2015 WEDA ENVIRONMENTAL EXCELLENCE AWARD

NOMINATION FOR CONSIDERATION FOR ENVIRONMENTAL DREDGING

ANCHOR QEA

Public Works and Government Services Canada | Travaux publics et Services gouvernementaux Canada

Public Works and Government Services Canada Phase 1 Esquimalt Graving Dock Waterlot Remediation Project

Nomination Submitted by WEDA Member Anchor QEA, LLC

SUMMARY

The Esquimalt Graving Dock (EGD) Waterlot is located in Esquimalt Harbour on Vancouver Island, British Columbia, and has a long history of naval and industrial activity within the harbour and on the uplands along the shoreline, dating back to the mid-1800s. The EGD, which has been operating since 1927, is managed by the federal custodian Public Works and Government Services Canada (PWGSC). The EGD is one of the largest solid-bottom commercial drydocks on the West Coast of the Americas and is 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, tributyltin (TBT), polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs). The highest levels of sediment contamination were found near the mouth of the EGD and beneath the South Jetty.

The remediation was conducted as part of the Government of Canada Federal Contaminated Sites Action Plan (FCSAP), which is a cost-shared program that supports federal departments, agencies, and consolidated Crown corporations in addressing contaminated sites for which they are responsible. The primary objective of this program is to address the risks these sites pose to human health and the environment and to reduce the associated financial liability. Completion of the project 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 project focused on removing the maximum amount of contamination practicable in an expedited timeframe, while minimizing interruptions to graving dock facility operations.

In support of these goals and objectives, PWGSC developed a multi-phase remedial action plan and engineering design for cleaning up contaminated sediments within the Waterlot and in adjacent areas administered by the Department of National Defence (DND). Phase 1 consisted of remediation of open-water sediments, excluding sediments beneath the South Jetty, which will be addressed in Phase 2 starting in 2015 (Figure 1). Phase 1 project work was completed between November 2012 and April 2014.

- Phase 1A consisted of installation of a temporary under-pier erosion protection sheetpile perimeter wall around the existing timber jetty to prevent re-contamination of remediated sediments during subsequent phases of the project (completed in April 2013).
- Phase 1B consisted of remediation of the open-water area of the Waterlot, with maximum practicable removal of approximately 144,000 cubic metres (m^3) of contaminated sediments, placement of approximately 24,000 m^3 of in-water slope armour, and placement of residuals management cover (RMC) over approximately 74,000 square metres (m^2) (completed in March 2014).
- Phase 1C consisted of construction of new intertidal marsh fish habitat 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 temporary under-pier erosion protection sheetpile wall in Phase 1A, as well as impacts to kelp beds and subtidal sediment habitats (completed in April 2014).

Use of the sheetpile perimeter wall provided an innovative approach to completing the phased remediation. The construction 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 operations at a very active EGD facility during construction. The project implemented a number of measures to ensure a high level of certainty in the project outcome through the use of a conservative, practical, and constructible design; proven technologies; and qualified contractors.

PROJECT TEAM MEMBERS

Project Owner: Public Works and Government Services Canada

Anchor QEA, LLC

Current WEDA Members on Project Team: Tom Wang, P.E., Matt Woltman, P.E., and Dan Berlin

Role: Remediation design and construction oversight

Klohn Crippen Berger

Role: Structural engineering

Golder Associates, Ltd.

Role: Site investigation, permits/approvals, environmental monitoring, geotechnical investigations, archaeology, habitat compensation design

SLR Consulting, Ltd.

Role: Site investigation, environmental monitoring, confirmatory sampling

Salish Sea Industrial Services

Role: Phase 1A prime contractor

Tervita Corporation

Role: Phase 1B prime contractor

Fraser River Pile and Dredge

Role: Phase 1B dredging contractor

Tsunup Ventures LP and their general partner, JJM Construction

Role: Phase 1C contractor

Nominating Entity: Dan Berlin, Anchor QEA, LLC

ENVIRONMENTAL BENEFITS

The EGD Waterlot Remediation Project is the largest sediment remediation project completed in Canada to date. EGD is located within Esquimalt Harbour, where elevated contaminant levels from years of industrial and commercial use have required fish consumption advisories. The EGD Waterlot contained some of the highest concentrations in the harbour prior to remediation, including very high levels of PCBs, PAHs, tributyl tin, and other metals up to 100 times cleanup criteria (Figure 2). This project incorporated conservative decisions to take the first key step in remediating contamination in the harbour, resulting in reduced risk to ecological receptors, and an expected reduction in human health risks associated with the consumption of Esquimalt Harbour seafood, once other sites in the harbour are remediated.

