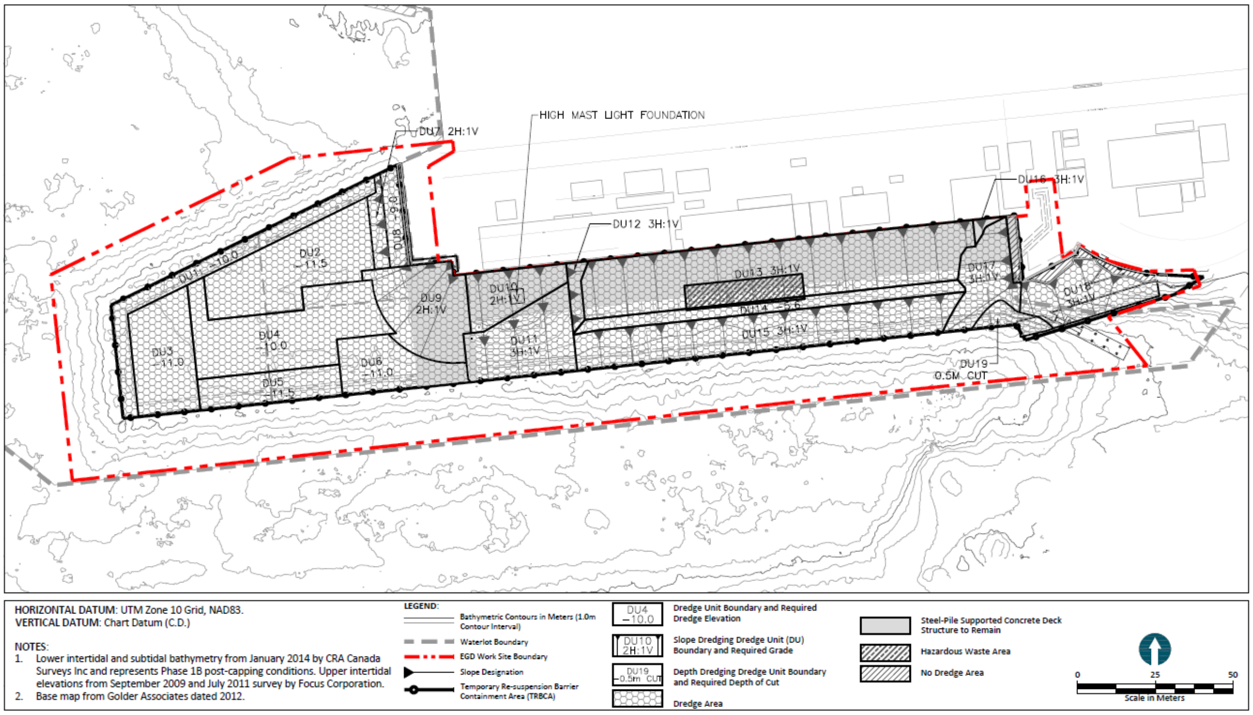

Figure 11. Phase 2 dredge plan.

To develop the dredge prism for remediation as part of Phase 2 design activities, a neatline surface representing the predicted deepest vertical extent of contamination through the project area was developed and used by the design engineer to specify the minimum required depth of removal for contaminated sediments.

The neatline surface for Phase 2 of the project was estimated using a triangular irregular network (TIN) of depth of contamination to determine the elevation and configuration of the clean sediment surface. Elevations were established for each boring to generate the TIN by subtracting the depth of contamination from the mudline surface elevation to derive the elevation of the base of the contaminated interval (i.e., the target neatline dredge elevation). It should be noted that the actual remediation volume was greater than the neatline volume due to dredge prism design constraints and incorporation of a payable overdredge allowance (selected at 0.3 m below required dredge grades and elevations based on previous project work completed at the EGD facility).

Geotechnical and Structural Restrictions

Several existing adjacent structures also required specific measures to prevent damage from remediation operations, including the timber crib near the mouth of the graving dock, an anchored sheetpile wall bulkhead, a small concrete retaining wall at the east end of the South Jetty, and all steel piles supporting the remaining jetty. These areas required setbacks from dredging operations and slope protection, where contaminated sediments could not feasibly be removed without potentially causing significant damage to infrastructure.

Equipment Selection

Equipment used to implement the remedial design was specified based on the ability to achieve the remedial objectives and site conditions to ensure the selected dredging method was feasible for remediating specific portions of the project area. The design required mechanical dredging as the method to be used for all remediation dredging, and hydraulic dredging was not allowed due to the presence of large debris and rock in the under-pier areas of the project area.

