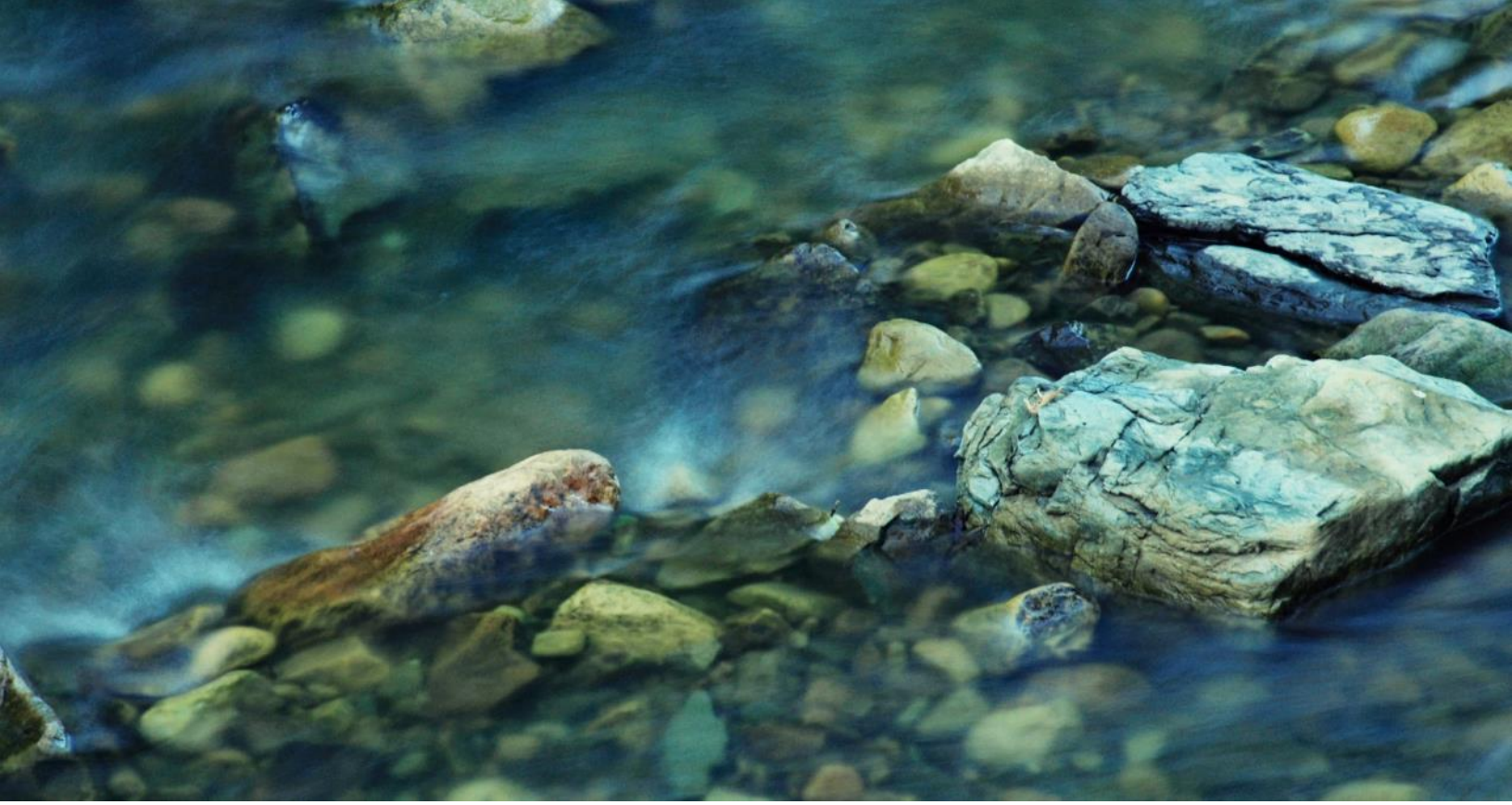

April 2020

ANCHOR QEA

Skagway Ore Terminal Sediment Remediation Project
Alaska Department of Environmental Conservation File No. 1526.38.004
Hazard Identification No. 401

Basis of Design Report

Prepared for White Pass & Yukon Route

April 2020

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Prepared for
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Project Number: 180159-02.03
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ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
BMP	best management practices
BODR	Basis of Design Report
CWP	Construction Work Plan
cy	cubic yard
DU	dredge unit
EPA	U.S. Environmental Protection Agency
EPP	Environmental Protection Plan
H:V	horizontal to vertical
KPFF	KPFF Consulting Engineers
NOAA	National Oceanic and Atmospheric Administration
Options Analysis	Remedial Action Options Analysis
project	Skagway Ore Terminal Sediment Remediation Project
RCRA	Resource Conservation and Recovery Act
TCLP	toxicity characteristic leaching procedure
TESC	temporary erosion and sedimentation controls
USACE	U.S. Army Corps of Engineers
Work Plan	Remedial Approach Work Plan
WPYR	White Pass & Yukon Route

1 Introduction

This Basis of Design Report (BODR) documents key design assumptions and criteria for implementing remediation activities to address sediment contamination in the Ore Basin in Skagway, Alaska. Remedial activities are intended to address historical sediment contamination associated with spillage from ore loading operations from the Ore Loader located in Skagway, Alaska (ADEC Hazard ID No. 401; Figure 1). This report was prepared by Anchor QEA, LLC, in association with KPFF Consulting Engineers (KPFF), on behalf of White Pass & Yukon Route (WPYR), who is taking the lead in addressing legacy ore-related sediment contamination at the site. This report was prepared in accordance with the Alaska Department of Environmental Conservation (ADEC)-accepted Remedial Approach Work Plan (Work Plan; Anchor QEA 2019a). This report describes the design elements and criteria that are the basis for the Skagway Ore Terminal Sediment Remediation Project (project) remedial design.