Remediation of the EGD Waterlot was a high priority for PWGSC and received FCSAP funding to conduct the $60M Phase 1 project. However, capital funding was not available to rebuild the South Jetty in concert with its remediation. A unique phasing approach was developed to contain and isolate sediment contamination under the South Jetty until a later date when Phase 2 remediation could be conducted. The temporary sheetpile perimeter wall was installed to isolate underpier contamination to support open-water dredging. Major structural components including steel sheetpiles were designed with a minimum service life of 10 years, based on the assumption that the aging South Jetty structure would need to be replaced within that timeframe. The sheetpile wall would be removed following demolition of the South Jetty and completion of Phase 2 remediation.

For the Phase 1B open water area, to remove the maximum contamination practicable, the remediation design was based on the extent of contaminated sediments that exceeded the most stringent of applicable federal and provincial generic numeric criteria. These criteria were also used as part of an intensive contingency re-dredging program to remove missed inventory and generated residuals following the completion of required dredging. The post-dredge confirmatory sampling program used an intensive sampling program, with surface and subsurface sediment samples collected every 25 metres, to ensure maximum removal and confidence in final site conditions. Approximately 41% of the project area was subject to contingency dredging, resulting in a final contingency re-dredging volume of 23,581 m^3, or 16% of the entire dredge volume (Figure 3).

Very minimal water quality impacts were generated as a result of the 10-month project. A fixed 50-foot by 50-foot frame was used to support a 6-m long silt curtain around the mechanical dredging operation,

which assisted in minimizing water quality impacts. Water quality compliance monitoring was conducted at monitoring locations 25 and 100 m from the work activity and consisted of turbidity, total suspended solids, and chemical monitoring throughout the water column to ensure compliance with stringent water quality criteria developed for the project. Passive dewatering was not completed on material barges in Phase 1B due to concerns about meeting water quality criteria. Instead, an advanced water treatment system was used for on-site treatment of dredgeate water, which was sited on a barge due to constrained access in the on-site upland areas. Treatment involved physical separation of solids and water in order to meet TSS and turbidity requirements for discharge. Sediment dewatering and water treatment was completed at night, so the treatment/dewatering barge was ready for the next day's dredging activities.

Following dredging, a 0.3 m thick clean sand residuals management cover (RMC) layer was placed over the entire dredge area to provide a clean post-construction surface. All areas were below the cleanup criteria following placement. Year 1 monitoring data indicate that some mixing of underlying sediments with RMC material has occurred from propwash and currents (as expected), and that the surface sediment concentrations remain below cleanup criteria. Areas with elevated contaminant concentrations adjacent to structures that could not be removed were covered and armoured to prevent exposure of remaining contaminated sediment.

Tight design tolerances for dredging and in-water slope armour material placement were required to successfully complete Phase 1B. An environmental bucket was used to achieve the payable overdredge allowance of 0.3 m rather than a traditional clamshell bucket due to the environmental bucket shape and allowance for completion of a near-flat cut. Baffled dredge buckets were used to reduce collection of water. In-water slope armour material placement also required precise placement activities, especially on slopes adjacent to structures, which required placement of slope filter material and armour rock as two separate layers with overplacement allowances of 0.15 m for filter material and smaller armour rock and 0.3 m for larger armour rock. Use of QINSy software and electronic depth control via line counters were effective in achieving these tolerances/allowances.

The habitat compensation portion of the project was also successful in offsetting temporary impacts associated with Phase 1A and 1B construction. Year 1 monitoring has indicated that the intertidal marsh habitat is developing successfully.

INNOVATION

Sheetpile Wall

Phase 1A consisted of the installation of a temporary underpier 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 remediated as part of Phase 1B of the project. The sheetpile wall provided a barrier against waves and 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 to minimize the disruption for EGD operations and to accommodate fishery windows.

