Construction Completion Report
Port Gamble Interim Remedial Action
Woodwaste Removal Project
Port Gamble, Washington

Prepared for
DNR

June 13, 2008
17318-01

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WOODWASTE REMOVAL PROJECT
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EXECUTIVE SUMMARY

The Port Gamble Interim Remedial Action successfully removed 16,500 cubic yards (cy) of dredged material containing abundant woodwaste from Port Gamble Bay near the former Pope & Talbot (P&T) mill site (Figures 1, 2, and 4). Project dredging was completed in January and February 2007, with sand cover placement over areas dredged to native sediment completed between February 20 and 24, 2007 (Figure 9). Woodwaste was transferred to a contained upland basin for sparging with fresh water to remove salt prior to planned beneficial reuse of the dredged material for landscaping purposes. Sparging is currently in-progress. The dredged material consisted predominantly of sawdust-like material and heterogeneous, dark sediment and woodwaste with a relatively minor amount of large wood debris.

Project development, design, permitting, and implementation, culminated from joint efforts and cooperation between contributing parties including the Washington State Department of Ecology (Ecology), the Washington State Department of Natural Resources (DNR), P&T, and Pope Resources. Efforts by these parties, resource agencies, Affected Tribes, and other stakeholders were crucial for completing permitting and planning activities in preparation of work for the Interim Remedial Action. Interaction between the various parties was also instrumental in identifying design objectives and project monitoring needs.

Except for the variations noted herein, the Port Gamble Interim Remedial Action was constructed in substantial compliance with project plans, specifications, and related design documents.

Lessons Learned Summary

In addition to project background, team responsibilities, dredging and cover placement activities, and construction documentation, this Construction Completion Report summarizes specific challenges and lessons learned from the project for consideration on future woodwaste removal projects. Key issues include:

- Logistical challenges during the first several weeks of dredging and uncertainties associated with the thickness of woodwaste material led to restructuring of the dredging contract to a time and materials basis. Additional site characterization data may have helped further inform design and reduced contractor risk.

- Logistical challenges with vessel movements (in a relatively small dredging area), equipment maintenance, presence of unexpected *in situ* wooden stub pilings, adverse weather, and other factors reduced daily production rates.

- Refinements in Global Positioning System (GPS) dredge bucket control would be useful for better documentation of day to day dredging progress and dredge elevation tracking.

- As expected, the type of dredge materials, degree of dewatering on the transfer barge, and low tides affected the efficiency of dredged material offloading. Barge dewatering was hampered by clogging of the sand and filter fabric filtration media used. Handling of large wood debris also affected management of dredge materials on the barge and dredge material offloading.

- Housekeeping was a significant issue during offloading and required diligent cleanup of dredged material spilled over the edge of or blown from the conveyor.

- Water column turbidity was generally not a problem during dredging, but was observed at times during sand cover placement. Current and wind-driven turbidity typically dissipated before reaching the downcurrent compliance monitoring point except for one occasion. Further control of turbidity may be feasible using a floating boom/skirt but would require careful deployment and frequent, if not constant, management during cover placement.

Additional observations and recommendations for future woodwaste removal projects are presented in the text of this report based on the lessons learned from the Port Gamble Interim Remedial Action.

1.0 INTRODUCTION

This Construction Completion Report summarizes construction activities for the Interim Remedial Action completed at the Port Gamble Bay Woodwaste site (Figure 1). The project involved dredging of 16,500 cubic yards (cy) of woodwaste from Port Gamble Bay near the former Pope & Talbot mill site in January and February 2007. The work was performed to remove sediment containing the greatest remaining accumulation of woodwaste in Port Gamble Bay, and to restore sediment-associated habitat functions in the project area.

This Interim Remedial Action was completed as a cooperative effort under the Washington State Model Toxics Control Act (MTCA – Chapter 173-340 WAC) by the Washington State Department of Ecology (Ecology), the Washington State Department of Natural Resources (DNR), Pope & Talbot (P&T), and Pope Resources. Ecology determined that the Interim Remedial Action is also consistent with state Sediment Management Standards (SMS – Chapter 173-204 WAC). Site construction activities completed by the DNR (Project Number 06-E31) were conducted as part of an Interagency Agreement between DNR and Ecology for the Interim Remedial Action.

Specific construction elements for the Interim Remedial Action included:

- Clamshell dredging of 16,500 cy of sediment materials containing silt, sand, and woodwaste (i.e., dredged materials);
- Placing dredged materials on a barge for dewatering and transfer to an upland containment area for temporary storage and sparging with fresh water to remove salt over a period of 6 months or more;
- Removing submerged logs, large wood debris, and wooden pilings for temporary upland storage prior to off-site disposal; and
- Placing import sand cover material over areas dredged to “native” sediments underlying the woodwaste.

Following sparging, the dredged materials are planned to be beneficially reused for landscaping purposes by Pope Resources at the mill site property. The beneficial reuse of dredged materials was based on Ecology’s determination that the dredged materials met MTCA requirements for unrestricted use soil cleanup levels.

1.1 Project Area Description and Historical Operations Summary

Generalized Pre-Dredge Conditions

The Port Gamble woodwaste removal site for the Interim Remedial Action is located on submerged aquatic lands at the northwest head of Port Gamble Bay (Figure 1). The design dredge area for woodwaste removal as depicted on Figure 2 was determined based on information from previous site investigations and discussions between the P&T, Ecology, and DNR during the design phase.

The original target dredging area included several separate dredge prisms identified as A through F as shown on Figure 2. The dredge prisms were determined based on existing bathymetry, the inferred thickness of low-density woodwaste material, and sideslope considerations. Based on dredging production rates and conditions encountered during the work, the final area of dredging encompassed approximately 1.9 acres over dredge prisms C, D, E, and F, including sideslopes, as shown on Figure 4.

Elevations of the pre-dredge surface ranged from about –10 feet Mean Lower Low Water (MLLW) to greater than –28 feet MLLW. The pre-dredge bottom profile was relatively flat to low-angle across much of the design dredge area, with steeper sideslopes toward the shoreline reaching approximate angles of 2 horizontal to 1 vertical (2H:1V). Pre-dredge site characterization data indicated the presence of wood chips, sawdust, and logs and large wood debris in accumulated thicknesses of up to 5 to 10 feet. The dredge surface was also marked by hummocky areas containing partially submerged logs, large wood debris, and localized mounds that were later determined to be wooden pilings buried within the woodwaste. In general, the woodwaste deposits tended to thin toward the outer limits of the design dredge area to the east and south.

Available data from previous site investigations suggested that the woodwaste interface with underlying sediments (interpreted as dominantly native deposits) might be relatively distinct over at least some portions of the design dredge area. Data sources included geophysics and sub-bottom profiling, bottom material grab samples, and limited coring data within and near the design dredge area. During dredging in January and February 2007, the woodwaste/native sediment interface was observed to vary from being a distinct contact at some locations, to irregular or transitional over an approximate 1-foot vertical zone or more at other locations.

Historical Operations

The adjacent uplands were the location of the former P&T Sawmill that operated continuously between 1853 and 1995. The P&T operations included the former sawmill, two chip loading facilities, a log transfer facility, and two log rafting and storage areas. Milling operations ceased at the site in 1995, and the sawmill was dismantled and removed in 1997. Upland portions of the site continue to be used for log storage and sorting, rock materials sales, and other purposes under the management of Pope Resources.

Structures remaining on the site associated with the former mill include the "Alder Barge" chip loading facility, a wooden wing fender pile wall, numerous rows of wooden mooring pilings for log rafting and storage, and dock structures.

These features are identified on the report figures. Wooden pilings generally visible above the water surface within the design dredging area were removed as part of construction activities for the Interim Remedial Action. The dock structures were used during the Interim Remedial Action for dredged materials and sand cover placement and transfer.

Limited information was available regarding annual production, wood chip and materials handling rates/volumes, historical dredging activities and locations, and other specific operational details. Limited information was also available regarding the locations of historical over-water structures containing pilings. This later proved to be a key data gap for predicting the number, type, length, locations, density, and conditions of the buried pilings encountered during construction.

Archaeological Resources

The area surrounding Port Gamble Bay is known to be both culturally and historically sensitive. Regional archaeological information suggests that aboriginal groups have occupied the Puget Sound region far into prehistory. However, it is likely that prehistoric Puget Sound shoreline prior to about 2,000 years ago would now be submerged. In addition, tectonic activity could have caused negative or positive shifts in the relative depth of the previous shoreline, as was discovered at the West Point archaeological site in Seattle.

Although there are no recorded prehistoric archeological sites in the immediate vicinity of the mill site, a pre-construction records search conducted by Historical Research Associates, Inc. (HRA) at the Washington Department of Archaeology and History indicated that two aboriginal shell midden sites were recorded on the eastern shore of Port Gamble Bay across from the mill site. A third lithic and tool scatter site was identified on the eastern side of the bay. A copy of a historical painting in the P&T conference room at Port Gamble dating from the late 1800s depicts Native Americans and canoes along the shoreline near the mill. The mill site is also a contributing resource of the Port Gamble National Historic District and National Historic Landmark.

After review of the available information and proposed dredging plans, and consultation among the U.S. Army Corps of Engineers (Corps), Affected Tribes, and the Washington State Historic Preservation Officer (SHPO), it was determined that the project had slight, but real, potential to disturb submerged archaeological resources. An Archaeological Monitoring Plan (December 20, 2006) was then developed to focus on identifying potentially significant prehistoric archaeological resources and human remains during dredging. The

Archaeological Monitoring Plan was implemented during the work, with no significant archaeological materials identified.

2003 Dredging

P&T dredged approximately 13,500 cy of sediment with abundant wood debris from nearshore areas adjacent to the former mill in 2003 (Figure 2). The 2003 dredging occurred over an elevation range of about –12 to –15 feet MLLW and was conducted following preparation of a Cleanup Action Plan under the Washington State MTCA (Chapter 173-340 WAC). The current Interim Remedial Action area overlaps with the 2003 dredging area, but the bulk of the reported 2003 dredging volume was shoreward of the Interim Remedial Action area (see Figure 2). The volume of dredged material removed from the overlap area in 2003 is inferred to be relatively small. The design dredge area for the current Interim Remedial Action extended the 2003 dredging area and was anticipated to contain similar material. The 2003 dredging encountered wood chips, sawdust, and other relatively smaller wood debris that were dredgeable using clamshell bucket methods.

1.2 Site Investigation Background

Site investigations began in the 1990s to characterize potential chemical constituents in upland and aquatic areas in the vicinity of the mill. The investigations included detailed studies conducted by P&T beginning in 1999 with soil, sediment, surface water, and groundwater sampling for physical and chemical testing. The investigations also included evaluation of Port Gamble Bay woodwaste materials that were deposited from historical log storage, handling, and chip transfer operations. The areal extent and thickness of accumulated woodwaste were identified using bathymetry and sub-bottom profiling geophysics methods, bottom materials sampling, sediment physical properties, and total organic carbon and total volatile solids content in sediments.

In 2001, the former P&T sawmill and the surrounding waters were formally listed on Ecology's Confirmed and Suspected Contaminated Sites List. This listing was based on results of investigations that concluded that woodwaste, in the form of logs and larger debris, bark, chips, and sawdust was present in the near shore sediments, and posed a risk to the marine habitat. Under the Washington State SMS woodwaste may be considered an "other deleterious substance" if such material creates adverse biological effects in the marine environment, or presents a significant human health risk.

1.3 Regulatory Review and Permitting

Project permitting and regulatory approvals involved considerable cooperative interaction between various parities to meet an aggressive schedule for completing the dredging work before the close of the in-water work window on February 15, 2007. Discussions between Ecology, DNR, and P&T during the summer of 2006 identified the design areas for dredging and target removal volume of up to approximately 20,000 cy. Ecology prepared a Joint Aquatic Resource Permit Application Form (JARPA) on July 24, 2006, that described the project and related substantive regulatory compliance items under MTCA, Clean Water Act Section 401 water quality, Corps Nationwide 38 permitting, and the Endangered Species Act (ESA). The JARPA also outlined potential impacts and proposed mitigation actions. A Biological Evaluation was prepared by Anchor Environmental, Inc. (Anchor) in July 2007, along with preliminary design plans. Performance requirements for construction were further refined in the final project plans (dated September 2007) and specifications prepared by Anchor, with technical input and review by Hart Crowser.

Ecology, as supported by Anchor and other parties, continued to address questions and permitting items arising during project review by the Corps, the U.S. Fish and Wildlife Service (USFW), the Washington State Department of Fish and Wildlife (WDFW), the National Oceanic and Atmospheric Administration (NOAA) Fisheries, Affected Tribes, and other stakeholders. These efforts were successful in reaching concurrence and approvals for various permitting and substantive compliance determinations prior to the start of test dredging in late December 2006.

Specific permitting and approval documents included:

- Corps Nationwide 38 Permit issued November 8, 2006, and modified in a December 22, 2006, (date stamped) letter to Ecology;

- Washington State Hydraulics Project Approval mitigation actions identified by WDFW in a November 8, 2007, (date stamped) letter to Ecology;

- Corps ESA concurrence that that the project would “not likely to adversely affect listed species and designated critical habitat “(Corps letter to NMFS and Ecology (date stamped) September 19, 2007), and related concurrence from NMFS and USFW that the project “may affect, not likely to adversely affect” (Corps letter to Ecology (date stamped) November 8, 2006); and

- Corps Section 106 determination in a December 20, 2006, (date stamped) letter to the State Historic Preservation Officer that the work would result in

> No Historic Properties Affected for the Port Gamble National Historical Landmark, Port Gamble Historic District, and that No Properties Affected for potential off-shore archaeological deposits (contingent on implementation of the December 21, 2007, Archaeological Monitoring Plan). The State Department of Archaeology and Historic Preservation provided a similar concurrence letter to the Corps on December 21, 2007.

The project was also facilitated by a December 20, 2007, Site Access Agreement from P&T, and the Interagency Agreement between DNR and Ecology. The various permits, agreements, and approvals included conditions and provisions for control of water quality, archaeological monitoring, and other environmental protection measures during dredging, barge dewatering and handling, and temporary upland containment of dredged materials. These provisions were implemented and documented during the work as required, including Section 401 substantive requirements for water quality.

1.4 Project Team

Figure 3 summarizes general roles and responsibilities for the Port Gamble Interim Remedial Action project team, including Ecology as the project sponsor and permitting lead, DNR project management for in-water work, and P&T project management for upland management of dredged materials. Figure 3 also identifies related construction contracting and management roles, and other stakeholder participation. The overall organization of the project team was effective for coordinating work elements of the Interim Remedial Action. The organizational structure allowed for timely resolution of problems arising from field conditions during construction, reaching decisions, and documenting the work completed.

Project responsibilities were generally divided between the in-water and upland components. DNR managed the in-water work that included dredging, material offloading, and sand cover placement; and P&T maintained responsibility for the construction and management of the upland sparging basin. Following bid selection by DNR, in-water work was conducted by American Civil Constructors-Hurlen (ACC-Hurlen), with Hart Crowser providing construction management, water quality monitoring, and related consultation regarding environmental and geotechnical issues. Mobilization/demobilization, dredging, dredged materials offloading and hauling, and cover placement activities were observed, monitored, and documented by Hart Crowser. Anchor provided technical support to address design and cover placement source/quality questions. Prior to dredging, ACC-Hurlen prepared a Construction Work Plan describing specific construction measures, procedures, and QA/QC steps to implement the Interim Remedial Action. Construction activities were implemented in accordance with

ACC-Hurlen Construction Quality Control (CQC) Plan described in the Construction Work Plan.

Under contract to P&T, Caicos was responsible for upland management of dredging materials and larger debris once these materials were offloaded for temporary upland storage. Anchor provided consulting support to P&T for upland activities. While aspects of the sparging basin relating to the dredging and offloading of materials are discussed in this report, further details on the progress of dredged materials sparging and subsequent beneficial reuse are deferred to P&T and others.

During the work, HRA observed representative dredging and dredged materials offloading activities to evaluate potential for discovery of archaeological artifacts. In addition to on-site monitoring, the HRA archaeologist provided artifact identification training to the ACC-Hurlen crew and Hart Crowser field staff. Representatives from the Affected Tribes provided key review of this information and conducted site visits. As discussed above, no archaeological materials were noted during the work. Additional details of the monitoring methods and activities are presented in the Archaeological Monitoring Plan under separate cover.

2.0 CONSTRUCTION ACTIVITIES SUMMARY

ACC-Hurlen initiated mobilization for site construction on December 20, 2006, following notice to proceed from DNR. Dredging, upland offloading of materials, and sand cover placement were completed between December 20, 2006, and March 1, 2007. Work in December included limited test dredging with the main production dredging effort begun in January 2007.