The design builds upon the Remedial Action Options Analysis (Options Analysis; Anchor QEA 2019b), which evaluated feasible remedial actions and selected a preferred remedial technology (i.e., mass removal of sediment contamination through mechanical dredging, with treatment and disposal) to address legacy sediment contamination in the Skagway Ore Basin (Ore Basin). Additionally, the Options Analysis documented available site information relevant to the sediment remediation, a summary of the project goals, the technical basis for defining the remedial footprint, and the rationale for selecting the preferred remedial option.

Based on the Options Analysis that was reviewed and accepted by ADEC, the remedial option for addressing contaminated sediment will consist of the following key elements:

- Mechanical dredging to remove up to 7,000 cubic yards (cy) of contaminated sediment
- Ex situ stabilization of the dredged material after removal to facilitate safe transport to the Disposal Facility. The stabilization is also expected to reduce the leachability of the material such that it will be suitable for disposal at a Subtitle D landfill.
- Dewatering and treatment of collected water, as required
- Transportation to an Offload Facility
- Disposal at a permitted upland disposal facility
- Placement of a clean sand cover over the dredge footprint to address potential residual contaminants
- Conducting daily progress bathymetric surveys and payment bathymetric surveys upon completion of project elements, such as dredging and sand cover placement

Upon acceptance of the basis of design by ADEC, construction bid documents (i.e., specifications and design drawings) will be finalized, and upon receipt of project permits and ADEC Contaminated Sites Program approval, the remedial actions will be implemented. By implementing the remedy, WPYR

aims to address legacy sediment contamination at the site in a manner that is protective of human health and the environment.

After the Contractor has been selected, the Contractor will be required to prepare pre-construction submittals that will be reviewed and approved by WPYR and ADEC. Based on this review, ADEC will issue a project approval notice prior to the start of construction. The pre-construction submittals include the Contractor's Construction Work Plan (CWP) and Environmental Protection Plan (EPP).

- The CWP will describe the Contractor's means and methods for completing the work and will include a project schedule showing the sequence of work.
- The EPP will describe the Contractor's environmental controls to ensure the project meets permit, contractual, and regulatory environmental requirements.

2 Remediation Elements

This section describes the criteria and design considerations associated with the project remediation elements. Additional detail regarding the remediation elements and associated sequencing can be found in Section 3.

2.1 Site Operational Conditions

Consistent with the project remedial action objectives (Options Analysis, Anchor QEA 2019b), Objective 5 states that the project will "implement a remedial action that does not adversely impact existing or reasonably anticipated future harbor operational uses, including existing or reasonably anticipated infrastructure and cruise ship vessel calls." In order to maintain a functioning waterfront facility during remedial construction activities, the following operational requirements were included in the design based on input from WPYR and other project stakeholders:

- Facility operations will take precedence over Contractor activities.
  - The project will be conducted outside of the cruise ship season to not conflict with cruise ship operations.
  - Fuel vessel operations, which are at the Ore Dock, will take precedence over the Contractor's work. The Contractor will be required to accommodate fuel barge operations. WPYR will coordinate the timing and movements of vessels using the Ore Dock.
  - Other harbor vessels, such as operations at the Alaska Marine Lines Dock and the Alaska Ferry Terminal are not expected to impact the Contractor's work.
- Work will be conducted during daylight hours. It is assumed that marine mammal monitoring will be required for the project through permit conditions and that visual observations for mammals will be required to conduct marine mammal monitoring; therefore, work will be restricted to daylight hours. Note that there are also local noise ordinances regarding work after 10:00 p.m., but these are not likely to be more restrictive than the requirement for daylight to conduct marine mammal monitoring.
- Work window: Anchor QEA understands that there may be a restriction on working in April and May due to the eulachon fishery in the adjacent Skagway River. It is assumed that these restrictions would be stipulated as part of project permit conditions and will then be incorporated into the design, as required.
- The Contractor will be allowed to use a portion of the upland area offshore of the Ore Terminal as a staging area. No contaminated material or other deleterious substances will be allowed to be stored at this location.

2.2 Dredging

This section describes the development of the dredging-related design elements. For additional information regarding development of the remedial footprint and removal elevations, please refer to the Options Analysis (Anchor QEA 2019b).