When initially installed, the sheetpile wall was pinned to the seaward edge of the deck of the timber jetty structure. This design of the sheetpile wall also considered requirements to contain suspended sediment generated during Phase 2 remediation. Prior to the initiation of Phase 2 remedial activities, the timber jetty structure will be removed and the wall will be driven deeper to an approximate top elevation of 0 m Chart Datum, in order to maintain its stability while still isolating the Phase 2 contaminated sediments from the newly remediated Phase 1 sediments.

When unpinned and driven deeper, the sheetpile wall design will change from a propped cantilever system to a free cantilever system. To understand the stability of the wall after the re-drive, the design for the original

sheetpile length/type and embedment requirements was based on an analysis of propwash forces on the sheetpile wall both following Phase 1 installation and during Phase 2 remediation using a Computation Fluid Dynamics (CFD) model. Additionally, the dynamic pressure acting on the sheetpile wall due to waves and suction forces was estimated to support the structural and geotechnical design. The re-driven sheetpile wall along with an integrated floating silt curtain will form a resuspension barrier to prevent recontamination of the Phase 1 area during Phase 2 remediation.

Sequencing

Sequencing and long-term scheduling of remediation activities was crucial to the ongoing operation of the EGD throughout the cleanup. The EGD is a popular location for the repair and refit work for cruise ships and bulk and general cargo vessels, ferries, naval and coast guard vessels, and other special purpose vessels. The EGD has the ability to service more than 90% of vessels operating on the West Coast of the Americas and receives more than 50 vessel calls per year. The Waterlot facility also includes temporary vessel moorage at the North Landing Wharf and the South Jetty. EGD vessel schedules and operations are recorded several years in advance to accommodate the incoming and outgoing flow of vessels; however, unscheduled access to these facilities is sometimes necessary for emergency vessel repairs. Besides EGD operations, coordination was also required for work in areas with structures owned and operated by DND, including two marinas. Coordination with the Queen's Harbour Master was required for all vessel navigation in Esquimalt Harbour.

Construction duration was limited to 10 months, and nearly all staging was conducted on marine vessels due to the limited upland staging areas available at EGD, further challenging scheduling and logistics for construction. A specific construction sequence was required to provide certainty for EGD operations in the Waterlot and to minimize the potential for recontamination from vessel propwash, with dredging conducted in the Zones with the highest concentration sediments first (Figure 2). However, the vessel booking schedule and arrivals/departures of vessels to/from the EGD work site inevitably changed throughout the project. Following the completion of dredging activities in a Zone, post-dredge sediment confirmation testing was conducted, which informed contingency re-dredge requirements. Slope armour materials were then placed in that Zone prior to initiating dredging activities in the next Zone, unless work could be conducted concurrently without disturbing EGD operations. In many cases, moving to another Zone required a coordinated relocation of moored vessels. RMC was then placed over the entire project area after the completion of all dredging and armouring activities to provide a clean post-construction surface, which required additional coordination and sequencing of all Zones.

Maximum Contaminant Removal

One of the most significant challenges was the presence of fine-grained contaminated sediments in the project area, which increased the potential for recontamination of remediated areas and deposition of dredge residuals. This risk was especially important at an active facility such as EGD. A number of measures were taken during design and construction to maximize the amount of contamination removed and minimize the impact of dredge residuals, starting with development of the dredge prism design. A statistical assessment was performed to conservatively increase confidence that maximum contamination removal could be achieved. Geostatistical interpolation, or kriging, was used to develop a three-dimensional contaminated neatline surface to predict the deepest vertical extent of contamination throughout the project area. Confidence levels were estimated for a range of potential dredge prisms, ranging from 50% for contaminated neatline removal with no paid overdredge volume to 99% for a dredge prism design with 0.5 m payable overdredge. PWGSC elected to complete remediation using the dredge prism design plus 0.3 m of allowable overdredge, resulting in a confidence level of 94% that all contaminated material would be removed.

In order to manage post-dredge residuals at the EGD Waterlot, the use of appropriate dredging performance standards, residual monitoring methods,

and residuals management measures were implemented. The post-dredge confirmation sampling program consisted of an intensive surface and subsurface sampling program with samples collected at higher density than the design testing program. The goal was to identify any limited areas where residual contamination was present above the sediment cleanup levels. These areas were then subject to contingency re-dredging and RMC placement. Re-dredging decisions were based on a predictive model using propwash mixing predictions, actual confirmatory sampling data, and assumption of placement of an RMC layer. Re-dredging was required if the predicted long-term mixed concentration was above cleanup criteria. Although some sampling data indicated full compliance with cleanup levels following dredging, PWGSC conservatively required placement of the RMC layer over the entire project area at the end of construction to ensure a clean post-construction condition.