The type of mechanical dredging equipment used for this project ranged from a traditional clamshell dredge for debris removal operations, environmental buckets for cleanup pass and water quality considerations, and articulated and/or telescoping dredges (e.g., Gradall) in the areas beneath the steel-piled concrete deck structure. In addition to the mechanical dredges, a small excavator was used to remove material in intertidal under-jetty areas where access was feasible. Examples of some different dredging equipment types are shown in Figure 12.

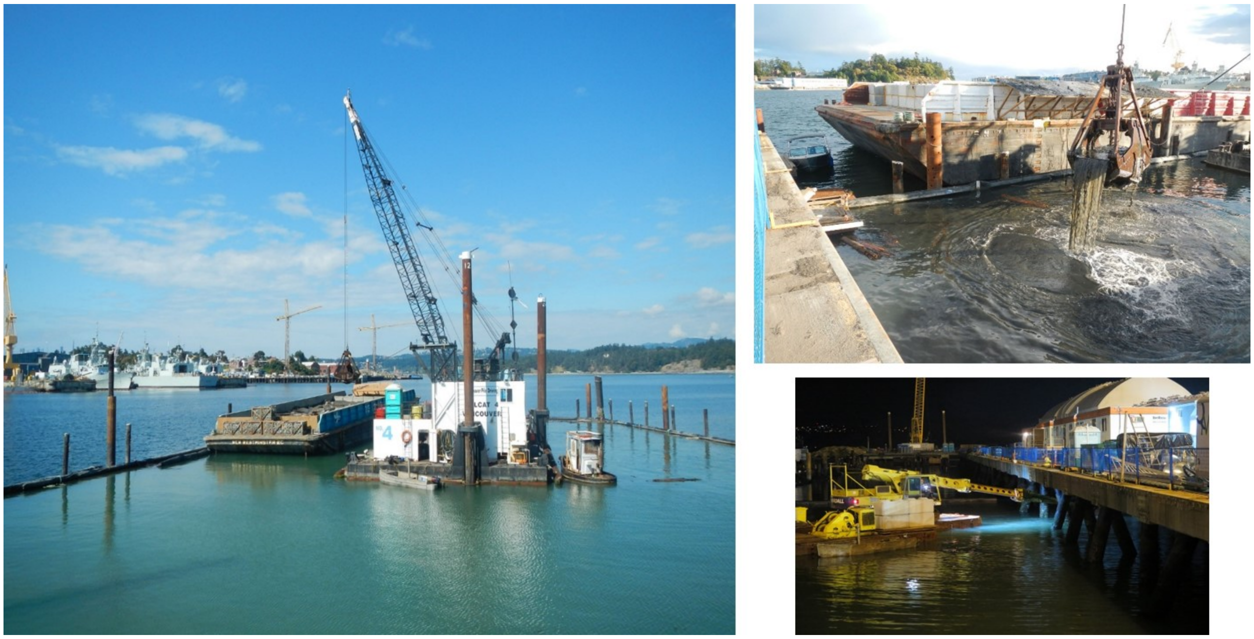

Figure 12. Mechanical dredging equipment.

Construction challenges encountered during completion of dredging activities included issues accessing under-pier areas and equipment reaching and removing the required volume of contaminated sediment, equipment encountering hard substrates and debris that complicated removal of the contaminated sediments, and dredge residuals generated due to contractor equipment and sequencing of work that required additional removal actions to be implemented in order to achieve cleanup objectives.

Several areas of the Phase 2 project site involved removal of contaminated material below existing pier decks and around support piling that were to remain in place and not be damaged during implementation of the project. In some cases, the equipment selected to complete the dredging activities was limited in access to these areas and could not meet the removal requirements of the design. The contractor was required to come up with innovative dredging technologies in an attempt to meet the design requirements, including implementation of non-conventional dredging technologies such as chain dredging (e.g., fabrication of articulated steel chain to pull back and forth between pile bents in under-pier areas where mechanical dredge equipment could not access) and the use of hydraulic jetting to loosen dense material and debris and move them to locations where they could be removed with the mechanical dredge equipment. Figure 13 shows examples of these innovative technologies that were implemented in under-pier and difficult-to-access areas for the project and assisted with removal of additional material that could not be accessed with the conventional dredging equipment.

Figure 13. Innovative dredging technologies (left, chain dredge; right, hydraulic jetting)

Additional dredging challenges included contractor generation of significant dredge residuals due to implementation of aggressive mechanical dredging technologies in the under-pier project areas. Use of the Gradall and other equipment to loosen material and move it to access points where it could be removed with a dredge bucket resulted in dredge residuals that moved down the slope cut areas and accumulated at the base of the redriven sheetpile wall. The fluid nature of these residuals limited their ability to be removed with the mechanical equipment available at the project site; however, the contamination concentrations of the material were elevated above the cleanup requirements and necessitated removal prior to construction of the engineered sediment caps. The significant accumulation of dredge residuals at the base of the dredge slope was also attributed to contractor sequencing for completion of the under-pier and open-water material removal activities. Dredging was not performed in uniform sequence of material removal from top of slope downward and this allowed for dredge residuals to accumulate in previously-dredged areas near the face of the redriven sheetpile wall.