2.2.1 Dredge Prism

The dredge prism identifies the minimum horizontal and vertical extents of dredging to be completed by the Contractor. The horizontal extents of contamination as defined by the dredge footprint boundary were determined through review of all cores within the Ore Basin, while the vertical extent was then based on cores within the dredge footprint (Figure 2). The horizontal extent was determined through the iterative process described in the Options Analysis based on the mass of lead removed. The vertical extents of removal are then based on removal depths to the top of the first "clean" sample interval below the contaminated sediment. "Clean" samples for the purpose of vertical delineation were defined as those that do not exceed the Washington State Department of Ecology Cleanup Screening Level (Sediment Management Standards [Washington Administrative Code 173-204-560]) within each core. The dredge footprint was then divided into discrete dredge units (DUs) with a specified required dredge elevation for each DU. The dredge elevation is defined as the elevation that the Contractor is required to remove all materials above. The elevations were chosen in an effort to not be overly conservative by requiring dredging too much sediment that is not considered to be contaminated based on the available data. Internal side slopes (i.e., dredge slopes between the DUs) and external side slopes (i.e., daylight dredge slopes around the perimeter of the dredge footprint) were then incorporated to define the dredge prism. The dredge prism defines the minimum sediment removal volume for the dredge design.

- To account for equipment tolerance a payable overdredge allowance of 1 foot will be applied to the bottom of the dredge prism that will result in some material being removed below the required dredge elevations.
- A 3-foot dredging offset from the Ore Dock structures, including the Ore Loader Platform, the Existing Dolphins, and the Timber Dock, has been included in the design to protect the structures from incidental damage due to hits from the dredge bucket.
- Berthing depths were not considered as part of the DU development.

2.2.2 Slope and Structures Stability

The design assessed potential impacts that dredging may have on the adjacent slope and structures, specifically, the Timber Dock, the Ore Loader Platform, and the Dolphins. The results of the analysis are provided in Appendix A. The analysis determined that dredging too large a vertical cut adjacent to the existing structures has the potential to adversely impact the structures through either causing an uncontrolled slope failure underneath the existing structures, or causing a differential pressure on

the piling that could result in piling and structure movement or reduction in the structures' load capacities.

To mitigate this concern, the vertical dredge cut at the 3-foot dredging offset will be limited to reduce the amount of material that could slough during one dredging pass and put pressure on the piling. To facilitate partial dredging of the slopes in an iterative manner, the DUs have been divided into subareas, referred to as Sequencing Areas, as shown in Figure 3. In Sequencing Area-A1, a maximum of a 2.5-foot vertical cut and in Sequencing Area-A2 a maximum of a 5-foot vertical cut have been prescribed to protect the adjacent structures. From this dredge cut, the Contractor will be required to dredge a required 2 horizontal to 1 vertical (2H:1V) slope down to the required dredge elevation for each DU. The Contractor will be required to complete all dredging in the Sequencing Area adjacent to the structures first (Sequencing Area-A; Figure 3). This is called "Preliminary Dredging," for the purposes of this report.

The completion of Sequencing Area-A first will allow time for sloughing to occur from the areas under the structures while the Contractor completes dredging in Sequencing Area-B. Upon completion of Sequencing Area-B, the Contractor will be required to clean up any material that has sloughed to the Preliminary Dredging grades. WPYR and the project engineers will then assess the extent of slough material that has occurred during the Preliminary Dredging and direct the Contractor to conduct "Additional Dredging" to the extent possible that is still protective of the structures. This may occur in one or two rounds of "Additional Dredging" depending on the extent of sloughing that occurs. At no time will the Contractor cut more than a 2.5-foot vertical cut in Sequencing Area-A1 or a 5-foot vertical cut in Sequencing Area-A2. Sloughing will be monitored on a daily basis throughout the project through bathymetric progress surveys conducted by the Contractor. If sloughing from under the dock areas does not occur, the required dredge elevations over the entire dredge footprint will not be achieved to prevent excessive risk of an uncontrolled slope failure. Figure 3 displays the Sequencing Areas, and the cross sections in Figure 4 demonstrate this iterative approach to dredging.

2.2.3 Geotechnical Criteria

Available geotechnical data were reviewed as part of the design process to inform design choices. The Options Analysis (Anchor QEA 2019b) provides a summary of geotechnical conditions in the Ore Basin and adjacent to the Ore Loader as part of a description of Physical Site Conditions. Based on review of sampling logs from the *Sediment Characterization Report* (Anchor QEA 2015) and site *Risk Assessment* (Golder 2018), surface sediments in the Ore Basin typically consist of fine-grained silts with organic material overlying silty sand just below the surface that sits atop a thick sequence of dense gravelly sand that is considered to be native (i.e., deposited prior to construction of the harbor). The finer-grained surficial material is thickest adjacent to the face of the Ore Dock at the toe of the slope under the Ore Loader, with core logs showing deposition to be greater than 6 feet in

some places. In nearly all of the observed cores from the two studies, contamination by ore-related metals was strongly associated with the finer-grained silt unit, although not necessarily at the surface. Golder (2018) found lower concentrations of ore-related metals in the upper 30 centimeters of sediment, and both Anchor QEA (2015) and Golder (2018) found only low metals concentrations in the deeper gravelly sand unit assumed to be native material.

- Based on the identified sediment geotechnical properties, 2H:1V external side slopes have been incorporated into the dredge prism around the perimeter of the extent of Required Dredging on the three sides that are not adjacent to the Ore Dock.
- Based on a review of available geotechnical properties below the subsurface in under-dock sediments (Hart Crowser 2019), it is estimated that the natural angle of repose for the material under the docks will be 1.5H:1V. This was determined using a numeric model to determine the effective friction angle of the material to estimate the angle at which sloughing is expected to occur. This slope angle is only an estimate based on limited available information and numerous factors will influence the actual angle of repose of the slough material, including the presence of piling and any variability in conditions.