Sustainable Approaches

Each Phase 1 contractor maximized use of local suppliers and other sustainable materials to limit the impact of transporting materials over long distances and support sustainability goals. They implemented a waste reduction program for reuse or recycling of waste materials, thus diverting materials from landfills. Phase 1A maximized reuse of the fender system, including fender logs and extracted timber fender piles that were suitable for reinstallation following sheetpile wall installation. Phase 1B utilized a disposal facility and armour rock supplier on Vancouver Island to reduce impacts associated with barging to the mainland. Phase 1B rock removed from the project area as part of dredging was also washed and reused as armour where possible. Other sustainable measures included use of environmentally responsible "green" materials and products with no or minimum volatile organic compound (VOC) emissions, use of materials and products containing the highest percentage of recycled and recovered materials practicable, carpool/rideshare programs, limitation of idling time for contractor vehicles and equipment, and use of biodegradable hydraulic oil in all marine equipment.

ECONOMIC BENEFITS

The Waterlot project was intended to further define and then reduce or eliminate PWGSC financial liabilities associated with sediment contamination originating from historical sources from the long history of ship building, repair, and maintenance. The site could be transferred to another entity as part of a potential future governance change, with the potential for any future increase in contamination, and associated liability, to be the responsibility of the new operating agency. PWGSC recognized that implementation of a less aggressive/comprehensive remediation project would not adequately reduce financial liability. Quantifying liability reduction from remediation and/or risk-management to a human health or ecological risk-based standard was problematic given the harbour-wide context; other DND-administered areas are contaminated and a management plan is in development. Completion of the dredging to remove the maximum amount of contamination allowed PWGSC to significantly reduce the environmental financial liabilities carried by the department.

Another benefit of the project was an improvement in navigation depths for vessels using the facility. This contributes to the continued operation of the EGD facility, which has an estimated total economic impact on British Columbia's economy of $183 million and supports an estimated 1,300 jobs in the greater Victoria area, generating approximately $16.5 million annually in federal, provincial, and municipal taxes. Continued operation of the EGD during the project was also essential to the vessels that rely on it, particularly a large fleet of BC ferries, naval and coast guard vessels, and cruise ships.

Other economic benefits resulted from the project to First Nations and the local community. PWGSC utilized separate construction contracts for Phases 1A, 1B, and 1C. Construction of the sheetpile perimeter wall (Phase 1A) and habitat compensation (Phase 1C) were set aside under the federal government's Procurement Strategy for Aboriginal Business (PSAB), which required that the contractor qualify as an Aboriginal business. This strategy assists aboriginal businesses to compete for and win federal contracting opportunities. For

Phase 1A, Salish Sea Joint Venture was comprised of members from the Esquimalt Nation and Songhees Nation in partnership with Pacific Industrial Marine. For Phase 1C, Tsunup Ventures was comprised of members from Tsartlip First Nation, in partnership with JJM Construction. In addition, First Nation members were employed by PWGSC to support water quality monitoring activities for Phase 1B, and archaeological monitoring for Phase 1C.

Other components of the project resulted in cost-effectiveness, particularly the use of on-island disposal and material suppliers, reducing the resources needed to complete the project. Barge and land transport to and from the project site was reduced compared to what would have been necessary for trips to and from the mainland. Reuse of timber fender piles and the existing fender system and armour rock also reduced costs and amount of resources required.

TRANSFERABILITY

The EGD Waterlot Remediation Project is the largest contaminated sediment dredging project completed by the Canadian federal government. It has provided substantial learning opportunities for PWGSC in terms of planning, designing, and managing a large, complex sediment remediation project using multiple construction contracts and a coordinated team of consultants and engineers. These lessons were shared with other federal staff through multiple presentations at the 2012 Real Property Institute of Canada Federal Contaminated Sites National Workshop in Toronto, and the 2014 Workshop in Ottawa.