Work activities for the in-water work components completed by ACC-Hurlen were divided into several distinct tasks:

- Mobilization and Offload Area Preparation;
- Dredging (First and Second Passes);
- Dredged Materials Barge Dewatering and Transfer;
- Dredged Materials Offloading and Hauling to Upland Sparging Basin;

- Sand Cover Placement (First and Second Passes); and

- Demobilization.

During dredging and offloading, Hart Crowser field representatives observed and logged contractor activities and production rates. Daily rates calculated included visually estimated quantities of materials dredged per day, bucket cycle times, *in situ* piling removal cycle times, and sand cover placement rates.

In addition, Caicos under contract to P&T was responsible for construction and management of the upland sparging basin to provide for additional dewatering and freshwater sparging of dredged materials prior to planned future beneficial reuse. Caicos also coordinated acquisition and delivery of sand cover placement material to the site.

The following sections summarize the tasks completed for site construction activities. The general sequence and duration of work for each task is summarized in Table 1. Variations from design and construction specifications are noted in the text. Quantities of imported and exported materials are summarized in Table 2. Construction methods and equipment are described in the text for major activities and production rates are summarized in Table 3. Design changes or modifications made in the field were documented and implemented following approval by DNR and Ecology.

2.1 Construction Task Sequence and Durations

ACC-Hurlen began mobilizing equipment and materials to the site on December 20, 2006. Overall the work required 11 work weeks through completion of dredging and cover placement, including approximately 1 week of shutdown during the holiday season. The February 15 closure of the in-water work window for Port Gamble Bay made for a compressed schedule to complete dredging by that time, given the late December start and holiday shutdown. Starting the first week of January 2007, operations were generally 12 hours each day (including lunch break), 7 days per week. Typical work days started at 6:30 a.m. and finished by 6:00 p.m. With the shorter days of early winter, there was approximately 1-1/2 hours of darkness at the start and end of each work day, which further affected production efficiency. The use of land- and barge-mounted floodlights alleviated this to some degree.

Following the contractor's mobilization to the site in late December, the assembly of the material offload system was completed on January 3, 2007. Dredging began on January 4, 2007, and continued until closure of the in-water work window February 15. In early February an extension to the allowable in-water work window to March 1 was granted by the agencies to complete cover placement activities. Operating 7 days per week continued through the end of dredging work on February 15. Placement of the sand cover occurred between February 20 and 24 prior to demobilization between February 26 and March 1, 2007.

Following completion of construction, post-construction thickness monitoring of the sand cover placement area was completed by Anchor in April 2007. Monitoring results are summarized below. The project is otherwise transitioning into longer-term monitoring phase to evaluate the status, condition, and habitat characteristics of the sand cover over time.

2.2 Bathymetric Surveys

Bathymetric surveys were conducted by both ACC-Hurlen and Global Remote Sensing (GRS) to document the progress of dredging. ACC-Hurlen conducted single beam surveys on January 12 through dredge prism C, and on January 23 through prisms D and E to assess the progress of the initial, i.e., "first pass" dredging. ACC-Hurlen completed the single-beam surveys as part of required construction QA documentation. GRS conducted independent multi-beam surveys under contract to Hart Crowser prior to construction on December 15, 2006, and also on February 6, 2007, following completion of first pass dredging. ACC-Hurlen then completed a final single-beam survey of the second pass dredging area on February 15, 2007. Pre- and post-dredging surveys by GRS were compared to calculate the total volume of material dredged removed using CAD.

A bathymetric survey following sand cover placement was viewed as having more limited value and was not completed. Rather, the quantity of cover material was documented during placement, and Anchor conducted cover placement thickness coring in April 2007, to verify the extent and thickness of the placement area.

2.3 Equipment

Equipment used by ACC-Hurlen during dredging, handling and upland transfer of dredged material, and sand cover placement included the following:

- One Manitowoc 4000 Vicon Crawler Crane with a 3.5 cy cable-operated clamshell bucket on a 50-foot x 150-foot x 10-foot spud barge;

- Two 40-foot x 150-foot or 190-foot x 10-foot material barges (1,500 to 2,000 ton capacities) with 4-foot-high fences;

- One 40-foot x 100-foot x 10-foot material barge (800 to 1,000 ton capacity) with a 3-foot-high fence;
- "Hypack" Hydrographic Survey Software package for dredge positioning;
- Two working skiffs and one small support tug;
- Two Volvo off-road haul trucks;
- Two CAT Loaders situated on material barges;
- One flexi-float spud barge for hopper/conveyor system;
- Hopper and conveyor system; and
- 25-foot survey work skiff with an Odom Echotrack Mark III single-beam sounder.

2.4 Dredging

In accordance with the design and specification requirements, ACC-Hurlen employed conventional clamshell bucket dredging for sediment and woodwaste removal (Photographs 1, 2, and 3).

Dredged Materials Encountered

Dredged materials generally consisted of three distinct types of material with varying physical and handling characteristics:

Sawdust-Like Material. Dredged material consisted of light brownish orange sawdust and fine-grained wood chips (Photographs 4 and 5). Relatively limited biological activity was observed in this material, i.e., sparse presence of vegetation, benthic organisms, and burrows. This material typically drained quickly, stacked well on the materials barges, and was relatively easy to handle during offloading and placement in the sparging basin. This material comprised roughly 20 percent of the total dredged material removed and was most prevalent in northern portion of dredge prisms D and E and northwest corner of prism F.

Heterogeneous Dark Sediment/Woodwaste. Dredged material consisted of a more heterogeneous mixture of wood chips of varying sizes, bark, larger twigs, in a dark, siltier sand matrix (Photographs 4, 6, 7, and 8). The dark sediment/ woodwaste mixture often contained conspicuous shell debris, shrimp, occasional small crabs and starfish, and worm borrows in large wood debris. This material also had a distinctive hydrogen-sulfide odor and frequently attracted birds because of the biological activity. This material did not readily dewater and was often problematic to handle during unloading. When logs and large wood debris were caught in the dredge bucket, the dark sediment/woodwaste material tended to fluidize and easily flow out. The dark sediment/woodwaste material made up roughly 80 percent of the dredged material volume.

Large Wood Debris. Includes larger logs and wood fragments either on the bottom or partially submerged. This material represented a small fraction of the overall woodwaste but as expected, slowed dredging production where encountered (Photographs 9, 10, 11, and 12).

Design Versus Actual Dredging Volumes

Project design plans and specifications identified a target removal quantity of approximately 17,200 cy over the approximate 2-acre area (including sideslopes) shown on Figure 2. The final dredging volume was estimated to be 16,500 cy, based on bathymetric survey data and related CAD volumetric calculations (Table 2). The achievable dredging volume was limited based on several factors described below, including lower than anticipated production rates, thicker than expected layers of woodwaste, adverse weather, and other field conditions.

Hart Crowser also tracked the volume of materials dredged by estimating the percentage of barge filling on a given day. With the known base volume for a barge (volume below the sideboards) quantities were estimated by approximately the height of materials above the sideboards. Barge displacement methods were not considered due to the conditions of the barges. Additionally, periodic hand-taped measurements of accumulated dredged material piles in the sparging basin were also conducted. The field estimated quantities of 17,300 to 17,500 cy compared favorably with CAD-calculated dredging volume of 16,500 cy and demonstrated the feasibility of the field estimation methods.

Factors Affecting Daily Dredging Production

The daily duration of dredging ranged up to about 8 hours per day, with an average of approximately 5 hours per day (Table 3). There were several days of more limited production. Daily dredging production rates were significantly affected by time needed for equipment set-up, maintenance, and dredged materials unloading:

- Significant delays due to mechanical failures occurred during the first week of production and involved the breakdown of the crane barge spud winch and the dredging computer package.

- Barge and support vessel movements around in-water obstructions including rows of dolphin pilings, docks, and wing walls were a significant time factor. The existing structures limited access to dredging in shorter arcs and required more frequent crane barge movements.

- During the work it was also noted that the material barges took on water in the internal compartments and required frequent pumping.

- Dredging was also affected by other factors including adverse weather, tides, surveying, and the presence of unexpected in-place buried wooden pilings.

- The frequency of barge movements increased as dredging approached existing in-water structures such as the former Alder Chip Barge and fender pile wall 9 (Figure 2).

Specific delays due to adverse weather (primarily high winds), resulted in approximately 3-1/2 days of lost dredging. One day of dredging was lost on January 16 due to crane operator illness. Additionally, several zero or minus tide events slowed production as it precluded the docking of barges at the offload hopper.

Typical production rates were in the range of 300 to 500 cy per day, with higher daily production of 800 to 900 cy achieved twice during the 41 total days of dredging. The highest production days coincided with dredging in areas that required limited crane barge movements in areas of relatively high sawdust content and few pilings, and where no barge dewatering problems were encountered.

First and Second Pass Dredging

Design dredge elevations were based on available sub-bottom geophysics profiling and relatively limited coring data from previous site investigations. Sediment coring included four locations within the project site and excluded some areas where woodwaste was thickest. Conditions encountered during dredging indicated that the interface of low-density sediment/woodwaste with underlying harder "native" sediments was less regular and often deeper than anticipated. For this reason, two passes of dredging became necessary to reach native sediments over the largest area practical. During second pass dredging, several deep pockets of woodwaste with abundant sawdust were encountered, most conspicuously in the northern panhandle of prism E (up to 12 feet thick in some areas) and extending into the northwest portion of prism F (Figure 2).

ACC-Hurlen Contract Restructuring

Given the deeper than expected interface of woodwaste and underlying native sediments, and limitations on dredging production experienced in January, the ACC-Hurlen contract was restructured on February 1, 2007, to a time and materials basis (DNR Change Order CO#1). The purpose of the contract restructuring was to focus redredging based on field conditions encountered to reach native sediments rather than relying solely on design target elevations. Redredging covered dredge prisms C, D, and portions of prism E, and eliminated redredging in prisms A, B, and G. Daily dredging production rates following restructuring of the ACC-Hurlen contract remained comparable to those achieved under the original contract.

Unanticipated Hard Digging

Unanticipated hard digging was encountered in the northwest portion of dredge prism C during the first week of dredging. The hard digging inhibited bucket penetration and indicated that the bottom was likely comprised of native sediments with little or no woodwaste. Dredging was modified to move on from hard areas following Hart Crowser concurrence. Further digging to target design elevations in hard areas was not required.

Unanticipated *In Situ* Pilings and Dolphins

Significant numbers of historical, wooden stub pilings were encountered in dredge prisms C, D, and E. The pilings were generally buried within woodwaste material and were not identified during previous investigations. The highest concentration of stub pilings were encountered in dredge prism C and were likely associated with historical over-water structures in this area.

ACC-Hurlen was generally successful in removing the pilings where encountered using the clamshell dredging bucket. In total Hart Crowser observed 85 pilings pulled during the dredging (Table 2). Early in the project, the typical procedure used by the crane operator when a stub piling was encountered was to initially try to pull it. If unsuccessful, the operator would dig around the piling and attempt to pull it again. In several instances three or more attempts would be made to extract the piling with periods of digging in between the attempts. The procedure was then refined to instruct the operator to move on from the piling if the second attempt at extraction failed. An additional estimated 33 pilings could not be removed using the clamshell bucket and remain in-place.

Hart Crowser field observations indicated typical piling removal cycle times between about 2 and 11 minutes for the crane operator to grasp the piling with the clamshell bucket, extract the piling, and transfer the piling to the materials barge. Similar cycle times were observed for unsuccessful pilings removal attempts.

In addition, two three-piling dolphins clusters located in the south portion of dredge prisms D and E required removal to facilitate barge positioning and movements.

Pilings Containing Creosote

Several of the wooden pilings exhibited creosote coatings upon removal and transfer to the materials barges. Only very minor, very short-term drippage of creosote was observed. Creosote was generally contained within the wood debris material stored on the materials barges and was not observed to further migrate to dredged material on the barge or drainage water. Further significant creosote drippage was not observed during offloading of the pilings to the temporary upland storage stockpile.

2.5 Dredge Materials Barge Dewatering and Transfer

During the first three weeks of dredging in January 2007, two flat-deck material barges were used for dredged materials loading and dewatering, and for wooden piling and large wood debris storage (Photographs 5 and 7). Dredged material and wood debris were transferred from the crane bucket and placed directly on the barge decks for temporary accumulation and initial dewatering prior to offloading. The large wood debris and pilings were segregated from intermixed sediment and woodwaste dredged material (Photographs 10 and 12). A third barge dedicated to temporary storage of large wooden debris and pilings was added later in January, as discussed below.

The volume of dredged materials each barge could accept was a function of the material type, moisture content, and the ability of the barge to dewater effectively. Consistency of the dredged materials varied across the site as discussed above. The majority of the dredged materials were comprised of heterogeneous, dark sediment/woodwaste mixture that required longer dewatering times than the sawdust material. As practical, dredged materials were typically mounded on the barges of 3 to 6 feet above (and away from) the sideboard fences. With clogging of the filter fabric used at the barge scuppers and perimeter, barge loads often retained a soupy consistency or standing water after more than 12 hours of dewatering. Wet sediment and/or insufficient dewatering resulted in the short filling of barges due to the inability of the material to stack with large volumes of water retained on the barges. This resulted in additional barge movements and production lags when dredging outpaced offloading. Conversely, woodwaste with a higher percentage of sawdust tended to retain less water and drained more quickly. This allowed for higher stacking on the barges, better utilization of overall barge volume capacity, and faster and more-efficient offloading.

Large Wood Debris and Piling Removal and Handling

The growing accumulation of pilings and large wood debris on the two material barges reduced the available area for dredge spoils by the end of the second week in January (Photograph 12). In addition, the presence of pilings and wood debris on the barges hampered offloading activities, as they required careful handling on the barges by the offload operator to prevent material loss to the bay. A third material barge, therefore, was brought to the site at the start of the third week in January. For the remainder of dredging activities, this barge was dedicated to the storage of pilings and large wood debris, leaving the other two barges dedicated to sediments/woodwaste. Limited amounts of non-wood debris (primarily metal cables, occasional tires, and miscellaneous material) were observed.

2.6 Dredged Materials Offloading and Hauling to Upland Sparging Basin

A dredged materials offload area was established on a concrete bulkhead to the immediate west of the dredging area and provided short transit times to dock, unload, and reposition the material barges for subsequent dredging (Figure 2 and Photographs 13, 14, and 15). The material offload system consisted of a flexi-float-mounted hopper with a conveyor delivery system to the truck load out area. The flexi-float was positioned approximately 20 feet waterward of the concrete bulkhead and anchored with two spuds. Conventional loaders were used to transfer the dredged material to the hopper/conveyor system for transport to haul trucks awaiting on the upland side. The total length of the conveyor belt was approximately 80 feet. The haul trucks circuited to and from the nearby upland sparging basin to deliver dredged materials.

Factors Affecting Offloading Efficiency

As expected, the efficiency of offloading operations depended highly on the physical characteristics of the dredged material and the degree of dewatering achievable. Wetter material required slower offloading to prevent material loss. Prior to adjusting the feed rate to the hopper, losses of wet dredged material were observed from the hopper, from the conveyor line (Photograph 19) by vibration, and during transfer to haul trucks. Additionally, the difficulty of stacking wet dredged materials in the haul trucks required short filling to prevent spillage during transit. With the short transit to the sparge basin, the short filling of trucks did not significantly impact offloading progress. Typical offloading times varied between 4 to 6 hours for the smaller barge and 6 to 9 hours for the larger barge.

During several extreme low tide events material barges could not dock at the offload station without grounding. This affected production on several days when dredging outpaced offloading and further digging would have to cease until a material barge could be offloaded.

Large Wood Debris and Pilings

Logs, pilings, and larger debris were transferred from the barges to the large wood debris loading dock using conventional loading equipment. These materials were temporarily stockpiled north of the sparging basin for rehandling and subsequent shipment for off-site disposal by others. Under the original ACC-Hurlen contract, 38 tons of debris were offloaded and weighed for payment purposes. Under the ACC-Hurlen's restructured contract after February 1, payment was not conditioned on the amount of debris, and weighing of the material was not completed. Alternatively, ACC-Hurlen estimated that they removed and offloaded 200 to 240 tons of additional debris. Hart Crowser concurred with this estimate based on rough volume to weight conversion factor for the larger debris.