2.2.4 Total Dredge Pay Volume

The Total Dredge Pay Volume is defined as the sum of the Preliminary Dredging volume and side slope volumes, plus slough material that may enter the dredge footprint from adjacent areas under the Ore Dock. The Total Dredge Pay Volume also includes Additional Dredging volume, including the payable overdredge allowance, and associated slough material from these potential dredge cuts. Note that as dredging continues deeper, the potential volume of slough material from under the Ore Dock increases due to the 1.5H:1V assumed slope of the slough material extending farther up the under-dock slope (Figure 4, Typical Additional Dredging Section, As Directed). The range of dredging volumes estimated for this project is provided in Table 1.

Table 1
Total Dredge Pay Volume Summary

Type of Dredging	Volume (cy)
Preliminary Dredging volume	3,000
Potential total slough material volume associated with Preliminary Dredging	700
Additional Dredging volume	600
Potential total slough material volume associated with Additional Dredging	2,700
Total Dredge Pay Volume	**Up to 7,000**

Notes:

1. The Preliminary Dredging volume represents the low end of the potential dredge volume range. This volume includes only the dredge prism to the grades associated with Preliminary Dredging (Figure 4 and described above), without any sloughing from under the Ore Dock or Timber Dock adjacent to the dredge offset area.

2. The Additional Dredging volume represents the high end of the potential dredge volume range and includes the extents of the dredge footprint to the full depth of contamination, without the additional slough from under the Ore Dock or Timber Dock adjacent to the dredge offset area. Additional Dredging would be conducted to the extent possible that it is protective of the structures, as directed by WPYR and the project engineers, based on an assessment of slough material that occurred as a result of Preliminary Dredging.
3. Slough volumes from under the Ore Dock or Timber Dock are estimated at a 1.5H:1V slope from the associated dredge elevations associated with each DU.
4. Total dredging volumes include 1 foot of payable overdredge allowance.

2.2.5 Equipment Selection

Based on a comparison of available Remedial Technologies, the Options Analysis (Anchor QEA 2019b) selected mechanical dredging as the preferred equipment to address the sediment contamination in the Ore Basin. This equipment was selected for its effectiveness, ability to remove the potential range of sediment types identified in the geotechnical evaluation, compatibility with the site, and availability of local and regional contractors. The Options Analysis also reviewed enhanced natural recovery, hydraulic dredging methods, and engineered capping as other active remedial options, but determined these were not suitable for the site based on a variety of factors.

2.2.6 Sediment Dewatering

Sediment dewatering is the removal of water from the dredged sediment. This typically occurs partially through passive dewatering at time of dredging as free water entrained in the dredge bucket that enters the receiving barge drains from the sediment.

- Barge dewatering of dredged sediment is assumed to be allowable within the dredge footprint if the technologies implemented achieve water quality criteria in the Water Quality Certification issued by ADEC. If allowed by permit conditions, dewatering in the work area will be required to pass through a filter media (e.g., filter fabric) to prevent the release of suspended solids from the barge.
- Barge dewatering will not be allowed outside of the work site.
- Dewatering that may be required outside of the work site and any associated on-site water treatment process, if required, will be the responsibility of the Contractor. The Contractor will be required to submit their proposed dewatering and water treatment (if applicable) processes for review and acceptance by WPYR and ADEC and demonstrate the water treatment system, if applicable, meets water quality criteria during construction through compliance monitoring. The Contractor would be responsible for any discharge permits that may be required.

The Contractor's means and methods for completing sediment dewatering, as documented in the CWP, will require the ADEC Contaminated Sites Program approval.

2.2.7 Stabilization

This section describes the design criteria, key assumptions, and requirements associated with ex situ stabilization to facilitate safe transport to the Disposal Facility. The stabilization is also expected to reduce the leachability of the material such that it can be characterized post-stabilization as suitable for disposal at a Subtitle D landfill. The stabilization process will include the addition of a binding agent (common amendments are Portland cement and fly ash) to eliminate free liquid. An additional benefit of stabilization is that it is expected to chemically bind the lead to the sediment matrix, rendering the lead less mobile (leachable).

- The Contractor will be required to propose stabilization material(s), application methods, and verification testing methods as part of the CWP. WPYR and the ADEC Contaminated Sites Program will review and approve the CWP.
- All dredged sediment will be stabilized.
- Dredged sediment stabilization will be implemented on a barge within the work area. The Contractor will be responsible for all best management practices (BMPs) associated with the stabilization process, including safe handling practices and amendment application for the selected amendment. BMPs will be proposed for review and acceptance in the Contractor's CWP.
- The Contractor will be required to conduct verification testing of the stabilized material using an ADEC-certified laboratory to conduct bulk metal and toxicity characteristic leaching procedure (TCLP) testing of the Resource Conservation and Recovery Act (RCRA) metals[1] to demonstrate that the stabilized dredged sediment is below hazardous waste thresholds prior to transport and for compliance with Subtitle D landfill disposal requirements. The Contractor will coordinate directly with the landfill to determine if additional testing requirements are needed.
- Measured values for leachability, as documented through TCLP testing of composited (unstabilized) samples from within the dredge footprint (Anchor QEA 2015), ranged from 5.1 to 27.8 milligrams per liter for lead. Verification testing will be required to demonstrate that the leachability of all stabilized material is below the federal criterion of 5.0 milligrams per liter for lead.