The project has also provided opportunities for transfer of technical innovations to the engineering and consulting community. Key innovations used on this project have been shared at multiple WEDA conferences, including project planning and phasing and effective environmental dredging techniques, particularly with respect with maximizing contaminant removal and managing residuals. Phase 1 design challenges were presented at the 2012 Dredging conference in San Diego, and at the 2013 WEDA conference in Honolulu. Design, construction, and contracting challenges were presented at the 2014 WEDA conference in Toronto and at the 2014 Pacific Chapter WEDA conference in Seattle. A technical paper on the Phase 2 project design is planned to be presented at the 2015 WEDA conference in Houston. Tervita has also shared their experience with the contractor community through multiple presentations on Phase 1B in Canada, including at the 2014 Remediation Technologies Symposium and 2014 British Columbia Environment Industry Association conference on Bettering Environmental Stewardship and Technology.

OUTREACH AND EDUCATION

PWGSC incorporated public communication and outreach efforts throughout the entire project. Key stakeholders included First Nations, EGD tenants, agencies/regulators, and members of the public/community. PWGSC coordinated with the Esquimalt Nation and Songhees Nation early during project planning, which included meetings with both Chiefs and Council to address key concerns regarding habitat impacts and potential archaeological resources. EGD has regular ongoing communications with both Nations. PWGSC also directly notified nearby residents of project progress, maintained an updated project website, and provided a phone information line to ask questions and provide any comments and concerns during construction. PWGSC directly notified the Mayors of the surrounding municipalities and made presentations at municipal public meetings. Tervita coordinated an Open House to address concerns of residents living near the Phase 1B disposal facility and trucking route.

Substantial coordination was also required with DND, who is the federal custodian and authority for Esquimalt Harbour. DND was a critical partner interested in overall success of the project due to its nature, scale, and location, and also since the remediation of the EGD Waterlot is the first key step in addressing historical sediment contamination in the harbour. A committee was formed with PWGSC and DND team members, which was successful in coordinating project implementation in DND-administered areas.