2.7 Upland Sparging Basin Construction and Operation

The sparging basin consisted of an approximate 3.3-acre area established on the adjacent upland to the southwest of the in-water dredging area (Figure 2). Portions of the sparging basin area were established over concrete foundation slabs for the former mill buildings, with the remainder of the basin area was underlain by sandy and gravelly soils. Caicos constructed the basin by placing concrete "ecology" block to form approximate 4-foot-high walls around the east, south, and west perimeter and draping filter fabric across the inside of the block wall (Photograph 16). Filter fabric and drain rock were also placed over the floor of the basin before placement of dredged materials. The north end of the sparging basin was left open to facilitate ease of haul truck ingress/egress during transfer of dredged materials. Materials were generally trucked and placed in the basin from south to north (Photograph 17). The overall sparging basin capacity of up to approximately 22,000 cy (as measured to the top of the perimeter wall) was not reached. A discharge sump for drainage water was established south of the sparging basin (not shown on Figure 2; Photograph 16); however, because of infiltration, no discharge from the sump to an exit line to

Port Gamble Bay was observed during dredged material transfer and placement into the sparging basin.

Dredged material placement was straight-forward with no significant logistical issues experienced. Once placed, the dredged material set up quickly. Personnel could typically walk on the piles of deposited dredged material within a couple of days, although obvious consolidation was not noted.

2.8 Anchor Dive Survey and Video

Following discussions with DNR, Ecology, and Hart Crowser, Anchor completed underwater diving transects on February 6 and 7, 2007, as the work transitioned from first pass to second pass dredging. The objective of the diver survey was to observe, probe, and evaluate the condition of the post-dredge surface. Videos of the transects were also completed. The survey include four transects through dredge prisms B, C, D, E, and F, with a number of grab samples and diver cores collected for visual assessment (February 7 and 12, 2007, email transmittals from Anchor).

The diver survey was successful in verifying where “hard” surfaces indicative that the sediment interface had been reached, and that such areas contained visibly-low quantities of dredging residuals. Biological recruitment in dredged areas was also apparent from the surveys, including the presence of various burrow types, and observations of occasional crabs and starfish; however, more specific biological information was not documented during the survey. Locations with suspected remaining wooden stub pilings buried in woodwaste were also observed. In addition, Beggiatoa mats were noted that are indicative of adverse effects to habitat from high sulfide content. The surveys further confirmed that second pass dredging was necessary in other areas to reach native sediment. This information, along with dredging observations, was useful for confirming the area for sand cover placement with DNR and Ecology.

2.9 Sand Cover Placement

Following the completion of dredging, ACC-Hurlen placed import sand cover material over dredge prisms C, D, and portions of E as shown on Figure 9. The import sand cover material was obtained from a nearby borrow pit operated by Pope Resources, with delivery coordinated by Caicos. Import sand previously delivered to the site from a dredging project in Port Townsend contained scattered refuse and was determined to be unsuitable for cover material.

Anchor coordinated laboratory grain size and chemical testing on samples from the Pope Resources pit import sand (February 1, 2007, memo from Anchor to

Ecology). The Pope Resources import material consisted of nearly equal quantities of sand and gravel with roughly 2 percent fines based on a composite sample of the pit-run soils. Grain size distribution ranged in the sample as follows:

	Percent (Dry Weight)
Gravel	48.7
Very Coarse Sand	6.2
Coarse Sand	10.4
Medium Sand	22.3
Fine Sand	8.9
Very Fine Sand	1.1
Total Sand	48.9
Fines (Silt and Clay)	2.3

Sand for cover placement was loaded from a temporary upland stockpile area onto a material barge using the northern dock area (wooden pier shown on Figure 4 and Photograph 18). The conveyor/hopper system from the dredged material offload area was relocated to the northern dock. This system was "reversed" to allow barge loading of upland stockpiled sand. The cover material was spread over the area shown on Figure 9 by swinging a partially open clamshell bucket over an approximate 20-foot arc just above the water surface (Photograph 21). Bucket sweeps were adjusted to cover an approximate 20- by 8-foot arc during each swing. Two approximate 6-inch lift passes provided for a total cover thickness up to about 1 foot.

As a check on the accuracy of the quantities to be placed during each pass, Hart Crowser made estimates of barge volumes prior to placements and conducted bucket counts during placement activities. Placement volumes in each approximate 20- by 8-foot arc segment approached 5 cy, consistent with the overall placement rate of 1,500 cy over the total placement area of about 1.2 acres.

The physical consistency and limited fines content of the gravelly sand cover material source helped to control water column turbidity during placement. As noted below in Section 2.10, localized water discoloration and turbidity were noted as the cover material was placed from above the water surface using a clamshell bucket (Photograph 21). The near-surface turbidity appeared to be attributable to temporary entrainment and suspension of air as the material fell through the water column. The combined sand and gravel content of the cover material (97.3 percent) likely minimized temporary turbidity and allowed the material to quickly settle out during placement. It is likely that turbidity would have been more persistent if the fines content had been higher, causing the material to remain in suspension longer in the water column.

Post-Construction Cover Material Sampling

On April 19, 2007, Anchor collected samples of seafloor bottom materials within and near the cover placement area. Samples were collected using a powergrab sampling device and then inserting short cores into the grab bucket to assess the thickness of the sand cover. Sampling locations and cover placement thicknesses are shown on Figure 9.

Cover material in three samples collected within prism D (AN-C200, AN-P200, and AN-2000) ranged in thickness from about 3 inches to greater than 8 inches. Samples near or just beyond the cover edge and dredging side slope areas (AN-0700, AN-1080, AN-1090, and AN-3000) ranged in thickness from 0.5 to 3 inches. Sample AN-1100 located just south of the cover placement area, contained no apparent sand cover.

These results indicate that the cover placement methods used were effective for placement of a relatively thin layer of sand cover to enhance habitat restoration and recruitment opportunities over the target areas shown on Figure 9. Minor accumulation of cover beyond the target area occurred near location AN-1090, most likely as a result of current and wind drift during placement.

2.10 Construction BMPs and Effectiveness

A variety of best management practices (BMPs) used during the Port Gamble project were primarily aimed at reducing turbidity and other water column impacts during dredging and cover placement, and preventing the loss of material back into the bay during handling. The methods employed included the following:

- Control of dredge bucket closure and cycle time;
- Dredging from top of slope down to lower elevations;
- Controlled lowering of clamshell bucket during dredging;
- Dewatering barge perimeter filtration;

- Containment and housekeeping of the offloading area;
- Adjusting feed rate to the hopper and conveyor during dredged materials unloading and sand cover placement loading;
- Controlling the arc swing of the clamshell bucket during cover placement; and
- Conducting water quality monitoring during dredging and cover placement.

In general these BMPs were effective in controlling water column turbidity and fallback of material into the water. Additional findings related to BMPs are summarized below.

Particulate Resuspension during Dredging

Turbidity was generally not an issue during dredging operations and was controlled through standard BMPs listed above. Minor localized turbidity would settle quickly following a bucket grab. In most instances, the turbidity had visibly settled by the time the operator returned for the next grab. The dredged material also tended to settle quickly and contained little observed entrained air. Additionally, the saturated condition of the woodwaste created little floating debris and eliminated the need for a debris boom.

The dredge design also called for sequencing cuts such that the top of slope materials was removed first to control sloughing and minimizing sediment resuspension and generated residuals. The bucket drop speed was also controlled throughout dredging. The effectiveness of these BMP was difficult to visually verify beneath the water surface, but water quality criteria for turbidity were met during the dredging.

Barge Perimeter Filtration

As previously mentioned, sediment dewatering on the material barges presented a challenge throughout the dredging phase. As a means to filter the sediment-laden water at the perimeter of the material barges, the contractor used both felt filter fabric and sand. The sand filtration method performed well for the first two barges loads. Following the second offload of dredged materials, the majority of the sand was removed along with the dredged material. This left gaps in the barge sides that required covering with filter fabric. Felt fabric was then used as a filtration media, but after the second or third barge load with the same fabric, the fabric pore spaces tended to clog and water could not adequately drain. As a result, several barge loads retained significant amounts of standing water even after 12 hours or more of dewatering. The filter fabric also tended to snag on the loader during dredged materials offloading and required diligent attention to replace.

Offloading Materials Losses and Housekeeping

Material loss was observed from time to time during operation of the hopper and conveyor for dredged materials offloading. This was primarily caused by the gap between the hopper and conveyor belt, which caused material to be "squeezed out" and lost before being placed onto the belt. This was particularly evident with wetter materials. Materials lost through the hopper base would accumulate on the flexi-float and required frequent attention to keep the area cleanup up (Photograph 19). Between barge loads crews would hand shovel the materials onto the conveyor belt and transfer them to an awaiting dump truck. It is estimated that between roughly 1/4 cy to approximately 1 cy of dredged material could be lost through the hopper base and require cleanup during a given barge offload.

Material loss was also observed from the conveyor line due to wind and mechanical vibrations. In this instance, wetter material would fare better on the conveyor line, as it tended to be more cohesive and project a lower profile into the wind. The bulk of wind transported material deposited on the adjacent uplands and away from the beach areas. This aspect of material loss was unavoidable and was generally away from the water and easily addressed. Mechanical vibrations appeared to be highest in the central portion of the conveyor line, which spanned the gap between the flexi-float and the concrete bulkhead forming the staging platform landward of the flexi-float. To prevent loss to the water a 16-foot by 8-foot plywood assembly (planking) was installed over the gap (Photographs 13 and 20). The accumulating material on the plywood required cleanup at roughly the same frequency as the flexi-float.

Other sources of upland material loss were from truck spillage and from splashes of materials upon impact to the truck bed. Ecology blocks and silt fencing provided containment in the uplands and prevented runoff of materials into the bay. Cleanup of the uplands areas would occur on an as needed basis and generally during a down time of activity on shore.

Cover Placement Turbidity

During placement of cover material from the over-water clamshell bucket, localized water discoloration and turbidity were noted near the surface. Air bubbles were conspicuous as the sand fell through the water column and appeared to contribute to keeping particulates in suspension (Photograph 21).

The near-surface turbidity tended to linger and be carried away from the application point by currents. During most of the placement process; however, turbidity dissipated before exceeding water quality limits at the downcurrent compliance points. In shallower waters, a secondary turbidity plume was observed after the bulk of the material impacted the seafloor. This secondary plume visibly appeared to settle within a few minutes after placement.

Minor, temporary exceedances of surface water turbidity criteria established for the project were noted during sand cover placement. These resulted from wind and current conditions that were difficult to otherwise accommodate by modifying the overwater placement technique using the partially open clamshell bucket to spread the material. The exceedances were observed to be short-lived and do not appear to have resulted in large amounts of placement material having been transported beyond the target placement zone as discussed above.

3.0 WATER QUALITY MONITORING RESULTS

Hart Crowser provided a two-person sampling team to conduct water quality monitoring during in-water work activities. Prior to construction, Hart Crowser completed an ambient water quality characterization evaluation in the vicinity of the dredging area on December 12, 2006. Through the month of January, monitoring events took place at a frequency of approximately once per week. With consistent attainment of water quality parameters, monitoring activities were ceased during the last 2 weeks of dredging in February. One sampling event occurred during the sand cover placement.

The Hart Crowser field representatives prepared water quality monitoring logs to document the monitoring activities. The logs listed personnel, sampling equipment used, visual observations, monitoring locations and GPS reference points, monitoring results, time/tide information, weather/current conditions, and related field activities. Based on this information, a complete listing of water quality monitoring results is presented in Appendix B.

3.1 Monitoring Methods

Monitoring activities involved field measurements of turbidity, dissolved oxygen, temperature, and salinity using a calibrated Horiba U-22 Water Quality Checker. During in-water work, monitoring points included a minimum of two locations downcurrent of the point of dredging and cover placement. The locations were selected to evaluate water quality relative to a compliance boundary 150 feet from dredging activities or the point of release of sandy material during cover placement. The monitoring locations were positioned to intercept visible turbidity plumes associated with in-water construction. Representative upcurrent and other "background" locations were also monitored. Locations for compliance and background samples were determined using GPS methods.

Monitoring at each sample location included drawing water with a peristaltic pump at depths within 3 feet of the water surface, the approximate mid-point of the water column, and within 6 feet of the bottom surface. Monitoring parameters and compliance criteria were compared with monitoring results from upgradient and other background locations at the time of the work.

3.2 Monitoring Results Summary

With one exception during sand cover placement, water quality monitoring data remained within the established compliance ranges for the project. These results affirmed the effectiveness of construction BMPs. A single exceedance of the turbidity compliance criteria (5 nephelometric turbidity units (NTUs) above background), occurred at downcurrent compliance location 1 during sand placement on February 21, 2007. Visible turbidity quickly dissipated as the material fell through the water column. No additional actions were taken, as sand cover placement was completed shortly thereafter. Also, slightly depressed DO readings below 6 milligram per liter (mg/L) were noted during one monitoring event at downgradient compliance location 4 on the same date. However, these readings were within 0.2 mg/L of comparative upgradient background DO and, therefore, were considered to be in compliance.

Monitoring results are further discussed in Appendix B.

4.0 CONSTRUCTION DOCUMENTATION

Required construction reports and documentation were prepared and submitted including daily Construction Reports from ACC-Hurlen, and weekly Progress Reports provided to DNR and Ecology by Hart Crowser. The required reports documenting inspection and monitoring of construction activities by Hart Crowser field representatives were also completed as planned.

Reports prepared for weekly construction progress, inspection, and monitoring were effective for QA/QC purposes, and determining the adequacy of the construction work performed. These documents also provided useful information for modifying project requirements as needed based on the conditions and logistical challenges encountered.

4.1 Requests for Information (RFIs) and Serial Letters

ACC-Hurlen submitted one RFI and five serial letters summarized here and in Table 4 during project construction:

- **January 2, 2007, Serial Letter on Caicos Barge Activity.** Coordination between ACC-Hurlen and Caicos established to give 24-hour notice of barge movements.

- **January 5, 2007, Notice of areas of hard digging and numerous stub pilings encountered.** The RFI was granted with respect to the hard digging areas. Further areas of hard digging will not need to be dug to design elevation granted they are documented and Hart Crowser representative concurrence is received. Additional pilings should be removed as necessary to facilitate woodwaste removal while maintaining schedule.

- **January 15, 2007, Notice of Dredging Obstructions.** The conditions noted were acknowledged.

- **January 24, 2007, Serial Letter for transfer of survey data to resolve discrepancies in benchmark.** Hart Crowser transferred 2004 bathymetry data to ACC-Hurlen and Hart Crowser received progress survey XYZ data from ACC-Hurlen. Discrepancy resolved with respect to benchmark.

- **January 24, 2007, Serial Letter giving notice of weather delays and request for schedule extension.** This RFI identified loss of one day due to weather on January 22. Ecology requested and received work window extension for completing cover placement between February 15 and March 1.

- **January 26, 2007, Serial Letter giving notice of potential for pilings and large wood debris to affect dredge cuts**. The RFI identified challenges with *in situ* wooden pilings. DNR agreed to additional compensation as part of Final Payment Resolution.

5.0 CONSTRUCTION COST SUMMARY

Costs for the Interim Remedial Action include construction costs and technical assistance to DNR for construction management support, water quality sampling, and related items. Construction quantities and line item cost summaries are presented in Table 5. The total construction cost for the Interim Remedial Action was $760,100. The total ACC-Hurlen construction contracting cost was $560,000, compared with the original bid amount of $495,550. The contract cost difference was largely due to additional dredging costs of just over $116,000 (Change Order CO#1) and compensation for removal of *in situ* wooden pilings of about $45,000 (Final Payment Resolution). Actual costs for dredging, wood debris removal, and contingency standby time (not used) were less than the original contract budget. In part this resulted from a lower volume of dredged materials removed than originally planned.

Inclusive of mobilization, contractor submittals, labor, and equipment/direct costs, the unit cost of materials dredged and offloaded was about $30 per cubic yard. This unit cost is relatively expensive compared to other sediment cleanup projects and reflects the influence of site conditions and logistical challenges discussed above. Cover placement was completed by ACC- Hurlen on a fixed fee basis for $66,500; however, only about 1,500 cy of the originally planned 3,500 cy were placed.

It should also be noted that the summarized construction total cost does not include design, permitting, pre-construction and post-construction surveys, and monitoring costs. DNR, Ecology, and other agency coordination costs are also excluded.

6.0 CONSTRUCTION CHALLENGES, SOLUTIONS, AND LESSONS LEARNED

The following section elaborates on some of the site-specific challenges inherent to the dredging of woodwaste and lessons learned, as well as recommendations for future woodwaste removals.