2.3 Transport and Offloading Facility

The following are the assumptions and requirements associated with transportation of dredged sediment from Skagway to the Offloading Facility:

- Prior to transportation of stabilized sediment, ADEC will require submission and approval of the Transport, Treatment, and Disposal Form (https://dec.alaska.gov/media/12127/transport-treatment-disposal-approval-form-for-contaminated-media-fillable.pdf). This document will

[1] RCRA lists a group of eight heavy metals (commonly referred to as the RCRA 8), which include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

be prepared by the Contractor and have the results of the verification testing attached, as provided by the Contractor, to document that stabilization has reduced sediment concentrations accordingly.

- The Contractor will select and propose the Offloading Facility as part of the CWP. WPYR will approve the Offloading Facility as part of review and acceptance of the CWP. It is assumed as part of this BODR that material will be shipped to the contiguous United States for disposal due to the lack of landfills in Alaska that can accept that material. While not specified in the design documents, discussions with Waste Management indicate that there are no facilities permitted to accept Subtitle D waste in Alaska. There is a chance the Contractor could propose a Disposal Facility in Canada and the merits and costs of the proposal would be reviewed by WPYR.
- The Contractor will be responsible for all site preparation, management, security, and daily housekeeping (including spill response) at the Offload Facility to control and contain any dredged sediment spills.
- A qualified marine inspector will be required to sign off that all vessels and loads are stable and seaworthy for the passage to Offload Facility, assuming the material is removed by barge.
- The Contractor will be responsible for the safe transport of all waste (e.g., contaminated sediment, effluent, debris) in accordance with all applicable regulations and guidelines.
- If applicable, the Contractor is responsible for obtaining appropriate certifications, permissions, and exemptions that may be required to allow for marine equipment and/or contaminated materials to move between Canada and the United States, and to operate in the waters of each country.
- No discharge from haul barges will be allowed during transport and as such, the Offloading Facility will be required to have a water treatment facility to treat the collected water from both transport and stockpiling operations, as necessary to comply with local water discharge regulations.
- If trucking is required between the Offload Facility and the Disposal Facility, waste shipped from the Contractor's Offload Facility will be tarped and adequately secured, to prevent spillage.

The following specific requirements will govern the operation of the Contractor Offload Facility:

- If upland stockpiles are used, these stockpiles will have full perimeter containment to prevent uncontrolled runoff of water that has been in contact with dredge material.
- Stockpiles will need to be covered to protect them from the weather. The Contractor will determine the means and methods for containment, subject to review and acceptance from WPYR.
- The Contractor Offload Facility will be isolated from surface water using standard temporary erosion and sedimentation controls (TESC), such as filter fence barriers and/or lined ecology block walls.

- Catch basins beneath stockpiles will be sealed and all water will be collected and stored on site for treatment and/or off-site disposal.
- The Contractor will be required to maintain a clean offloading facility, and/or wheel/truck wash, to prevent vehicles from tracking contaminated sediment off site.
- Equipment will be fueled in a designated area that separates fueling operations and protects the environment from accidental spills during fueling.
- The Contractor will maintain a spill kit on site in the event that a leak develops from their equipment. In the event of a spill, all other work will stop until the Contractor has adequately cleaned the spill.

For environmental protection associated with offloading sediments, the Contractor will be required, as a minimum, to establish the following controls:

- Offloading will occur over a spill plate so that sediment or effluent is not dropped into the water.
- The spill plate will have positive drainage to a collection area that is easily accessible so that spills can be properly cleaned up and spilled sediment can be collected for appropriate disposal.
- Spillage of sediment or debris during offloading will be promptly cleaned up. If uncontrolled spillage occurs, all offloading operations will cease until the spillage is contained and cleaned up.

In addition to the protective measures described above, the Contractor will be required to confirm with the facility's owner that the Contractor's activities will not exceed the structural capacity of any facilities they propose to use for offloading and staging.

2.4 Disposal

The following are the key assumptions and requirements associated with disposal of the stabilized sediment. Again, while not specified as part of the design documents, it is assumed that material would be taken to the contiguous United States for disposal due to the lack of facilities in Alaska that can accept the material.

- The Contractor will select and propose the Disposal Facility at the time of bidding to WPYR for review and acceptance. If the Contractor elects to propose an alternate Disposal Facility at a later date, they will be required to get acceptance from WPYR prior to using the facility.
- The Disposal Facility must be an existing permitted Subtitle D or C facility.

2.5 Clean Sand Cover Placement

Clean sand cover will be placed in all dredged areas after removal is completed to address potential generated residuals. Generated residuals are dredged contaminated sediments that are suspended during dredging and/or fall back from the dredging bucket as it rises through the water column. Additional information regarding residuals can be found in the Options Analysis (Anchor QEA 2019b). The clean sand cover provides a post-remediation surface condition that is below ambient

and pre-construction concentrations immediately after construction. Over time, concentrations will likely rise to closer to ambient concentrations due to either mixing of the clean sand cover with any remaining underlying contaminants, if there are erosive forces (e.g., propwash) that cause movement of the placed clean sand, and natural and vessel-induced resuspension and deposition of sediments from adjacent areas and the Skagway River.