PROJECT FIGURES AND PHOTOS

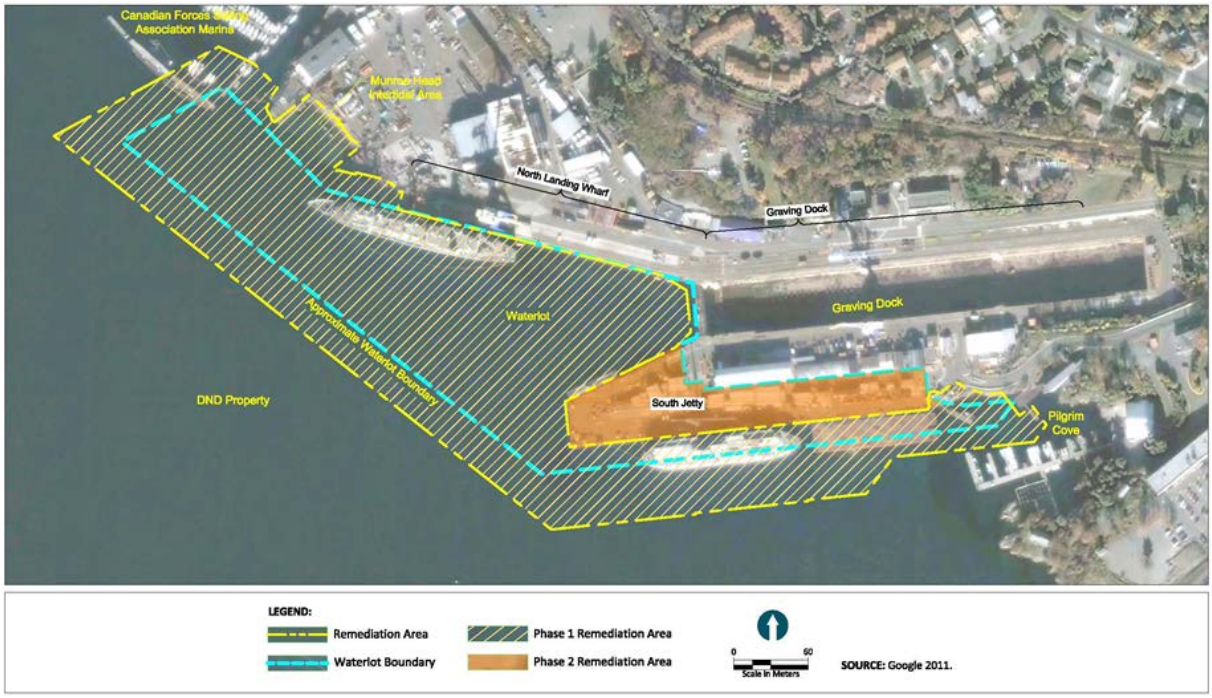


Figure 1. Project Area and Boundaries

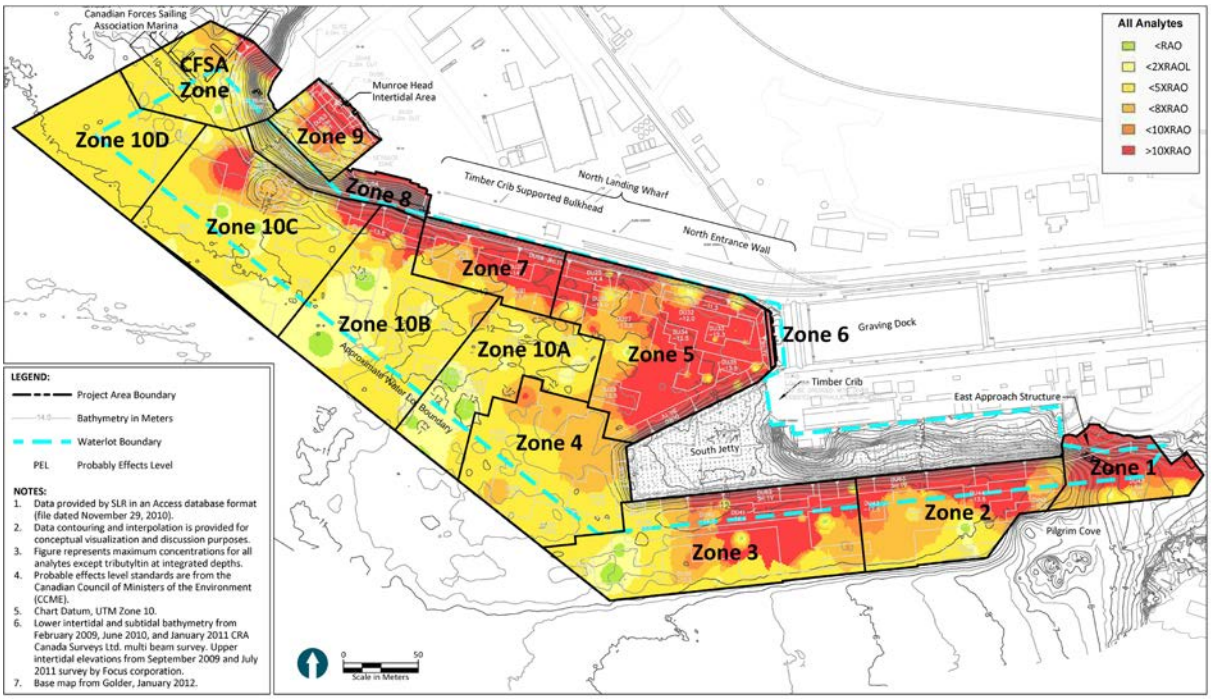


Figure 2. Remediation Zones and Contaminant Characterization

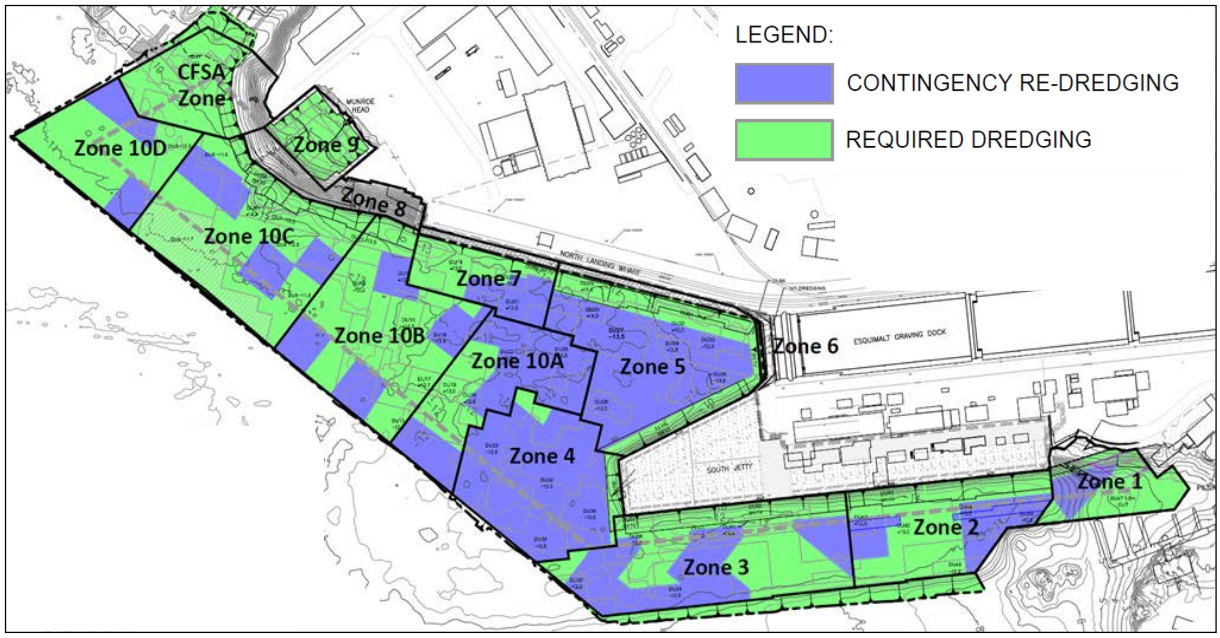
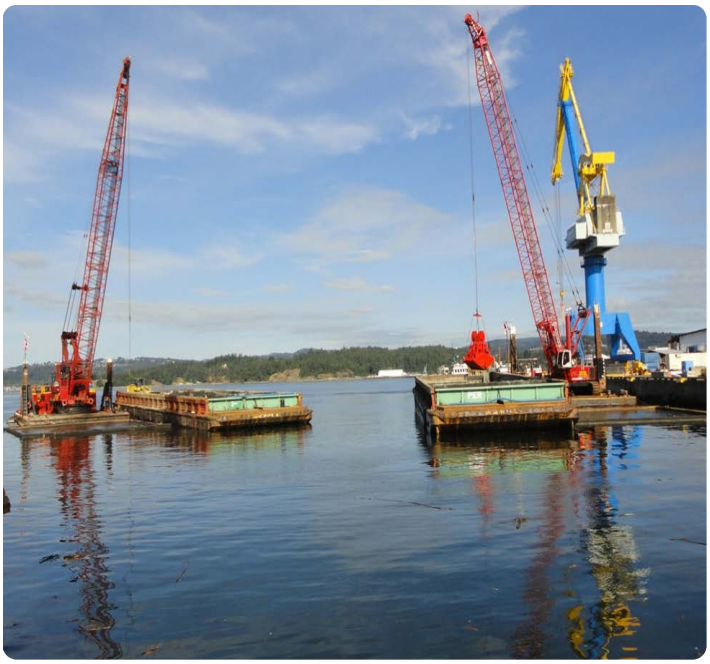