6.1 Site Characterization and Dredged Material Prism Thickness

During dredging the interface between woodwaste and native sediment was deeper and more transitional in many areas than anticipated based on available site investigation data. In some cases, the interface with the harder, native sediments was up to several feet deeper than expected. Additional site characterization in the form of cores, probes, and other physical data would have provided additional design data and decreased dredging uncertainty. The benefits of obtaining such data for future projects include:

- Confirming the overall dredgeability of the material;

- Optimizing means and methods for dredge material removal, handling, dewatering, and transfer;

- Providing additional information about expected dredging residuals and the sediment leave surface;

- Assessing potential for sloughing, heaving, or other movement of materials during dredging (and anticipating related contract performance issues);

- Further assessing the nature and extent of debris, pilings, and other potential obstructions;

- Assessing the potential for water quality problems during dredging (not experienced at Port Gamble);

- Assessing the extent to which existing conditions might contribute to dredging schedule delays or difficulty in achieving a definitive post-dredge interface with the underlying sediment surface;

- Assessing expected post-dredge conditions where subsequent cover placement is contemplated;

- Decreasing potential for change conditions claims and increasing contract bidder confidence and cost and schedule estimates; and

- Providing a better opportunity for the contractor to implement a performance-based contract.

Recommendations

Recommendations for further site assessment on future woodwaste dredging projects include:

- Re-review of historical drawings and aerial photos with a focus on known or suspected areas for pilings, including potential for buried structures, and/or other construction impacts;

- Consideration of the potential benefits and limitations of geophysics methods for identifying buried pilings, other structures, and/or other construction impacts;

- Completing sufficient subsurface cores to better establish the distribution of woodwaste, and the nature of the transition or interface between woodwaste and underlying sediments. Coring data are also critical to more-fully characterize woodwaste type, variability, and physical properties. Although sediment cores for the Port Gamble project were generally consistent with the depth extent of woodwaste during dredging, the coring data were limited to four locations that were not optimally located for dredge prism assessment purposes;

- Completion of additional diver surveys, videography, and probing with focus on the type and depth of wood debris, extent of debris and pilings, and/or other construction impacts, as practical;

- Additional woodwaste grab samples and coring explorations through and below the interface with underlying sediment to further evaluate material variability, physical properties, and potential habitat value of underlying sediment; and

- Consideration of pilot test dredging in several locations to better assess overall material dredgeability, variability, handling, dewatering characteristics, and underlying sediment interface. Ideally this information should be available to incorporate into the design. However, information prior to bidding and/or prior to construction would also be beneficial. Dredged material could be temporarily placed on a barge to observe physical behavior and dewatering.

6.2 Optimization of Dredging Equipment

Optimization of dredging equipment continues to be a significant discussion topic for design and implementation of sediment and woodwaste cleanup efforts. For the work completed at Port Gamble, discussions focused on how to gain better production efficiency, adapt dredging equipment to varying dredge cut thicknesses, achieve a “cleaner” dredge cut, and further reduce generation of woodwaste dredging residuals. Further flexibility to optimize the types of dredging equipment used during construction would be desirable to address these issues. The type and size of clamshell or other excavation bucket are a particularly important consideration for optimizing work efficiency and achieving as clean a finished cut surface as practical. Crane reach is an additional factor critical to minimizing barge repositioning and optimizing production efficiency.

As for many dredging projects, the Port Gamble work specifications were developed with performance-based objectives and attempted to minimize more proscriptive limitations on construction means and methods. Specifically, proscriptive parameters for the dredging bucket type/capacity, crane size and reach, material barge sizes, and related parameters were not identified. This approach is commonly used to preserve the contractor’s flexibility for determining the appropriate equipment and construction means and methods based on consideration of cost and performance objectives. This approach also maintains the contractor's responsibility for the performance outcome. For the Port Gamble Interim Remedial Action, equipment selection and implementation were left to ACC-Hurlen as described in its Construction Work Plan. Further modifications to equipment and dredging methods were difficult given the contract structure and tight time schedule for in-water work.

ACC-Hurlen used a Manitowoc crane with a 3.5 cy clamshell bucket throughout the project in conjunction with two material barges shuttling to and from the offloading area. A third barge was added to handle timber pilings removed during dredging. Production was constrained to 300 to 500 cy per day using this equipment, and required two passes to remove woodwaste below the original target depths. Changes to a time and materials contracting approach on February 1, 2007, did not significantly increase the production rate.

In addition, two dredging passes were required to achieve a final cut surface with low quantities of woodwaste residuals. This was primarily because of deeper-than-expected dredge cuts, along with the difficulty of cleanly excavating woodwaste with only a single pass of the 3.5 cy clamshell bucket. Construction observations and discussions with DNR and Ecology noted further concerns with clamshell bucket overfilling and local resuspension of particulates.

Recommendations

- For the Port Gamble dredging, use of a larger closed bucket may have been feasible to increase production, negate the need for two dredging passes, and further limit generation of residuals. Production efficiency was also affected by a relatively small barge maneuvering area. The latter situation required additional barge movements to reposition the crane, but could have conceivably been remedied by using a large crane with longer reach. However, contractual or logistical means were not available to address these items.

- Dredging specifications for similar woodwaste remediation projects could include provisions for the contractor to modify means and methods if certain performance criteria related to production rates, presence of residuals, depth of cut, etc. are not met. This could be achieved either by a general requirement to modify to means and methods as necessary to meet the criteria in question, or by listing the specific work modifications and equipment changes to be made. A similar approach was used in the Port Gamble specifications to modify means and methods to address potential water quality issues.

It should be noted that the viability of invoking additional owner-required work modifications or equipment changes could result in additional contractor risks and project costs. Contract requirements for the contractor to use specific construction methods and equipment also carry additional cost and schedule risks if modifications later become necessary. For example, limiting dredging to a larger clamshell bucket might, in some instances, promote additional water column turbidity or result in more complex materials handling issues that could increase the contractor costs.

6.3 Bucket Location Software and GPS Controls

The bucket location GPS and software used in Port Gamble consisted of a single receiver located at the end of the crane boom. This setup would allow precise location of the bucket within a dredge prism but did not record bucket orientation or elevation.

Recommendations

Recommendations for bucket location software and GPS controls on future woodwaste dredging projects include:

- Provide additional specification on minimum requirements of bucket location software (or equivalent) to assure needed bucket location information.

- Include documentation of dredge bucket orientation and bottom elevations. This information is useful for better control of dredging cut depth and to further evaluate dredging efficiency and sloughing in slope areas.

- Specify a software package that has an auto-save function as a safeguard in the case of a power loss, which occurred several times during the Port Gamble project.

- Specify that bucket location software be CAD compatible. There were unexpected difficulties with compatibility of Dredge Pack bucket location information with CAD.

6.4 Log Debris Handling Methods

As discussed above, the wood debris logs and pilings occupied a large portion of the barge capacity during the first 2 weeks in January that could have been used for dredged woodwaste. Eventually, a third barge was brought on site to store the logs and pilings, which made for quicker and more-efficient offloading of both the debris and woodwaste. Although we did not directly observe that log/piling storage constraints delayed production, this could affect future jobs where the dredging production is greater.

Recommendations

Recommendations for log debris handling methods include:

- Means and methods for handling and managing logs and large debris within the woodwaste and in-place wooden pilings would have benefited from further site characterization data. Because the pilings were not identified as being as numerous as encountered, means and methods were somewhat underscoped.

- ACC-Hurlen used a forklift for handling debris logs and pilings from the storage barge. This proved to be inefficient in that it tied up three to four crew members for equipment operation and rigging and led to multiple handling. On a site with high volumes of piling and/or large wood debris, a dedicated wood barge with a barge-mounted log picker, or similar equipment, would be a preferable method.

6.5 Definition of "Debris" for Specifications

For Port Gamble "debris" was defined as anything greater than 24 inches long in any dimension. This allowed a 23-inch-diameter log that is less than 24 inches long to go into the sparging basin as woodwaste. This in fact did occur with splinters from larger debris logs or in-place pilings during removal. Conversely, the definition required a 25-inch-long stick or splinter or wood that was less than 0.5 inch in diameter to be segregated and weighed as debris.

The debris specification was also difficult to oversee and ensure compliance with the specification, especially when most observations were from the barge and also with limited daylight during much of the workday. Debris material was also difficult for the contractor to consistently identify and pick. Screening dredged material through a grizzly or similar device would have been difficult to implement and likely would have created a bottleneck and additional housekeeping issues during unloading.

Although debris material did reach the sparging basin, this condition was determined to be acceptable by P&T as the end user of the material.

Recommendation

The specification for debris should be carefully evaluated for future woodwaste projects, depending on the type and size of debris expected. For projects with less flexibility for adjusting the type and size of acceptable woodwaste as the project progresses, physical screening of the material or separation during dredging would probably be required. This places further value on data from pre-dredging materials characterization.

6.6 Dredged Material Barge Offloading

Low tides affected offloading operations from time to time and complicated scheduling of barge movements. Docking at the offload area was not possible when tides were at or below approximately elevation 1 foot MLLW. During these times, dredging outpaced offloading and further dredging ceased until a material barge could be offloaded.

Recommendation

Planning and scheduling for offloading could have been more efficient at times, but providing further scheduling controls through specification requirements would be problematic. One approach would be to require the Contractor to prepare a vessel movement and offloading plan, but the level of certainty and detail needed to make the plan workable might be unrealistic to expect. Alternatively, the specifications could require a float-mounted dock extension or other means to ensure that fully loaded barges could be docked and unloaded at the critical tide levels identified. The cost-benefit of this requirement would need to be evaluated in future designs.

6.7 Hopper/Conveyor Placement

The arrangement of the conveyor line at Port Gamble placed it nearly perpendicular to the prevailing southwest wind. During high wind, material was blown from the conveyor line.

Recommendations

- Future projects using conveyored offload should account for wind direction and protection of the conveyor line, as possible.

- Placing a cover on the conveyor would be problematic and probably create blockages; however, for consistently finer wood debris this might be a potential option.

6.8 Schedule Constraints and Delays

As anticipated by all parties, the construction schedule was significantly constrained by the February 15 close of the in-water work window. The compressed schedule created a steep learning curve for the crew at the beginning of the project, leading to logistical inefficiencies. Delays early in the project further compounded scheduling issues. Periodic adverse weather conditions and equipment malfunctions also contributed to delays. The condition of the equipment used in Port Gamble led to several delays from crane breakdowns, computer malfunctions, and barges taking on water.

The relatively small size of the site was initially viewed as advantage because of short barge transit distances. In reality the small size of the site and in-water constrictions such as dolphin pilings, docks, and wing wall made barge and vessel movements more complicated. Barge movements around in-water obstructions were a significant time factor in the tight working conditions at Port Gamble. Additionally, equipment problems and crew inexperience with large barge movements led to delays early in the project.

Recommendations

- When feasible project scheduling should include contingencies for delays related to these factors. Starting earlier in the fish window is also highly desirable.

- Requiring a vessel movement plan as noted above might prompt more logistical planning by the Contractor, but how well the plan could actually be implemented is questionable.

6.9 Woodwaste/Sediment Dewatering and Housekeeping

Difficulties with barge dewatering occurred on the Port Gamble project that impacted the schedule in several ways and remained a concern from housekeeping and water quality standpoints. Sediment that could not be adequately dewatered required short filling of barges and haul trucks due to the inability of the material to stack. This also slowed the feed rate to the hopper to prevent material loss from overtopping and "slopping" during filling. This resulted in additional barge movements, more frequent cycling of haul trucks, and production lags when dredging outpaced offloading. Haul truck cycling was not a major issue in Port Gamble due to the short haul distance, but could potentially impact production on a site with a longer haul distance. Specific issues included the following:

- Wetter dredged material tended to slop off the conveyor due to the vibration of the equipment and splash during truck loading. This required more active housekeeping to remove accumulated material along the conveyor line and in the truck staging area. Although containment of the material at Port Gamble was manageable, additional difficulties could arise at sites with longer transfer distances or road-tracking concerns. From a water quality and housekeeping standpoint, the accumulation of dredged material near the waters edge proved to be a continual issue throughout the project. Accumulation on the hopper barge created high potential of material loss back into Port Gamble Bay. This condition required frequent attention, particularly with very wet material.

- The Contractor used both felt filter fabric and sand as means to filter the sediment-laden water at the perimeter of the material barges. Perimeter sand performed well for the first two barges loads. Following the second offload of materials the sand clogged rapidly, and the majority of the sand was removed during offloading of dredged material. This left gaps in the barge sides that required covering with filter fabric. The felt fabric used in Port Gamble provided a good means to filter the sediment-laden water after initial installation. Following the second barge load with the same fabric, the fabric clogged and did not adequately drain water. Additionally, the fabric was easily damaged during offloading and frequent maintenance was required to keep fabric in-place.

Recommendations

- Although the project specifications required ACC-Hurlen to apply various BMPs to control water quality, additional requirements for future projects should specify appropriate housekeeping measures to prevent accumulation of dredged material where it poses a threat of release to the environment. This would include uncontained dredged material within certain proximity(ies) to surface water, storm drains, or runoff pathways.

- For future projects, bench testing of various filtration fabrics or other media would provide additional information for the Contractor to evaluate dewatering options. Specifications could also require diligent replacement of the filtration media when it was inadvertently removed or clogged, or as directed by the Engineer's field representative.

6.10 Production Bathymetric Surveys

In addition to the above-listed scheduling delays, the timing of progress surveys somewhat impeded dredging. Production losses arose from the need to vacate the dredging areas during the survey, and survey vessel movements. A problem also arose with the site survey elevation benchmark. This survey problem was corrected by Global Remote Sensing for the pre-dredge survey and did not affect performance of dredging or cover placement work.

Recommendations

- On projects with tight schedules the specifications could require surveys (when feasible) to occur after normal production hours or on weekends.

- Specifications should require that site survey benchmarks be confirmed by the entities responsible for surveying, and that such confirmation should be provided prior to the beginning of work.

6.11 Turbidity

Turbidity issues were not noted during dredging and associated water quality monitoring, but were more apparent on one occasion during cover placement, as discussed above.

Recommendation

- For future projects, a temporary surface boom with a skirt extending several feet into the water column might provide sufficient containment until the cover material settles. The feasibility of this method is strongly dependent on wind and current conditions. This would also add significant time and logistical challenges to continue deploying the boom in optimal locations as cover placement progressed. Time constraints to complete cover placement at Port Gamble severely limited the feasibility of this approach.

- Other placement approaches, such as releasing the material from the bucket below the water surface, provide much less control over the placement location and thickness. Placement via subsurface tremie tube or diffuser might also be considered but would add significant cost and logistical challenges to achieve relatively thin placement thickness.

- Depending on site-specific conditions and project size, pilot testing of cover placement methods might also be considered to assess potential turbidity problems and remedies. This would add additional project costs and require lead time to incorporate results into engineering design.

6.12 Contracting

As for many construction projects, contracting for the Port Gamble Interim Remedial Action emphasized a performance-based approach to complete the work per design criteria and specifications. The contract was then restructured on February 1 to time and materials basis in an effort to optimize production in view of on-going logistical challenges and the deeper, less regular interface with native sediments encountered. As noted above, the change in contract structure resulted in little change in the production rate and efficiency. However, the total dredged volume of 16, 500 cy approached the target objective lower bound.

Observations and Recommendations

- Additional site characterization data from test trenching or pits to better assess the "hard floor" for dredging would make a true performance-based contracting strategy more feasible. This in turn decreases contractor risk and provides information about the post-dredging surface and dredging residuals thickness on a pilot scale. One approach would be to conduct test dredging, observe the material on a barge or upland surface, and visually monitor the point of dredging before and after test dredging.

- Time and materials contracting may potentially be advantageous where significant uncertainties remain regarding the extents and dredgeability of woodwaste, interface depth with underlying sediments, etc. This would be most applicable when project site constraints and schedule may significantly impact construction means and methods. As a caution; however, the absence of well defined performance goals for target dredge elevations and volume could adversely impact production efficiency and achieving design objectives.

- If a time and materials approach is identified for a woodwaste dredging project, the contract should also include financial performance incentives for production or related design benchmarks. Such incentives should be closely tied to contractor and independent quality assurance measures that the work is performed at a satisfactory level.

  Financial incentives could include a variety of monetary compensation options depending on how specific bid items are paid. Compensation could include an outright lump sum bonus or enhanced unit cost for meeting established performance goals. Alternatively this could be crafted as a "sliding scale" bonus or unit cost enhancement, depending on how closely various target objectives are met. For example, the contractor could be financially compensated for meeting early finish schedule dates if this decreases the owner's uncertainty for start-up of critical follow-on phases of the project. It may also be advantageous to provide financial incentives for reaching and maintaining threshold production rate(s) at an early point in the project. This in turn helps the owner to increase certainty that the work will be completed by a given date. Other financial incentives could be tied to achieving specific QA requirements for survey results, water quality monitoring, etc.