Following assessment of the residuals contamination characteristics and working the contractor to correct sequencing issues that resulted in continued generation of the dredge residuals, the material was removed via hydraulic suction dredging (diver assist) from the base of the redriven sheetpile wall. The contractor mobilized a dive team and staged Geotubes on a barge moored outside the TRBCA and proceeded with completion of diver-assist hydraulic suction dredging to remove the dredge residuals from the project area. The diver team completed their work following completion of other mechanical dredging work in the area and were successful in removing the dredge residuals from the base of the redriven sheetpile wall. The dredge slurry was pumped into the Geotubes (staged on the moored barge) and dredge water was pumped back into the TRBCA. Sediment that accumulated in the Geotubes was taken off site for disposal at an upland landfill facility.

Engineered Sediment Capping

Some areas of contaminated sediment could not be removed because they were within required structural setback areas or geotechnical slope limitations. In addition, PAH contamination associated with existing and historical creosote-treated wood piles was beyond feasible dredging depths in some areas. For sediment contamination that could not be removed, placement of an engineered sediment cap was required by the design.

Engineered Sediment Cap Types

Due to differences in slopes, propwash forces, chemical concentrations, and other parameters, several different cap types were designed for construction around the South Jetty structure. Specifically, five different caps varying in composition of the required isolation material (sand) and armour material were designed for Phase 2 (Figure 14) consisting of combinations of rock armour, filter layer, and sand isolation material.

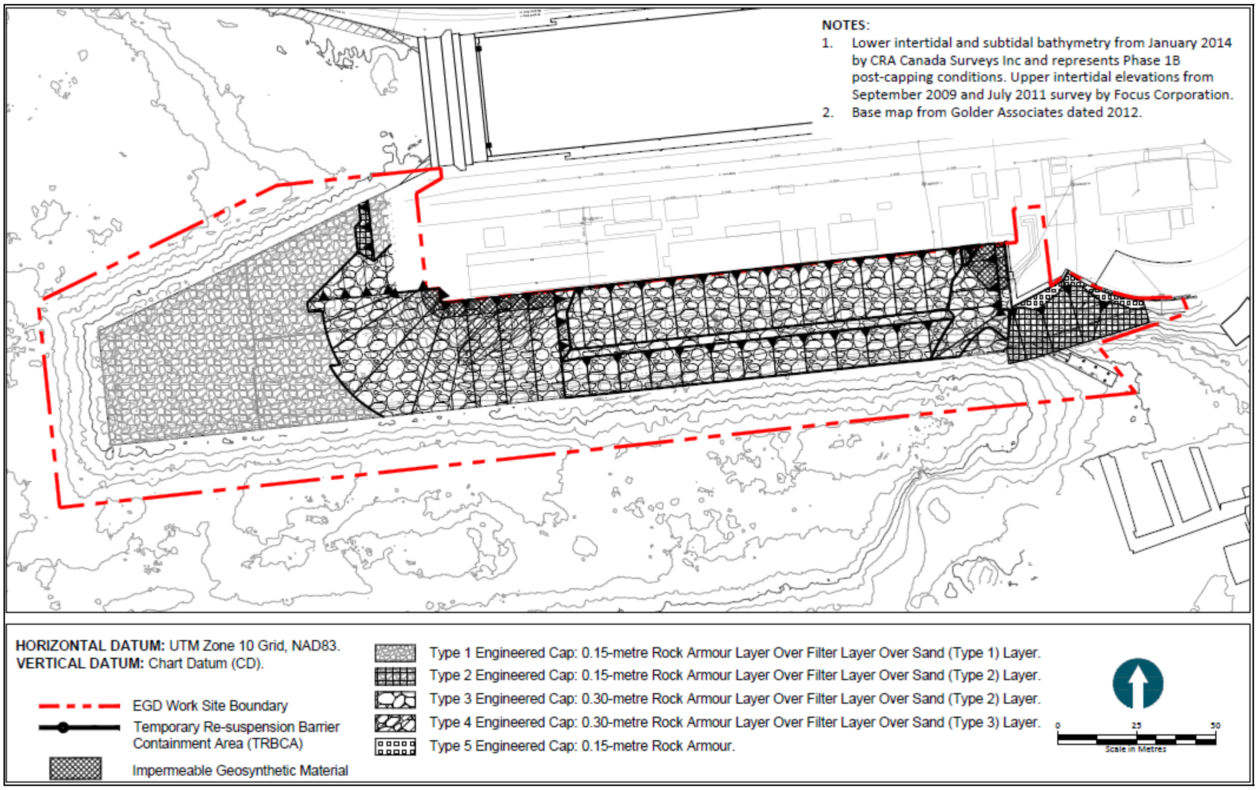

Figure 14. Phase 2 capping plan.