Other objectives for placing the clean sand cover are to enhance potential natural recovery from natural sedimentation and to help dilute remaining underlying residual contaminants should erosive forces be sufficient to mix the clean sand cover with the underlying sediment. It is likely that given the similar grain size of the sand cover with existing surface sediment conditions, that the material will have equivalent stability (under propwash or other disturbances that resuspend sediments) and remain in place. The placement of clean sand cover also serves as a measure to leave the surface of the dredge footprint with lower concentrations than post-construction conditions would likely be if residual contamination remains. Use of clean sand cover at sediment remediation projects has proven to be an effective method to address surficial residuals contamination immediately post-removal (Bridges et al. 2008).

The following are criteria associated with placement of the clean sand cover:

- Clean sand cover will be a minimum of 1 foot thick with an overplacement allowance of 6 inches.
- The clean cover will be a sand material that is free of debris or other non-sand materials.
- The Contractor will be required to conduct chemical testing of the clean sand material prior to placement for acceptance by WPYR to demonstrate that the material is suitable for placement in the marine environment. Material testing results will be compared against Washington State Marine Sediment Cleanup Objectives (Washington State Department of Ecology 2019), with numeric standards provide in Appendix B. The following analyses will be required:
  - Metals by U.S. Environmental Protection Agency (EPA) publication SW846, 6000/7000 series methods
  - Semivolatile organic compounds by EPA SW846, Method 8270
  - Polycyclic aromatic hydrocarbons (PAHs) by EPA Method 8270
  - Polychlorinated biphenyls (PCBs) by EPA SW846, Method 8082
  - Dioxin and furans by EPA Method 8290
  - Grain size distribution
  - In situ moisture content
  - Total organic carbon

Confirmation sampling of the post-dredge sediment surface is not planned prior to placement of the clean sand cover, as the dredging is being conducted to remove a mass of legacy ore contaminants, as no risk based concentrations of ore-related contaminants have been identified to require remedial

action. This approach is intended to be consistent with Remedial Action Objective 1 in the Options Analysis (Anchor QEA 2019b), which states that the objective of the remediation is to remove the majority of the mass of sediment contamination associated with historical ore handling operations in accessible areas of the harbor. Bathymetric surveying will be used to document the amount of material removed in reach DU and this information will be provided to ADEC in a construction closure report. Upon completion of Preliminary Dredging (and potential Additional Dredging as defined previously), clean sand cover will be placed.

Clean sand cover placement means and methods will be determined by the Contractor and described in their CWP, for review and acceptance by WPYR and ADEC Contaminated Sites Program.

2.6 Construction Best Management Practices

BMP controls will be identified in the specifications to minimize, to the extent practical, potential adverse construction impacts to the environment and the magnitude of residual contamination. This section describes key BMPs that the Contractor will be required to use during dredging, transport, disposal, and clean sand cover placement operations.

- The Contractor will be required to use real-time kinematic positioning controls, such as a differential global positioning system electronically displayed in the dredge and backfill operator's cabin to provide real-time positioning control for the dredging and placement operations.
- Specifications will prohibit taking multiple bites during dredging.
- The Contractor will be required to take complete dredge cuts—from the moment the bucket is closed at the mudline, the Contractor will be required to return the bucket to the surface and deposit dredge material onto the barge before returning the bucket back to the mudline.
- The Contractor will be prohibited from overfilling dredge buckets to reduce spillage back to the seabed.
- The Contractor will be prohibited from leveling the bottom surface. Instead of leveling to remove high spots, the Contractor will be required to make an Additional Dredging pass to remove any high spots that are identified during the Post-Construction Survey.
- The Contractor will be prohibited from overloading the material barge beyond the top of the side rails.

2.6.1 Silt Curtains

Silt curtains and screens are specialized BMPs that have proven effective in reducing surface water turbidity in relatively quiescent environments and are a BMP used to retain suspended sediment plumes at environmental dredging sites located in low-energy environments without deep water (Francingues and Palermo 2005). Water passes below or around fabric curtains because they are not typically sealed with the bottom. Water also discharges around the curtains when they are opened to

allow the necessary passage of work equipment. As discussed in Bridges et al. (2010), based on a review of the available data, there is uncertainty as to whether silt curtains are effective in retaining contaminants within the curtain footprint, and there are also concerns that contaminants can migrate below the bottom of the curtain while the curtain is in place or upon curtain removal.

Based on U.S. Army Corps of Engineers (USACE) Guidance (ERDC 2008) and Anchor QEA's experience, it is anticipated that silt curtains would be largely ineffective at containing suspended sediment or have minimal impacts on overall water quality and would be challenging and costly to employ in Skagway. The intent of silt curtains for this project would be as a BMP to address water quality considerations and reduced redistribution of suspended sediment during construction. Both of these items will be monitored through anticipated water quality monitoring (see next section).