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Table 1 - General Construction Activities and Sequence

Date	Construction Activity
11/22/2006	Contract Notice to Proceed
12/15/2006	Global Remote Sensing Multi-Beam Bathymetry Survey (Pre-Dredge Survey)
12/18/2006	Pre-Construction Meeting
12/20/2006	Contractor Mobilizes to Site
12/22/2006	Initial Test Dredging before Holidays
12/23/2006 to 1/1/2007	Holiday Break
1/4/2007	Begin Main Production Dredging
1/13,23,31/2007	ACC-Hurlen Single-Beam Bathymetry Surveys
2/1/2007	End First Pass Dredging to Design Elevations (per Contract) and Start Redredging to Native Sediments per Restructured Contract with ACC-Hurlen (Change Order CO#1)
2/6/2007	Global Remote Sensing Multi-Beam Bathymetry Survey (Approximate Post-First Pass Dredging)
2/14/2007	Last Day of Dredging
2/16/2007	ACC-Hurlen Single-Beam Bathymetry Survey (Final Post-Dredge Survey)
2/20/2007	First Day of Sand Cover Placement
2/24/2007	Last Day of Sand Cover Placement

Table 2 - Dredging, Piles, and Cover Materials Quantities[a]

Dredge Volume in cy	
Contract Specification Volume Estimate	17,200
Hart Crowser Daily Barge Volume Estimate	17,300
Hart Crowser Sparging Basin Volume Estimate	17,500
Pre- and Post-Dredge Bathymetric CAD Volume Calculation	16,500
Non-Sediment Debris Removed	
In Situ Wooden Pilings (Number)	85
Unsuccessful Piling Removal Attempts	33
Large Wood Debris in Tons[b]	240 to 280
Sand Cover Volume in cy	
Hart Crowser Daily Barge Volume Estimate	1,430
Hart Crowser Bucket Count Estimate[c]	1,512
NW Rock Delivery Estimate	1,500
Sand Cover Placement Area in Square Feet	
First Pass	45,000
Second Pass	49,800

Notes:

a. See text for additional discussion of volume estimates.

b. Note - only 40 tons of material weighed. Remaining large wood debris quantity based on visual estimate by ACC-Hurlen and concurrence from Hart Crowser.

c. Assumes Average Bucket Volume of 3.5 cy

Table 3 - Summary of Construction Activity Times

Dredging	**Minimum**	**Maximum**	**Average**	**Dredging Total Hours**
Hours/day[a]	1.0	8.5	5.2	217.6
cy/hour	19	135	78	NA
cy/day	142	900	453	NA
Bucket Cycle Time in Minutes	0:47	4:18	2:29	NA
Total Dredging Work Hours[b]				451
Dredging Support Activities[c]	**Minimum**	**Maximum**	**Average**	**Support Activities Total Hours**
Crane Positioning in hours/day	0.15	1.2	0.4	16
Material Barge Positions in hours/day	0.25	3.0	1.2	48
Delays in Hours	**Minimum**	**Maximum**	**Average**	**Delays Total Hours**
Mechanical Problems in hours/day	0.50	6.75	0.64	26
Successful Pile Pulling in hours/day	0.10	1.0	0.18	3.4
Successful Pile Pulling Times per Pile in minutes/pile	1:49	11:00	5:26	NA
Unsuccessful Pile Removal in hours/day	0.10	1.0	0.28	2.8
Unsuccessful Pile Times per Pile in minutes/pile	4:00	10:00	5:55	NA
Offloading (drainage, conveyor, or other logistical challenges) in hours/day	0.25	5.50	0.58	23
Adverse Tides/Weather[ed] in hours/day	0.50	8.50	0.52	21
Other[d,e] in hours/day	0.33	8.50	0.57	23
Sand Cap Placement	**Minimum**	**Maximum**	**Average**	**Sand Cap Total Hours**
Hours/day	1.0	5.5	3.6	18
cy/Hr	56	146	96	NA
Total Capping Work Hours[f]				55

Notes:

NA Not Applicable

a. Includes all days when dredging occurred. Several days had no dredging work due to weather, surveys, and crew illness.

b. Dredging lasted for 41 days at 12 work hours/day including lunch break.

c. Can include up to several crane moves/day and can include both material barges moves/day.

d. Delay hours in which a total day of dredging was lost is based on highest production day of 8.5 hours of dredging/day.

e. Other delays includes production loss due to surveys, operator illness, and non-project-related boat movements.

f. Capping activates lasted for 5 days at 11 work hours/day.

Table 4 - ACC-Hurlen Request for Information and Change Order Summary

Date	Description	Resolution
1/2/2007	Serial Letter on Caicos Barge Activity	ACC-Hurlen and Caicos would coordinate to give 24-hour notice of barge movements.
1/5/2007	Notice of Hard Dredging and Stub Piles Dredging Obstructions	No deeper dredging was required in areas of hard dredging with Hart Crowser Representative concurrence. Additional pile stubs should be removed as necessary to facilitate woodwaste removal while maintaining schedule, to the extent practicable.
1/15/2007	Serial Letter Regarding Continued Dredging Obstructions	Discussed during 1/18/07 weekly construction meeting. Subsequently resolved during discussion for Change Order CO#2.
1/24/2007	Serial Letter Regarding Survey Benchmark Discrepancy	Survey benchmark discrepancy resolved by Global Remote Sensing and ACC-Hurlen joint site visit. 12/15/06 GRS pre-dredge survey adjusted accordingly.
1/24/2007	Serial Letter Requesting Work Window Extension due to Weather Delays	Ecology requested and received work window extension to March 1. Dredging terminated prior to February 15 close of in-water work window. Sand cover placement and demobilization completed by March 1.
1/26/2007	Serial Letter Regarding Piles, Large Wood Debris, and Woodwaste Affecting Dredge Cut Quality Relative to Specification Tolerances	Resolution was related to contract amendment/restructuring and was resolved during amendment discussion for Change Order CO#2.

Table 5 - Construction Quantity and Cost Summary

Item	Description	Units	Unit Price	Estimated Quantity	Bid Cost per Estimated Quantity	Actual Quantity	Cost per Actual Quantity
ACC-Hurlen Construction Costs							
Lump Sum Items							
1	Mobilization	LS	$68,000	1	$68,000	1	$68,000
2	Submittals	LS	$20,000	1	$20,000	1	$20,000
Unit Price Items							
1	Dredging	CY	$19.00	17,200	$326,800	12,859	$244,321
2	Debris Separation (Large Wood Debris)	Ton	$3.50	1,500	$5,250	37.56	$131
3	Standby Time	Day	$9,000	1	$9,000	0	$0
Additive Alternate Lump Sum							
1	Optional Sand Cover Placement [a]	LS	$66,500	1	$66,500	1	$66,500
Change Order Items							
CO#1	Additional Dredging	LS	$116,429	0	$0	1	$116,429
CO#2	Piling Obstructions	LS	$44,619	0	$0	1	$44,619
Construction Contracting Subtotal Including Tax (Rounded)					**$495,550**		**$560,000**
Hart Crowser Construction Management							
Construction Support[b]							$153,181
Construction Support Contract Change							$46,900
Construction Management Subtotal Including Tax (Rounded)							**$200,100**
Total Project Construction and Construction Management (Rounded)							**$760,100**

Notes:

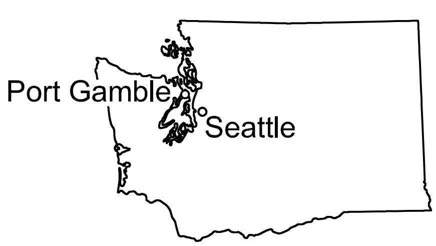
a. 3,500 cy were assumed for original bid. Approximately 1,430 cy total placed.

b. Hart Crowser field observations, water quality monitoring, engineer and contractor documentation, pre- and post-dredging bathymetry coordination, and preparation of construction completion report.

Excludes design phase costs, permitting, and stakeholder interaction.

Excludes sparging basin construction and management, planned upland beneficial reuse of dredged materials, acquisition and delivery of sand cover material to site, wood debris and piling disposal, and other stakeholder costs during construction.

Note: Base map prepared from USGS 7.5 minute quadrangle map of Port Gamble, WA.



0 1000 2000

Scale in Feet

N

Port Gamble Bay Woodwaste Removal
Port Gamble, Washington

Vicinity Map

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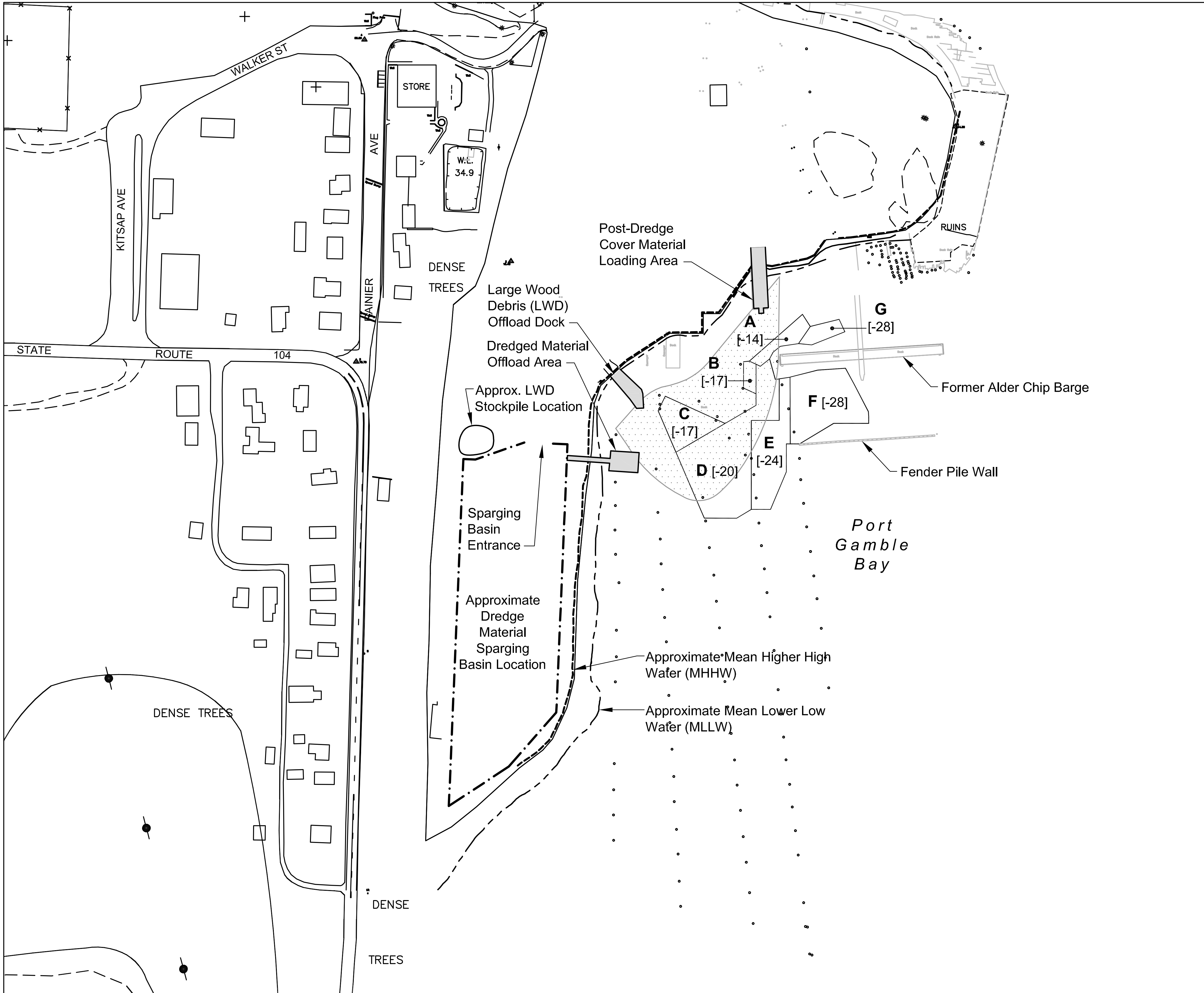
Figure
1

EAL 07/24/07 1731801-021.dwg



LEGEND:

F [-28]	Dredge Area and Design Dredge Elevation in Feet (MLLW)
(box)	Design Dredge Area Limits (Toe of Slope)
•	Reported Wooden Pile Location prior to Removal by Others
(stippled)	2003 Dredge Area

Notes:

1. Base map prepared from electronic file provided by Anchor Environmental, L.L.C., titled, "05020702-C002.dwg" dated 12-08-06.
2. See Figure 5 for Pre-Dredge Elevation Contours.
3. See Figure 4 for generalized extent of actual dredging completed.

N

0 200 400
Scale in Feet

Port Gamble Bay Woodwaste Removal
Port Gamble, Washington

Pre-Dredge Construction
Site Plan and Features

17318-01 7/07

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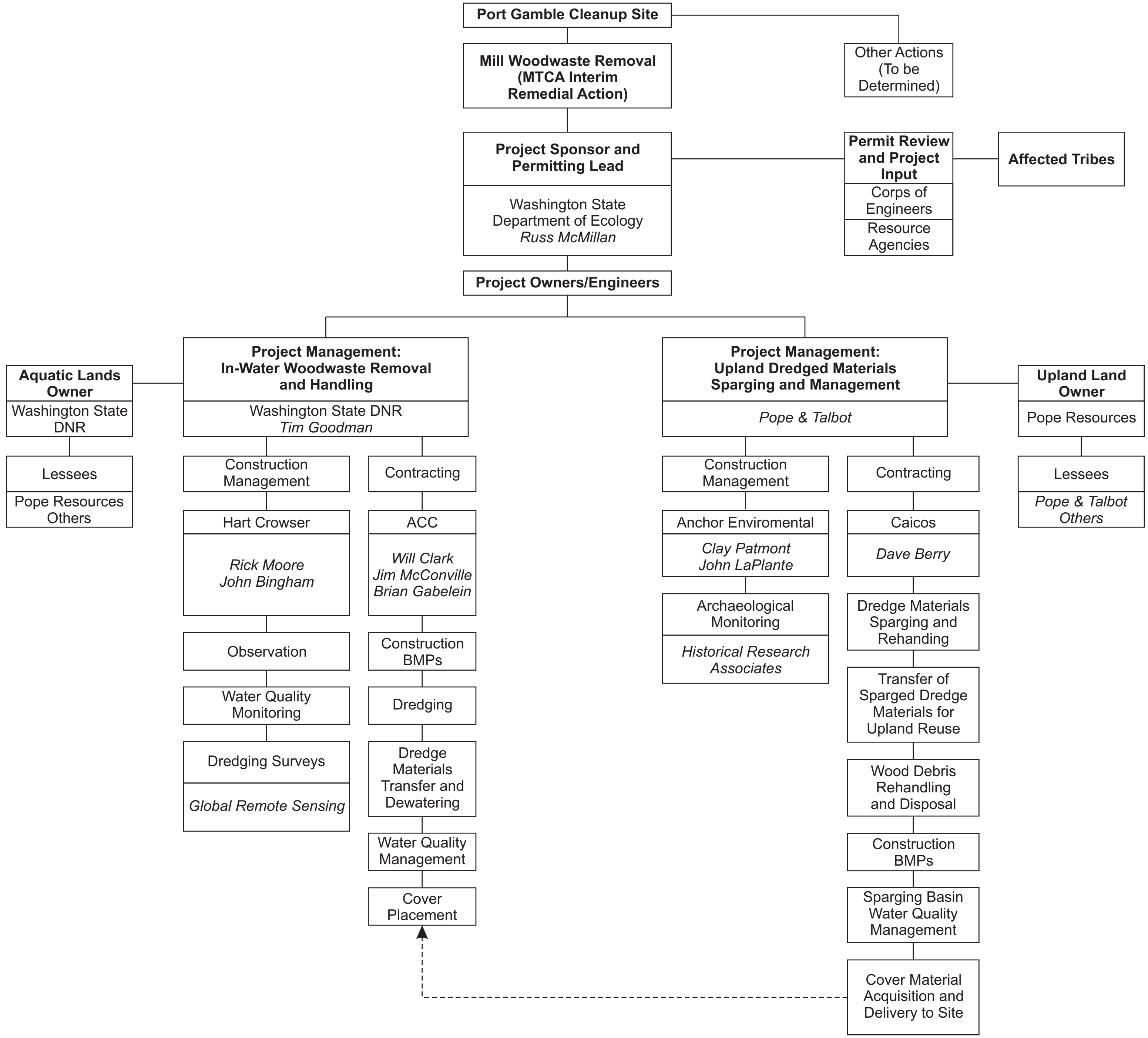
Figure
2