Impermeable Liner

An impermeable geosynthetic material was also incorporated into the design to supplement the chemical isolation layer in the upper portions of the Cap Type 3 and 4 areas near the existing sheetpile bulkhead wall, where the full thickness of the sand material layer could not be placed. In this area, the dredging elevation was restricted by the geotechnical slope recommendations required to support the existing sheetpile bulkhead wall, and the elevation of the overhead concrete structure of the remaining jetty also restricted the capping material placement thickness. The impermeable geosynthetic material was designed to form one continuous section of material and was placed directly on top of the post-required dredging surface.

Construction challenges in placement of the engineered sediment cap materials primarily included equipment access to the under-pier areas. The contractor developed an innovative approach to place material in the under-pier areas using a material conveyor staged on an engineered Flexifloat system. The equipment set up was small enough that it could move within the TRBCA, and a larger derrick barge and material barge could be staged outside the TRBCA to load and conveyor as it placed the different capping materials. Additionally, the contractor built an access road along the upper slope areas (beneath the jetty deck) to allow for access of small dozers and excavators that assisted with movement of the material as it was placed from the conveyor system. Figures 15 and 16 provide some examples of the equipment and configurations that were used for construction of the engineered sediment caps.

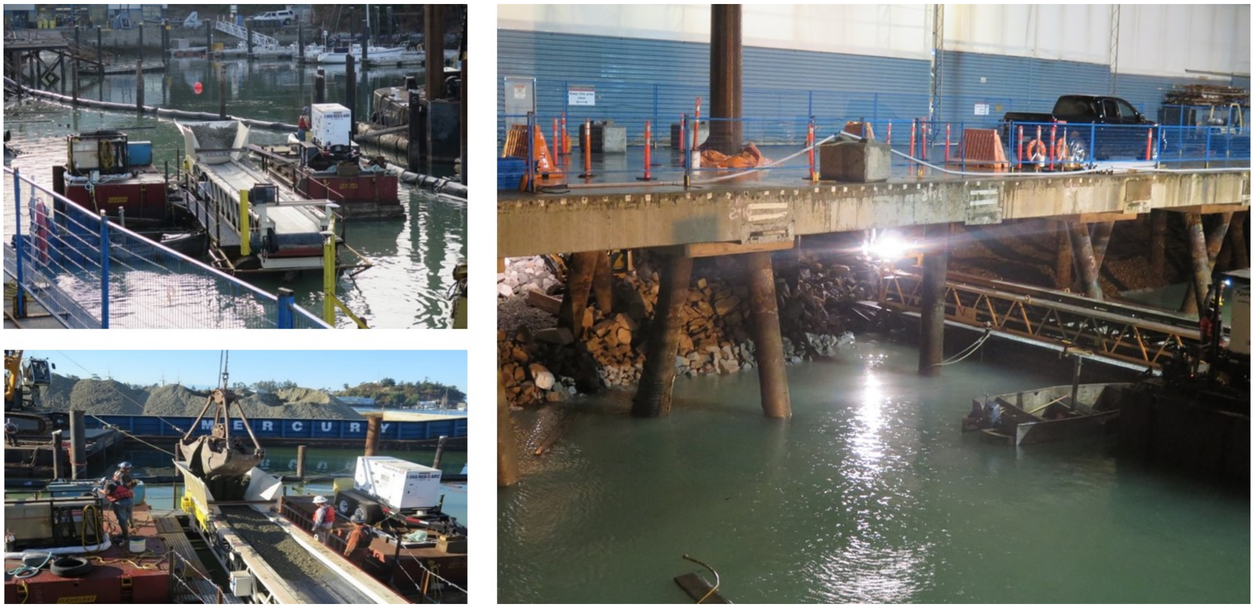

Figure 15. Conveyor equipment for placement of engineered capping material.

Figure 16. Under-pier road access and engineered cap construction.

CONCLUSIONS

This paper describes the key design and construction challenges faced by PWGSC, the consultant design team, and the remediation contractor for implementation of Phase 2 of the EGD Project. The complexity of the project necessitated adaptive management and coordination with the remediation contractor throughout all aspects of project implementation, and the challenges encountered can serve as examples for future project design and implementation coordination. Phase 2 of the EGD Project was completed in accordance with the design objectives set forth for the cleanup effort and can be utilized as a valuable case study for other complex sediment remediation projects.

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