Employment of full-length silt curtains are considered impractical due to the water depth and tidal range and the implications of the silt curtains routinely disturbing and resuspending bottom sediments. Partial height curtains were considered, but based on an evaluation of the intended function (water quality and reducing spread of suspended sediments) and based on Anchor QEA's experience and USACE guidance, even partial height curtains would likely not be effective in the high energy environment of the Ore Basin. The combination of currents, the large tidal range, and strong weather and wind would render silt curtains ineffective as well as being a hindrance to dredging operations and a safety concern to manage through set-up, inspections, and take down. USACE guidance states that for all practical purposes, 1- to 1.5-knot currents are problematic for silt curtains and lead to difficult designs and employment. The National Oceanic and Atmospheric Administration (NOAA) suggests a range of velocities due to tidal currents of 0.3 knots on flood to 0.7 knots on the ebb (NOAA 2002). Coupled with wind-driven currents of approximately 1 knot for 35 mile per hour winds (Golder 2018, Appendix A), this would imply that conditions exceeding normal operating conditions for silt curtains would occur routinely in the Ore Basin. Similarly, and just as importantly, other sites have demonstrated limited utility in preventing migration of contaminants due to tidal fluctuations and wind (ERDC 2008). This has been documented in lower-energy environments than the Skagway Ore Basin, such as New Bedford Harbor, Connecticut (ERDC 2008), and the Lower Grasse River, New York (Connolly et al. 2007).

These issues are exacerbated in deeper water, which requires a deeper curtain that can act as a bigger "sail" and can also be difficult to effectively anchor. The displaced curtains can also become a hazard to navigation and/or block access to the work area, and the curtains often need to be frequently repositioned or re-anchored. Generally, the use of silt curtains and screens have significantly reduced overall dredge production rates (Connolly et al. 2007), and typically lead to significantly extended schedules to complete remediation, consequently increasing the impact from the dredging operation. For the reasons described in this section silt curtains have not been proposed as a standard BMP requirement to be employed during dredging.

2.7 Water Quality Considerations

Resuspension or discharge of suspended solids and/or effluent from barges during dredging and dewatering of sediments can create localized water quality impacts. Therefore, it is anticipated that ADEC Division of Water will impose conditions (through permits or authorizations) limiting the increase in turbidity that may result from construction activities and would be measured at specific compliance distances from the dredging work area (i.e., dredging and sediment barges). Potential water quality impacts associated with dredging, loading, and dewatering are temporary in nature and would be located at or close to the point of dredging.

Development of water quality protocols is ongoing as of the time of this document and will require ADEC Contaminated Sites Program approval. These protocols will include monitoring procedures to help confirm that the Contractor is meeting water quality criteria at ADEC-specified compliance distances from work activities.

3 Construction Sequence and Schedule

3.1 Construction Sequencing

The Contractor will establish the construction sequence and proposed construction schedule based on their means and methods and this will be documented for review and acceptance as part of the CWP. The specifications impose certain sequencing requirements that must be followed. These are the basis for the following anticipated general sequence of remedial activities:

- Mobilization
  - Contractor will mobilize equipment and supplies to the site and establish any on- and off-site (e.g., Offloading Facility) temporary facilities to support the work.
- Required Dredging
  - The Contractor will conduct Required Dredging adjacent to the Dredge Offset Area in Sequencing Areas-A1 and -A2, working from the top of the slope down to the required dredge elevation for each DU. The Contractor will then proceed to Sequencing Area-B and dredge to the elevation and grades shown on the drawings.
  - Following Required Dredging, the Contractor will conduct a bathymetric survey to verify that Required Dredging was completed. The survey will be reviewed and accepted by WPYR.
  - Required Dredging is anticipated to take 1 to 3 weeks to complete, based on the Contractor's means and methods and the amount of Additional Dredging that may be required.
- Additional Dredging
  - After completion of Required Dredging, the Contractor will conduct a bathymetric survey of the dredge footprint and adjacent under-dock slope areas to determine if sloughing has occurred and to what extent. These surveys will be provided to WPYR.
  - The Contractor will be required to clean up any slough material that may have occurred to meet the required grades shown on the drawings.
  - Based on the amount of slough that has occurred, if any, WPYR will work with project engineers and direct the Contractor to conduct Additional Dredging in localized areas to further remove contaminated sediment while remaining protective of existing structures.
  - Upon completion of the first round of Additional Dredging, WPYR and the project engineers will re-evaluate the amount of slough that has occurred and may direct the Contractor to conduct a second round of Additional Dredging.
- Stabilization
  - Sediment will be dewatered by gravity separation and amendment with a stabilization reagent.

  - Stabilization will occur on a barge in the work area of material from both Required Dredging and Additional Dredging.
  - The Contractor will demonstrate through verification sampling that the stabilized sediment does not pose a hazard for transport and is below hazardous waste thresholds. The results of this testing will be presented to WPYR for acceptance prior to the stabilized sediment leaving the harbor. Note that this verification testing will be provided to ADEC for acceptance via the Transport, Treatment, and Disposal form discussed previously.
  - General steps associated with stabilization include the following:
    - Mixing the sediment with the selected amendment
    - Allowing the stabilized material to cure prior to sampling
    - Collecting samples of stabilized sediment for laboratory analysis
    - Acceptance of the stabilization by WPYR
    - These items are anticipated to be concurrent with dredging but extend several days to 1 week after dredging is completed
- Transportation and Disposal
  - Upon acceptance of stabilized material by WPYR and ADEC (through the Transport, Treatment, and Disposal form), it can be transported off site.
  - It is assumed that the treated sediment will be sent to an Offloading Facility and subsequent Disposal Facility in the contiguous United States. There are established facilities for offloading in both Seattle, Washington, and on the Columbia River in Oregon.
  - It is assumed that the Contractor will use an ocean-going tug and tandem haul barges capable of transporting the entire Required Dredging volume in one trip. A second trip may be required depending on the amount of slough material and Additional Dredging directed by WPYR.
  - Roundtrip travel to the offloading facility and back to Skagway, if needed, is expected to take 2 weeks.
  - From the Offloading Facility, material will be transported to the Contractor's selected landfill for disposal, either by rail or by truck, based on the facility(ies) selected by the Contractor.
- Clean Sand Cover Placement
  - Upon acceptance of all dredging, clean cover sand will be placed to the thickness and limits specified in the bid document drawings.
  - Following placement of the clean sand cover, the Contractor will conduct a bathymetric survey to verify that the required thicknesses were achieved. The survey will be reviewed and accepted by WPYR.
  - Placement of the clean sand cover material is expected to take approximately 1 week.