SRN 07/26/07 1731801-023.dwg

EAL 07/24/07 1731801-AA.cdr



Port Gamble Bay Woodwaste Removal
Port Gamble, Washington

Port Gamble Project
General Organization Chart

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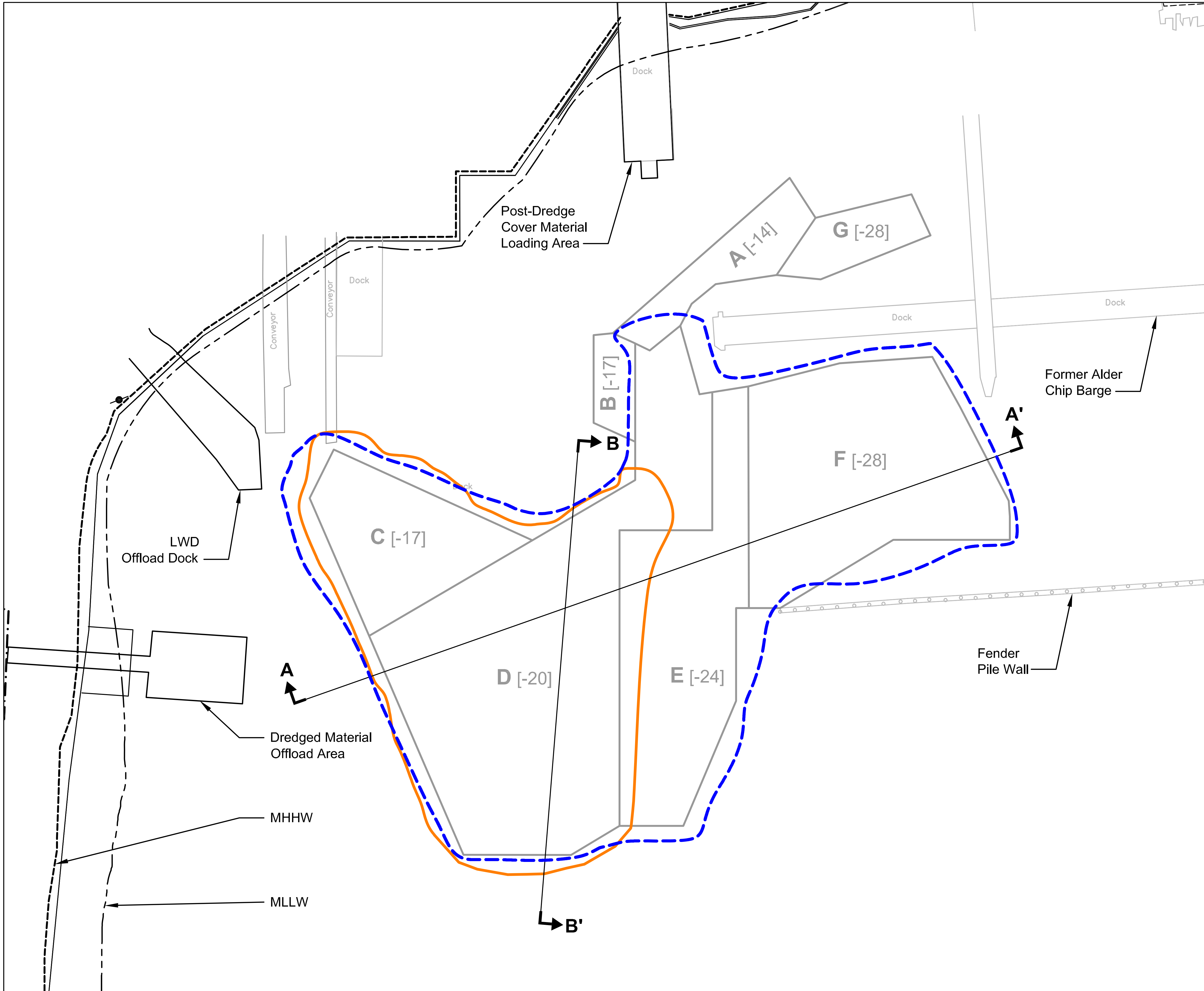
Figure **3**



LEGEND:

G [-28]	Dredge Area and Design Dredge Elevation in Feet (MLLW)
(rectangle symbol)	Design Dredge Area Limits (Toe of Slope)
(grey line)	Design Dredge Area (Toe of Slope, See Note 1)
(blue dashed line)	Approximate First Pass Dredging Limits (through 02/01/07, See Note 2)
(orange line)	Approximate Second Pass Dredging to Apparent Native Sediments Limits (through 02/16/07, See Note 3)
A A'	Approximate Cross Section Location and Designation (See Figure 8)

Notes:

1. Base map prepared from electronic file provided by Anchor Environmental, L.L.C., titled, "05020702-C002.dwg" dated 12-08-06.
2. First pass dredging extent based on dredging bucket mark maps from ACC Hurlen and February 6, 2007, multi-beam bathymetry by GRS.
3. Second pass dredging extent based on dredging bucket mark maps from ACC Hurlen and February 16, 2007, single-beam bathymetry by ACC Hurlen.

N

0 60 120
Scale in Feet

Port Gamble Bay Woodwaste Removal
Port Gamble, Washington

Generalized Dredging Extent

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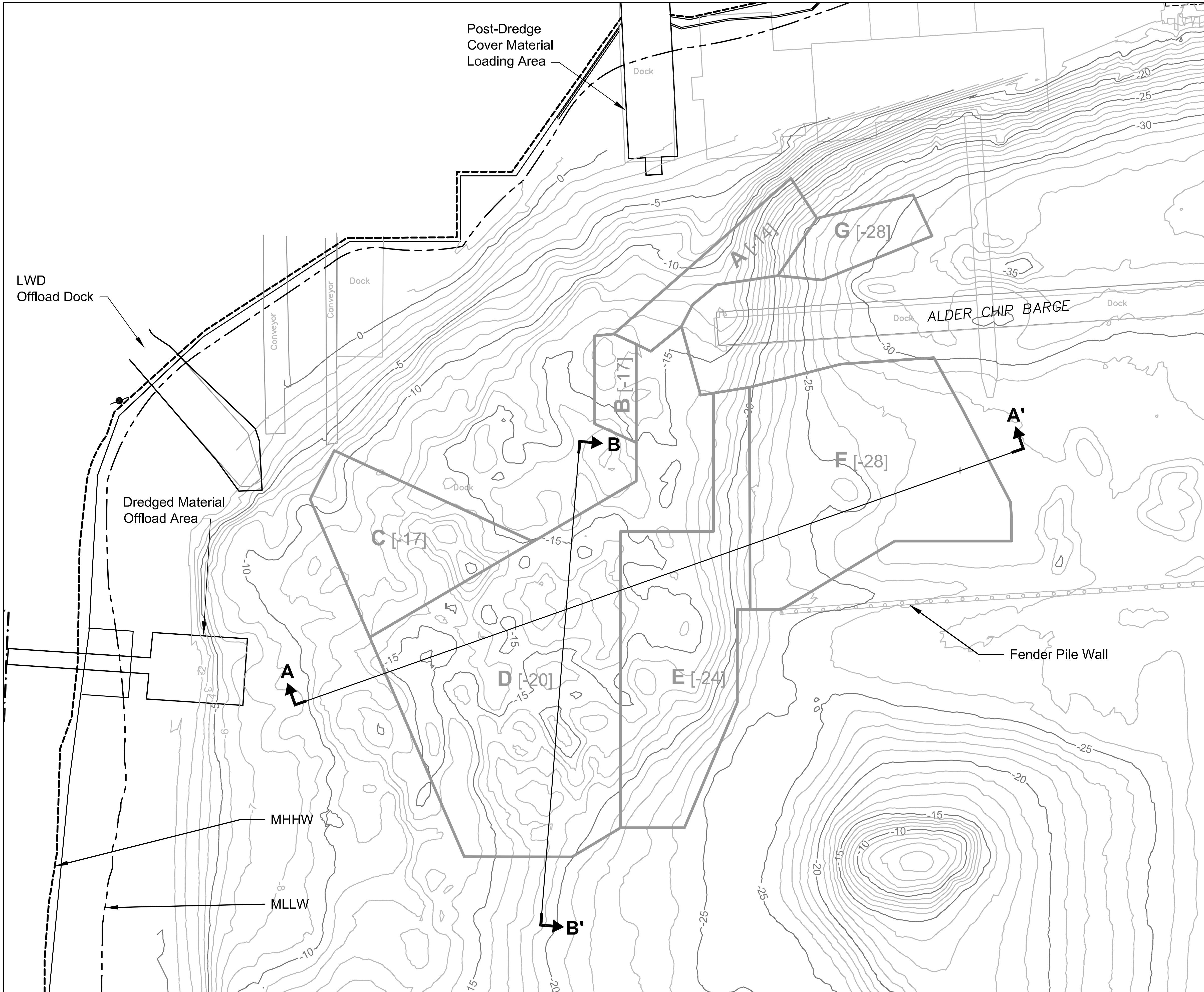
Figure 4

SRN 07/24/07 1731801-031.dwg



LEGEND:

G [-28] Dredge Area and Design Dredge Elevation in Feet (MLLW)

Design Dredge Area Limits (Toe of Slope)

-30 Pre-dredge Multi-Beam Bathymetric Elevation Contour in Feet (12/15/06 by GRS) MLLW Datum (1-foot interval)

A A' Approximate Cross Section Location and Designation (See Figure 8)

Notes:

1. Base map prepared from electronic file provided by Anchor Environmental, L.L.C., titled, "05020702-C002.dwg" dated 12-08-06.

0 60 120
Scale in Feet

N

Port Gamble Bay Woodwaste Removal
Port Gamble, Washington

Pre-Dredging Bathymetry Map

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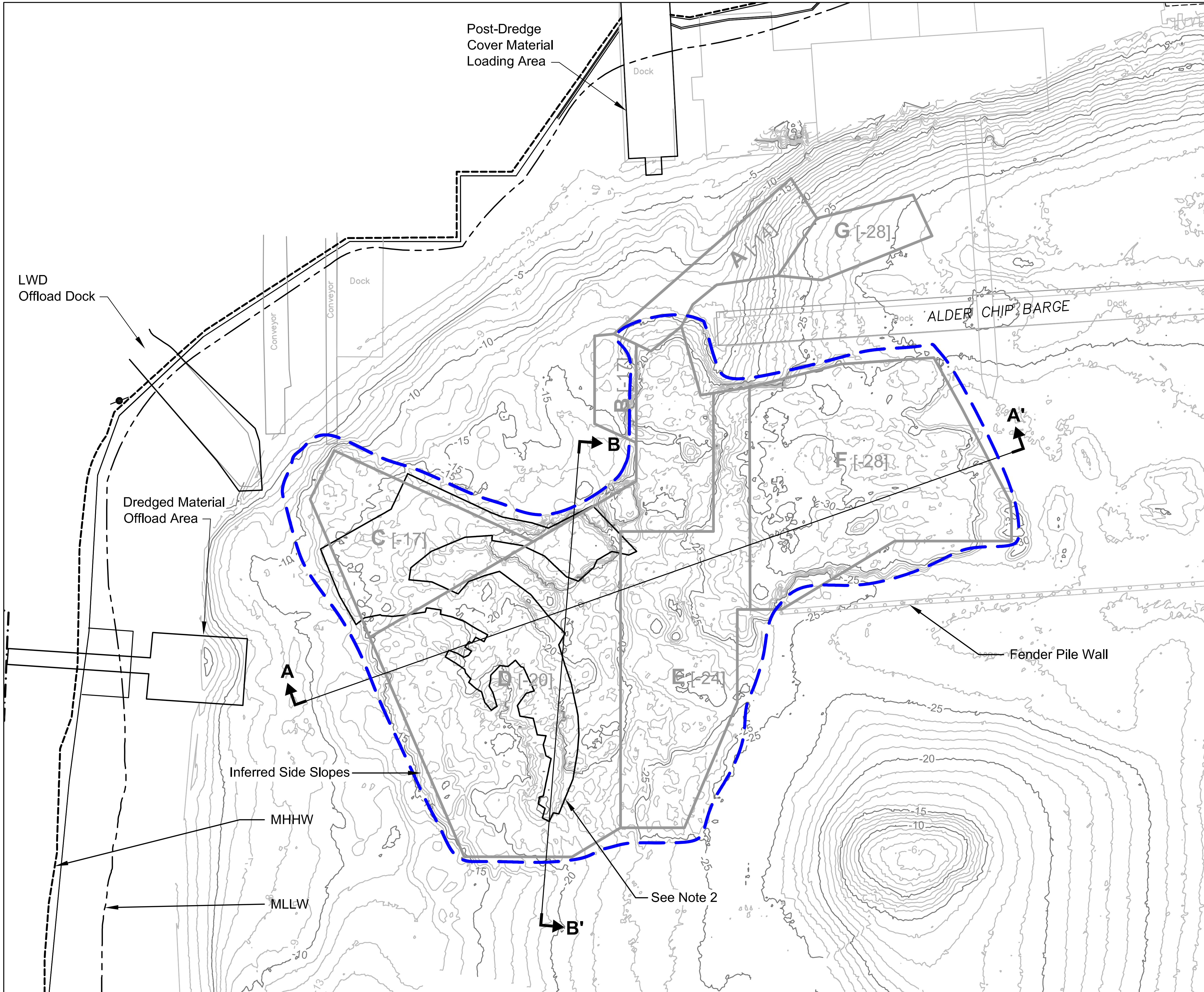
Figure
5

SRN 07/24/07 1731801-024.dwg



LEGEND:

G [-28]	Dredge Area and Design Dredge Elevation in Feet (MLLW)
	Design Dredge Area Limit (Toe of Slope)
-30	Multi-Beam Bathymetric Elevation Contour in Feet (02/06/07 by GRS) MLLW Datum (1-foot interval)
	Approximate First Pass Dredging Limits (through 02/01/07, See Note 3)
A A'	Approximate Cross Section Location and Designation (See Figure 8)

Notes:

1. Base map prepared from electronic file provided by Anchor Environmental, L.L.C., titled, "05020702-C002.dwg" dated 12-08-06.
2. Area redredged to native sediments prior to 02/06/07 GRS survey. Redredging extent based on 02/06/07 dredging bucket mark map by ACC Hurlen.
3. First pass dredging extent based on dredging bucket mark maps from ACC Hurlen and February 6, 2007, multi-beam bathymetry by GRS.