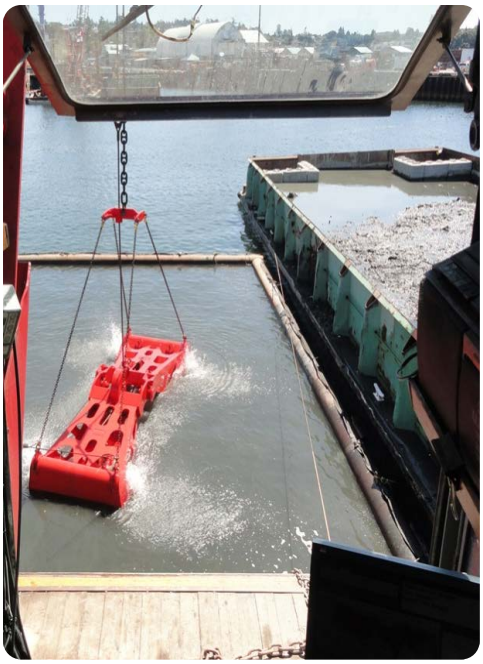


Figure 3. Phase 1B Required and Contingency Dredging

Photo 1. Phase 1B Dredging with Silt Curtain Frame





Photos 2 and 3. Concurrent Phase 1B Dredge Plants

Photo 4. Completed Phase 1A Sheetpile Perimeter Wall around South Jetty

Photo 5. Phase 1B Barge Water Treatment System