0 60 120
Scale in Feet

N

Port Gamble Bay Woodwaste Removal
Port Gamble, Washington

First-Pass Dredging Bathymetry Map

17318-01 7/07

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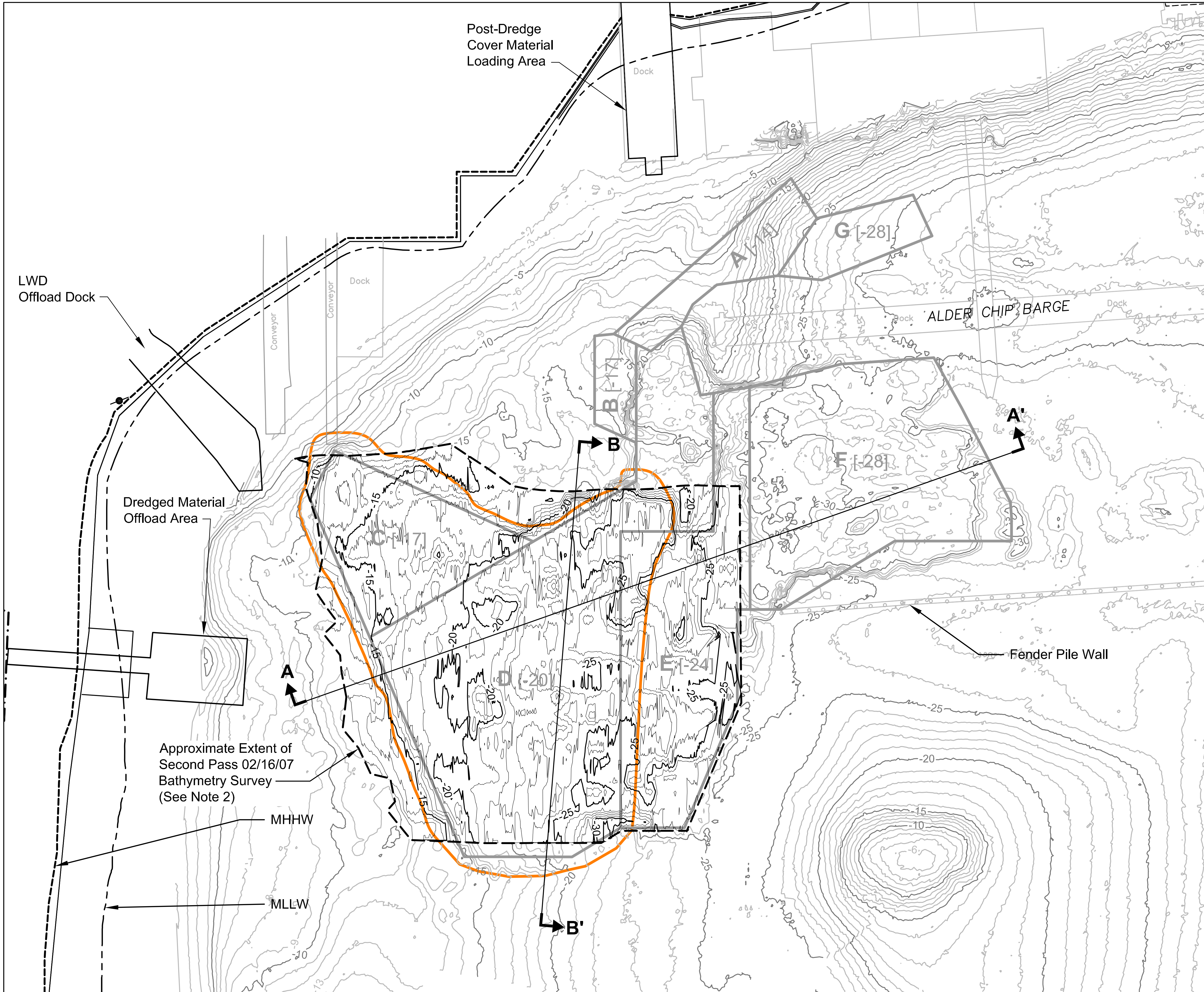
Figure
6

SRN 07/24/07 1731801-025.dwg



LEGEND:

G [-28] — Dredge Area and Design Dredge Elevation in Feet (MLLW)

Design Dredge Area Limits (Toe of Slope)

-30 — Multi-Beam Bathymetric Elevation Contour in Feet (02/06/07 by GRS) MLLW Datum (1-foot interval)

-30 — Single-Beam Bathymetric Elevation Contour in Feet (02/16/07 by ACC Hurlen) MLLW Datum (1-foot interval, see Note 2)

Approximate Second Pass Dredging to Apparent Native Sediments Limits (through 02/16/07, See Note 3)

A A' — Approximate Cross Section Location and Designation (See Figure 8)

Notes:

1. Base map prepared from electronic file provided by Anchor Environmental, L.L.C., titled, "05020702-C002.dwg" dated 12-08-06
2. Single-beam bathymetry only covered second pass dredging extent shown on Figure 4.
3. Second pass dredging extent based on dredging bucket mark maps from ACC Hurlen and February 16, 2007, single-beam bathymetry by ACC Hurlen.

0 60 120
Scale in Feet

N

Port Gamble Bay Woodwaste Removal
Port Gamble, Washington

Second/Final Pass Dredging Bathymetry Map

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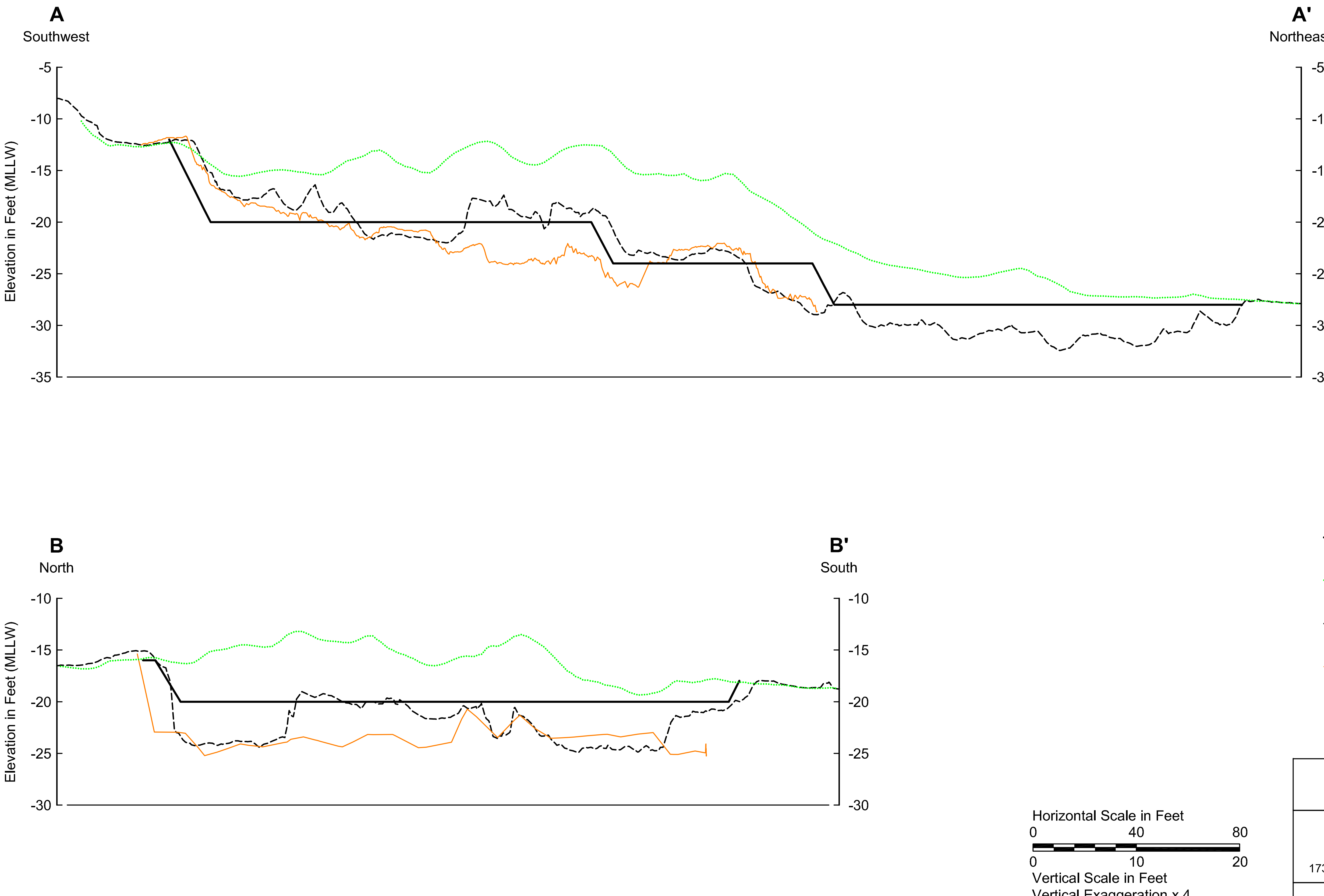
Figure
7

SRN 07/24/07 1731801-026.dwg



Port Gamble Bay Woodwaste Removal
Port Gamble, Washington

Cross Sections A-A' and B-B'

17318-01 7/07

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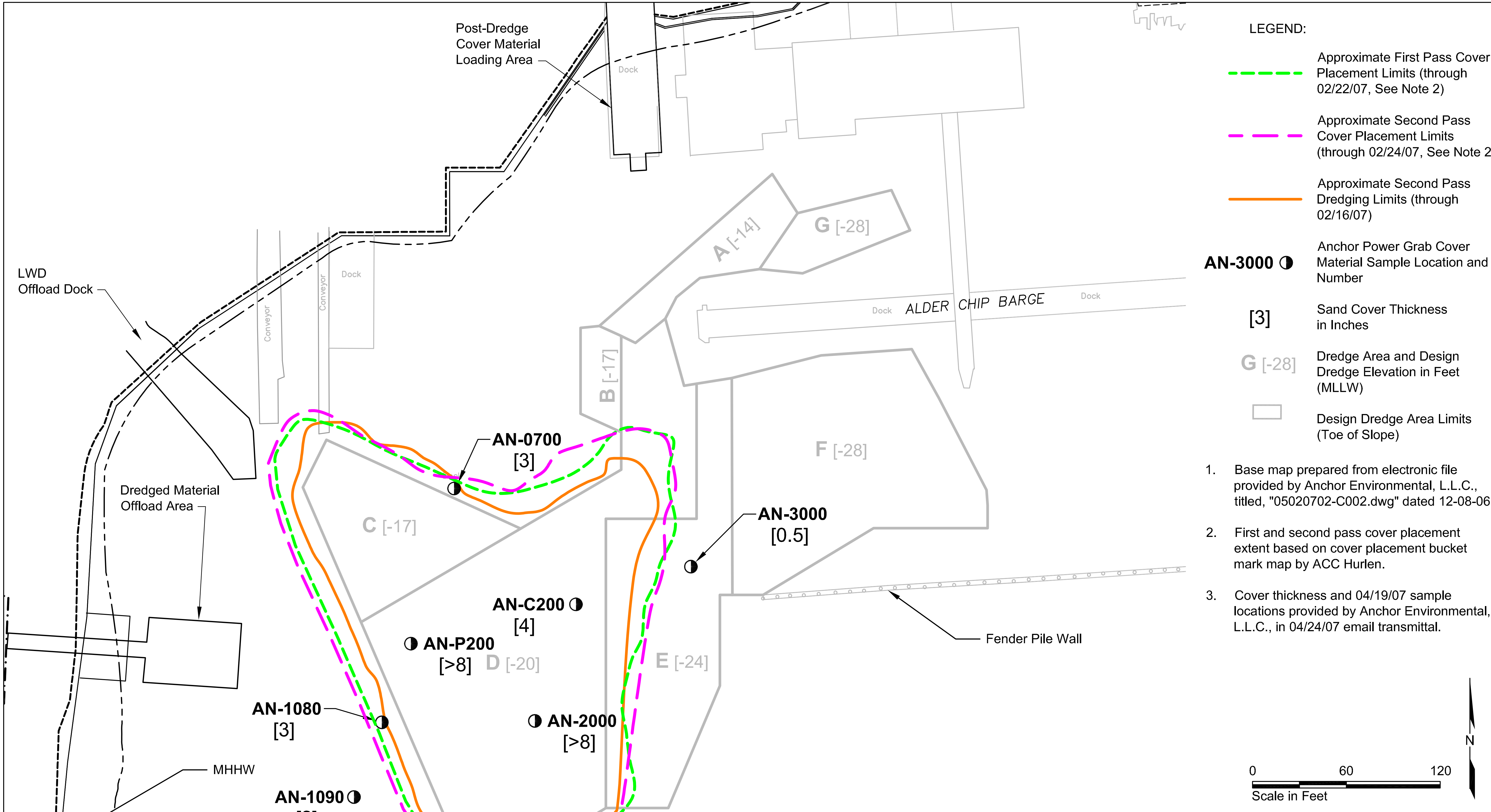
Figure
8

SRN 07/24/07 1731801-033.dwg



Port Gamble Bay Woodwaste Removal
Port Gamble, Washington

Sand Cover Placement and Post-Cover Placement Thickness Sampling Results

17318-01 7/07

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Figure 9

SRN 07/24/07 1731801-030.dwg

APPENDIX A
REPRESENTATIVE CONSTRUCTION PHOTOGRAPHS

Photograph 1 - Dredging barge, crane, and bucket about to excavate sediment.

Photograph 2 - Dredge bucket (approximately 3 to 3.5 cubic yard volume).

Photograph 3 - Dredge bucket full of sediment at water surface.

Photograph 4 - View of sawdust-like dredged material (light color), heterogeneous sediment/woodwaste (dark color), and large wood debris.

Photograph 5 - Example of sawdust-like dredged material (left) and silty, sandy woodwaste (right) on barge.

Photograph 6 - Wet dredge sediment excavated during test dredge (12/22/06). Sediment is predominantly the heterogeneous, dark (sandy) sediment/woodwaste-type dredged material.

Photograph 7 - Wet silty, heterogeneous sediment/woodwaste dewatering/ decanting on barge.

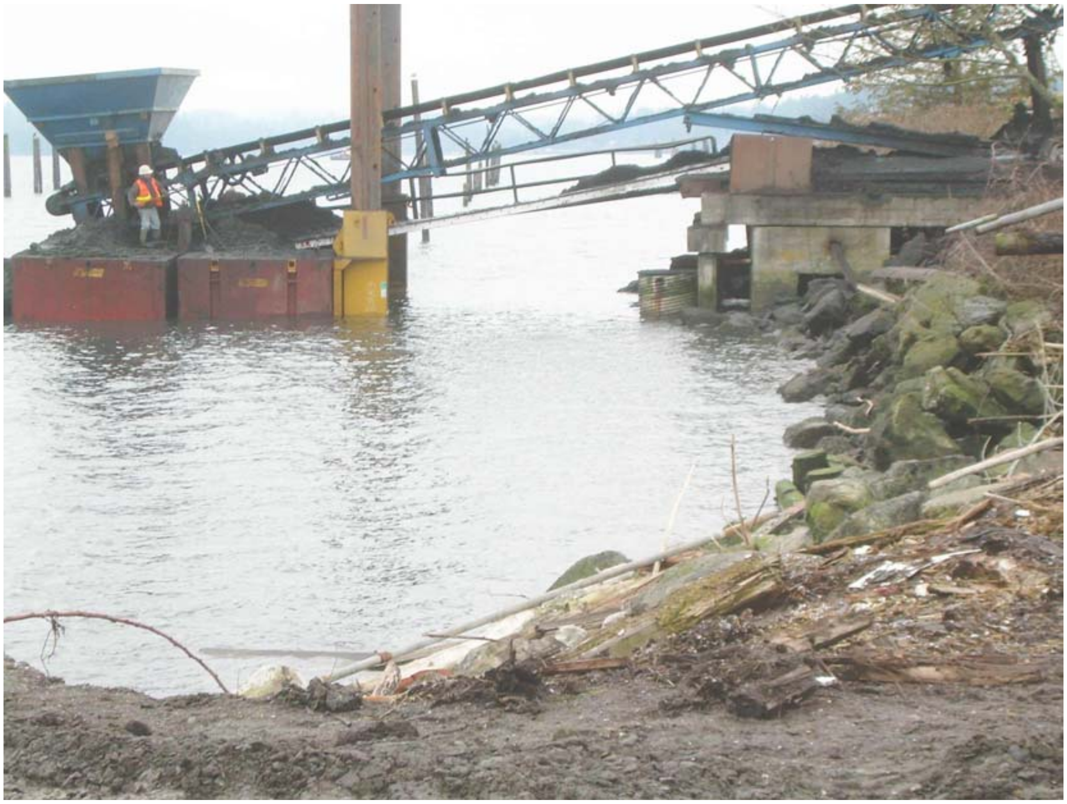
Photograph 8 - Dewatered sandy sediment on barge containing more wood material and less silt.

Photograph 9 - Large wood debris being loaded onto barge.

Photograph 10 - Timber pile being loaded on barge.

Photograph 11 - First pile of large wood debris after offloading and weighing.

Photograph 12 - End of barge being used to stockpile large wood debris. Note size of some of the logs.



Photograph 13 - Offloading setup after planking installed between flexi-float (left) and upland structure (right) to catch sediment spilling off of conveyor.

Photograph 14 - Loader and off-road truck offloading dredge sediment.

Photograph 15 - Dredge sediment offloading area hopper and conveyor setup.

Photograph 16 - South end of sparging basin with wet silty dredge sediment at beginning of project. Note outfall inlet ecology blocks and geotextile at right in foreground.

Photograph 17 - South end of sparging basin on January 19, 2007. Note the variability of the material.

Photograph 18 - Loading of barge with cover sand material.


Photograph 19 - Spilling of wet sediment off of offloading conveyor prior to installation of planking to catch sediment.

Photograph 20 - Close up of planking under offloading conveyor.

Photograph 21 - Sand cover placement with bucket above water to attain thin placement thickness. Note trail of air bubbles.

APPENDIX B WATER QUALITY MONITORING RESULTS

APPENDIX B
WATER QUALITY MONITORING RESULTS
PORT GAMBLE INTERIM REMEDIAL ACTION
WOODWASTE REMOVAL PROJECT
PORT GAMBLE, WASHINGTON

This appendix presents the results of water quality monitoring conducted during the Interim Remedial Action at Port Gamble. The purpose of the water quality monitoring was to assess potential water quality impacts during in-water work activities including woodwaste dredging completed in January and February 2007, and sand cover placement completed over a portion of the dredge area in February 2007.

The objectives of water quality monitoring were as follows:

- Establish initial background water quality criteria before construction, and additional background information obtained during construction;
- Ensure that turbidity and dissolved oxygen (DO) remained within target threshold limits as agreed to by DNR and Ecology;
- Allow for appropriate adjustment of construction activities to protect surface water quality, as necessary; and
- Document the results of water quality monitoring.

It should be noted that a formal Water Quality Certification was not issued for the project; however, turbidity and DO threshold criteria were established consistent with Water Quality Standards for Surface Waters of the State of Washington established in Chapter 173-201A WAC. These criteria were established for Port Gamble Bay as an Excellent category water as follows.

Turbidity

For background turbidity less than 50 nephelometric turbidity units (NTUs), compliance limit established as 5 NTUs above background at a representative downcurrent sampling location (i.e., nominally 200 feet downcurrent of in-water activity area). Background concentration remained below 50 NTUs for the duration of the project.

Dissolved Oxygen (DO)

Compliance limits for DO were established as a daily minimum of 6 milligrams per liter (mg/L), or no more than a 0.2 mg/L decrease in DO from construction activities when background DO is within 0.2 mg/L of the 6 mg/L criteria.

MONITORING METHODS AND PROTOCOLS

Monitoring protocols and frequency criteria were established based on discussions and email correspondence with DNR and Ecology. Protocols were further refined based on site-specific conditions as the work progressed. A summary of the monitoring methods follows.

Monitoring Methods

Baseline and Background Monitoring

Initial baseline monitoring for establishing background was completed on December 22, 2006. Baseline monitoring results helped to establish initial target ranges for turbidity, DO, and other parameters as listed in Table B-1. The December 22 event was conducted following malfunctioning of the turbidimeter on December 12. Background turbidity readings ranged from 2.1 to 4.8 NTUs during the December 22 event. DO readings ranged from 8.2 mg/L during the December 12 event to 15.30 mg/L during the December 22 event. Additional background monitoring continued throughout the construction effort to best represent current conditions during the work. Baseline monitoring included nine locations throughout the planned work area.

Construction Monitoring

Water quality monitoring was conducted on a weekly basis based on construction schedule, weather, and logistical considerations. Monitoring during woodwaste dredging occurred on January 8, 13, 19, and 26, 2007. Monitoring during sand cap cover placement occurred on February 21, 2007. Monitoring results are presented in Tables B-2 through B-6.

During each event, monitoring was conducted at downcurrent compliance locations at a target distance of about 200 feet from the in-water work area. Upgradient and cross-gradient background locations were also monitored for comparison. The compliance and background monitoring locations varied with work activity, tide, and wind conditions. Compliance locations were frequently located to the south of the dredging areas as a result of prevailing northerly winds. Wind and current changes revised this pattern on several occasions.

Monitoring was intended to obtain turbidity and DO data most representative of dredging and cover placement activities with potential to impact water quality. For this reason, the results reported in Tables B-2 through B-6 include a variety of tidal stages rather than being limited to specific ebb and flood periods. Limiting monitoring to specific ebb and flood periods would have been less representative of critical case conditions during dredging and cover placement. Rather, monitoring coincide with in-water work periods with representative intensity and duration.

Monitoring Methods

Monitoring consisted of lowering a weighted, flexible tube to three sampling depths at each monitoring location. Monitoring depths included near-surface, mid-column depth, and near-bottom, as listed in Tables B-2 through B-6. Seawater samples were then pumped from each sampling point for monitoring using a Horiba U-22 multimeter. A Horiba U-10 multimeter and LaMotte turbidimeter were used during the January 26, 2007 event. State Plane location coordinates were recorded at each location via GPS. No problems were encountered using these methods.

SUMMARY OF RESULTS

Monitoring data obtained during the Interim Action were evaluated to assess the effectiveness of best management practices (BMPs) during construction to prevent water quality impacts. Turbidity remained within the target compliance range except for one reading during the February 21, 2007, sand placement monitoring event at location 1, 1500 hours (see Table B-6). Turbidity was associated with placement of sand cap material and was observed to quickly dissipate as the material fell through the water column. A subsequent turbidity reading at 1600 hours (location 4) was in compliance relative to upgradient background locations 3 and 6. No additional actions were taken, as sand cover placement was completed shortly thereafter.

Although DO was slightly depressed below the 6.0 mg/L criteria at location 4 at 1600 hours on the same date, the readings were within 0.2 mg/L of the comparative upgradient background DO at location 3 at 1545 hours. DO readings, therefore, are considered to be in compliance.

It should also be noted that on several occasions during the January 8, 13, and 19, 2007 monitoring events, visible turbidity was observed along the shoreline to the west and north of the dredging areas. This turbidity resulted from prevailing wind and tidal conditions transporting particulate material into the shoreline from natural sources to the south in Port Gamble Bay. The shoreline turbidity conditions were not observed to be related to construction. For this reason, monitoring data collected within the turbid shoreline zone downcurrent of dredging were not indicative of construction-related impacts. No additional actions were taken.

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Table B-1 Port Gamble Water Quality Monitoring Results for December 22, 2006 **12/22/2006**
Hart Crowser
17318-01

Sample Location	Monitoring Depth below Vessel Rail in Feet[1]	pH	Turbidity in NTUs	DO in mg/L	Salinity in %	Temperature in Degrees C	Time	Depth to Bottom in Feet[1]	State Plane Coordinates[2] Northing	Easting
1	41.0	7.48	2.10	15.30	3.2	8.22	11:00	46	316522.63	1211861.34
Background	20.0	7.51	2.10	14.74	3.2	8.15				
	5.0	7.53	2.20	14.77	3.2	7.94				
2	9.5	7.54	4.00	12.89	3.2	7.47	11:30	12	315661.76	1211155.15
Background	5.0	7.56	3.60	12.74	3.2	7.67				
	3.0	7.56	3.70	12.78	3.2	7.64				
3	7.0	7.56	4.30	12.88	3.2	7.54	11:45	9	315886.26	1211163.90
Background	5.0	7.56	3.70	12.49	3.2	7.70				
	2.0	7.56	3.70	12.39	3.2	7.68				
4	8.0	7.57	4.00	12.33	3.2	7.75	12:00	10	316094.84	1211167.90
Background	5.0	7.58	3.70	12.28	3.2	7.68				
	2.0	7.58	3.80	12.23	3.2	7.67				
5	24.5	7.58	4.00	12.88	3.1	7.65	12:15	29	316209.37	1211457.59
Background	15.0	7.58	3.80	12.14	3.2	7.54				
	5.0	7.60	3.80	12.00	3.2	8.02				
6	8.8	7.58	4.80	11.73	3.2	7.34	12:30	11	316392.65	1211198.16
Background	5.8	7.58	4.20	11.45	3.2	7.71				
	2.0	7.59	4.20	11.39	3.2	7.73				
7	30.0	7.58	3.80	11.30	3.2	8.11	12:45	35	316325.31	1211553.59
Background	15.0	7.58	3.70	10.43	3.3	7.96				
	5.0	7.58	3.50	10.57	3.2	8.14				
8	33.6	7.58	4.20	10.57	3.2	7.57	13:15	39	316384.67	1211676.61
Background	15.0	7.58	4.20	10.84	3.2	7.30				
	5.0	7.58	4.20	10.95	3.2	7.18				
9	35.0	7.57	4.60	10.44	3.2	8.05	13:45	39	316345.86	1211811.15
Background	15.0	7.59	4.00	10.40	3.2	8.15				
	5.0	7.59	4.00	10.41	3.2	8.12				

Notes:
1. Depths are measured from the vessel rail located 1.5 feet above the water surface of water.
2. GPS coordinates in NAD83 WA N.
3. Used Horiba U-22 multimeter.

Table B-2 Port Gamble Water Quality Monitoring Results for January 8, 2007 **1/8/2007**
Hart Crowser
17318-01

Sample Location	Monitoring Depth below Vessel Rail in Feet[1]	pH	Turbidity in NTUs	DO in mg/L	Salinity in %	Temperature in Degrees C	Time	Depth to Bottom in Feet[1]	State Plane Coordinates[2] Northing	Easting
1	17	7.55	5.9	10.31	3.2	8.17	1100	20	316486.1	1211381.7
Compliance	12	7.62	5.7	9.75	3.2	8.06				
60 yd to dredge	5	7.65	6.1	9.4	3.2	8.03				
2	10	7.67	12.0	8.35	3.2	8.07	1115	12	316382.8	1211197.6
Compliance	7	7.69	9.7	8.24	3.2	8.07				
50 yd to dredge	4	7.7	8.6	8.33	3.2	8.01				
3	8	7.71	5.9	7.41	3.2	8.05	1200	10	316094.7	1211167.2
Background	5	7.71	5.7	7.4	3.2	8.02				
60 yd to dredge	3	7.72	5.7	7.37	3.2	8.02				

Notes:
1. Depths are measured from the vessel rail located 1.5 feet above the water surface of water.
2. GPS coordinates in NAD83 WA N.
3. Monitoring location 2 is in shallow water where it may be affected by wave action and wind-generated turbidity near the shoreline. This location was also closer to the dredge than the compliance distance and is not indicative of water quality impacts from dredging.
4. Used Horiba U-22 multimeter.

Table B-3 Port Gamble Water Quality Monitoring Results for January 13, 2007 **1/13/2007**
Hart Crowser
17318-01

Sample Location	Monitoring Depth below Vessel Rail in Feet[1]	pH	Turbidity in NTUs	DO in mg/L	Salinity in %	Temperature in Degrees C	Time	Depth to Bottom in Feet[1]	State Plane Coordinates[2] Northing	Easting
4	10	6.7	9.3	17.06	3.1	4.24	1400	15	316522	1211395.6
Compliance	6	7.28	6.4	14.73	3.1	5.78				
60 yd to dredge	3	7.49	4.7	13.6	3.1	5.66				
5	30	7.65	5.1	10.87	3.1	5.63	1415	40	316464.4	1211637.4
Compliance	20	7.68	4.5	10.39	3.2	5.83				
70 yd to dredge	10	7.69	4.7	10.26	3.2	5.69				

Notes:
1. Depths are measured from the vessel rail located 1.5 feet above the water surface of water.
2. GPS coordinates in NAD83 WA N.
3. Monitoring location 4 is located in shallow water where it may be affected by wave action and wind-generated turbidity near the shoreline. This location was also closer to the dredge than the compliance distance and is not indicative of water quality impacts from dredging.
4. Used Horiba U-22 multimeter.

Table B-4 Port Gamble Water Quality Monitoring Results for January 19, 2007 **1/19/2007**
Hart Crowser
17318-01

Sample Location		Monitoring Depth below Vessel Rail in Feet[1]	pH	Turbidity in NTUs	DO in mg/L	Salinity in %	Temperature in Degrees C	Time	Depth to Bottom in Feet[1]	State Plane Coordinates[2] Northing	Easting
	1	17	7.57	7.5	14.59	3.2	7.28	1130	19	316490.7	1211392.4
Compliance		10	7.65	4.7	12.91	3.2	7.09				
65 yards to dredge		5	7.69	4.2	12.04	3.2	7.06				
	2	28	7.71	3.9	13.73	3.2	7.15	1145	33	316458.9	1211533.8
Compliance		15	7.72	3.5	11.78	3.2	7.16				
60 yards to dredge		5	7.75	9.0	10.66	3.2	7.06				
	3	21	7.77	5.3	9.06	3.2	7.08	1200	26	316376.2	1211367.5
Compliance		15	7.77	4.2	8.90	3.2	7.12				
50 yards to dredge		5	7.79	4.4	8.62	3.2	7.09				
	4	9	7.77	4.0	11.56	3.2	6.94	1230	10	315712.1	121164.2
Background		5	7.78	3.8	10.63	3.2	7.00				
		3	7.79	3.9	10.06	3.2	6.95				
	5	21	7.79	4.5	11.12	3.2	7.02	1300	26	316033.6	1211245.3
Background		15	7.79	5.0	10.45	3.2	7.08				
		5	7.79	3.9	9.84	3.2	7.07				

Notes:

1. Depths are measured from the vessel rail located 1.5 feet above the water surface of water.
2. GPS coordinates in NAD83 WA N.
3. Monitoring locations 1 and 2 are in shallow water where they may be affected by wave action and wind-generated turbidity near the shoreline. These locations were also closer to the dredge than the compliance distance and are not indicative of water quality impacts from dredging.
4. Used Horiba U-22 multimeter.

Table B-5 Port Gamble Water Quality Monitoring Results for January 26, 2007 **1/26/2007**
Hart Crowser
17318-01

Sample Location		Monitoring Depth below Vessel Rail in Feet[1]	pH	Turbidity in NTUs	DO in mg/L	Salinity in %	Temperature in Degrees C	Time	Depth to Bottom in Feet[1]	State Plane Coordinates[2] Northing	Easting
	1	38	7.38	1.35	14.68	3.31	7.9	1145	42	316468	1211738
Compliance		15	7.46	1.00	12.70	3.35	7.3				
70 yards to dredge		5	7.41	1.00	12.55	3.38	6.8				
	2	11	7.44	1.21	12.38	3.39	7.2	1205	13	316577	1211474
Compliance		7	7.43	0.25	12.38	3.42	7.3				
		3	7.41	0.42	12.47	3.42	7.1				
	3	30	7.46	0.26	12.42	3.39	6.9	1215	34	316170	1211564
Compliance		20	7.42	0.21	12.11	3.37	7.0				
80 yards to dredge		5	7.43	0.15	11.70	3.34	7.5				
	4	34	7.45	0.51	11.71	3.36	7.4	1235	38	316345	1211727
Background		20	7.42	1.15	11.50	3.28	8.5				
75 yards to dredge		5	7.44	1.05	11.16	3.24	8.6				
	5	30	7.44	1.54	11.15	3.23	8.8	1310	34	316593	1211650
Background		15	7.44	1.07	11.21	3.24	8.8				
80 yards to dredge		5	7.43	1.86	11.32	3.22	8.8				

Notes:
1. Depths are measured from the vessel rail located 1.5 feet above the water surface of water.
2. GPS coordinates in NAD83 WA N.
3. Used Horiba U-10 multimeter and a LaMotte 2020e turbidimeter.

Table B-6 Port Gamble Water Quality Monitoring Results for February 21, 2007 **2/21/2007**
Hart Crowser
17318-01

Sample Location		**Monitoring Depth below Vessel Rail in Feet[1]**	**pH**	**Turbidity in NTUs**	**DO in mg/L**	**Salinity in %**	**Temperature in Degrees C**	**Time**	**Depth to Bottom in Feet[1]**	**State Plane Coordinates[2] Northing**	**State Plane Coordinates[2] Easting**
	1	17	7.49	**25.0**	11.00	3.5	8.80	1500	22	316103	1211354
Compliance		10	7361	20.0	8.50	3.4	8.60				
85 yards to dredge		5	7.64	13.5	7.57	3.4	8.60				
	2	8	7.7	5.8	6.32	3.4	8.60	1530	10	316389	1211231
Background		5	7.72	6.1	6.29	3.4	8.60				
70 yards to dredge		3	7.73	5.8	6.15	3.4	8.60				
	3	8	7.74	10.0	5.97	3.4	8.80	1545	10	316552	1211432
Background		5	7.75	8.7	5.66	3.4	8.80				
64 yards to dredge		3	7.77	9.6	5.80	3.4	8.90				
	4	17	7.72	10.5	5.95	3.4	8.60	1600	22	316102	1211353
Compliance		10	7.72	9.2	5.88	3.4	8.60				
89 yards to dredge		5	7.71	9.5	5.65	3.4	8.60				
	5	32	7.63	5.3	9.26	3.3	8.51	1700	34	316302	1211703
Background		16	7.66	6.9	7.89	3.3	8.55				
		5	7.67	4.1	7.26	3.3	8.56				
	6	7	7.64	9.2	6.20	3.3	7.91	1725	9	316587	1211451
Background		5	7.66	7.1	6.10	3.3	8.16				
		2	7.67	6.9	6.03	3.3	8.28				
	7	30	7.65	1.1	6.74	3.3	8.34	1745	32	316200	1211450
Background		17	7.68	1.3	6.15	3.3	8.38				
70 yards N of sand cover placement area		5	7.69	1.2	6.14	3.3	8.42				

Notes:
Bolded and boxed entry indicate readings beyond target compliance criteria.
1. Depths are measured from the vessel rail located 1.5 feet above the water surface of water.
2. GPS coordinates in NAD83 WA N
3. Moved barge East 50' at 1515. Downtime may have caused possible settling between 1 and 4.
4. Used Horiba U-22 multimeter.