- Demobilization
  - Contractor will clean up the work site and staging area(s) and remove any constructed temporary facilities.
  - Contractor will demobilize equipment and supplies from the site.

The following are a list of assumptions regarding the sequence and durations provided above:

- Dredging production rate is assumed to be between 400 to 800 cy per day.
- Clean sand cover placement production rate is assumed to be between 100 to 300 cy per day due to relatively thin lift of sand required and the potential rough sea state during the winter construction season.

3.2 Project Schedule

The project schedule is driven primarily by receipt of final permits, permit conditions, project review and approval by ADEC, Contractor availability, and the 2020 cruise ship season in Skagway (i.e., roughly May 1 to October 1). In general, the intent is to complete the project as soon as is practical after receipt of project permits and ADEC approvals but outside of the cruise ship season. It is estimated that project permits will be received in late spring/early summer 2020, at which time, project design documents will be finalized incorporating any final permit conditions. The project will then be bid, and a qualified Contractor will be hired by WPYR. The Contractor will be required to develop pre-construction submittals (CWP and EPP) for review and approval by WPYR and ADEC. Upon acceptance of these pre-construction submittals the Contractor can commence active construction at the site. The anticipated schedule is for construction to occur in winter 2020/2021 and to be completed in 1 to 2 months.

4 Post-Construction Considerations

4.1 Potential Site Closure

One of the objectives of the remedial actions described in this report is to facilitate site closure by ADEC. Previous discussions have indicated that ADEC would consider site closure with institutional controls. The remediation of the sediment within the project footprint described in this document is intended to address accessible legacy contamination in sediment from historical Ore Loader operations. As such, it is assumed that the portion of the site associated with this remedial action would be able to be closed by ADEC upon completion of the work. To facilitate documentation for future site closure, a Site Closeout Report will be developed and submitted to ADEC upon completion of construction. WPYR understands that areas under the adjacent Ore Dock that are not directly addressed by this remedial action may require future investigations or institutional controls to address any contamination that may remain in place after completion of the remedial actions described in this report.

4.2 Post-Construction Monitoring

Note that the development of a post-construction monitoring strategy is ongoing at this time and is outside of the scope of this document. WPYR will coordinate an approach with ADEC regarding this future element independent of this document.

5 References

Anchor QEA (Anchor QEA, LLC), 2015. *Sediment Characterization Report, Skagway Ore Dock and Small Boat Harbor Dredging: Gateway Intermodal Dock Reconstruction Project and Legacy Harbor Contaminant Mitigation Program*. Prepared for Alaska Department of Environmental Conservation, U.S. Environmental Protection Agency and U.S. Army Corps of Engineers on behalf of the Municipality of Skagway, Alaska. June 2015.

Anchor QEA, 2019a. *Skagway Ore Terminal Remedial Approach Work Plan*. Prepared for Alaska Department of Environmental Conservation, on behalf of White Pass & Yukon Route Railway. May 2019.

Anchor QEA, 2019b. *Remedial Action Options Analysis*. Prepared for Alaska Department of Environmental Conservation, on behalf of White Pass & Yukon Route Railway. October 2019.

Bridges, T.S., S. Ells, D. Hayes, D. Mount, S.C. Nadeau, M.R. Palermo, C. Patmont, and P. Schroeder, 2008. *The Four 4s of Environmental Dredging: Resuspension, Release, Residual and Risk. Dredging Operations and Environmental Research Program*. U.S. Army Corps of Engineers, Engineer Research and Development Center/Environmental Laboratory TR-08-4. January 2008.

Bridges, T., K. Gustavson, P. Schroeder, S. Ells, D. Hayes, S. Nadeau, M. Palermo, and C. Patmont, 2010. "Dredging Processes and Remedy Effectiveness: Relationship to the Four Rs of Environmental Dredging." *Integrated Environmental Assessment and Management* 6:619–630.

Connolly, J.P., J.D. Quadrini, and J.J. McShea, 2007. "Overview of the 2005 Grasse River Remedial Options Pilot Study." In: *Remediation of Contaminated Sediments—2007. Proceedings of the Fourth International Conference on Remediation of Contaminated Sediments. Savannah, Georgia*. Columbus, Ohio: Battelle.

ERDC (U.S. Army Corps of Engineers Engineer Research and Development Center), 2008. *Technical Guidance for Environmental Dredging of Contaminated Sediments*. USACE ERDC/EL TR-08-29. September 2008.

Francingues, N.R., and M.R. Palermo, 2005. Silt Curtains as a Dredging Project Management Practice. U.S. Army Engineer Research and Development Center. TN-DOER-E21.

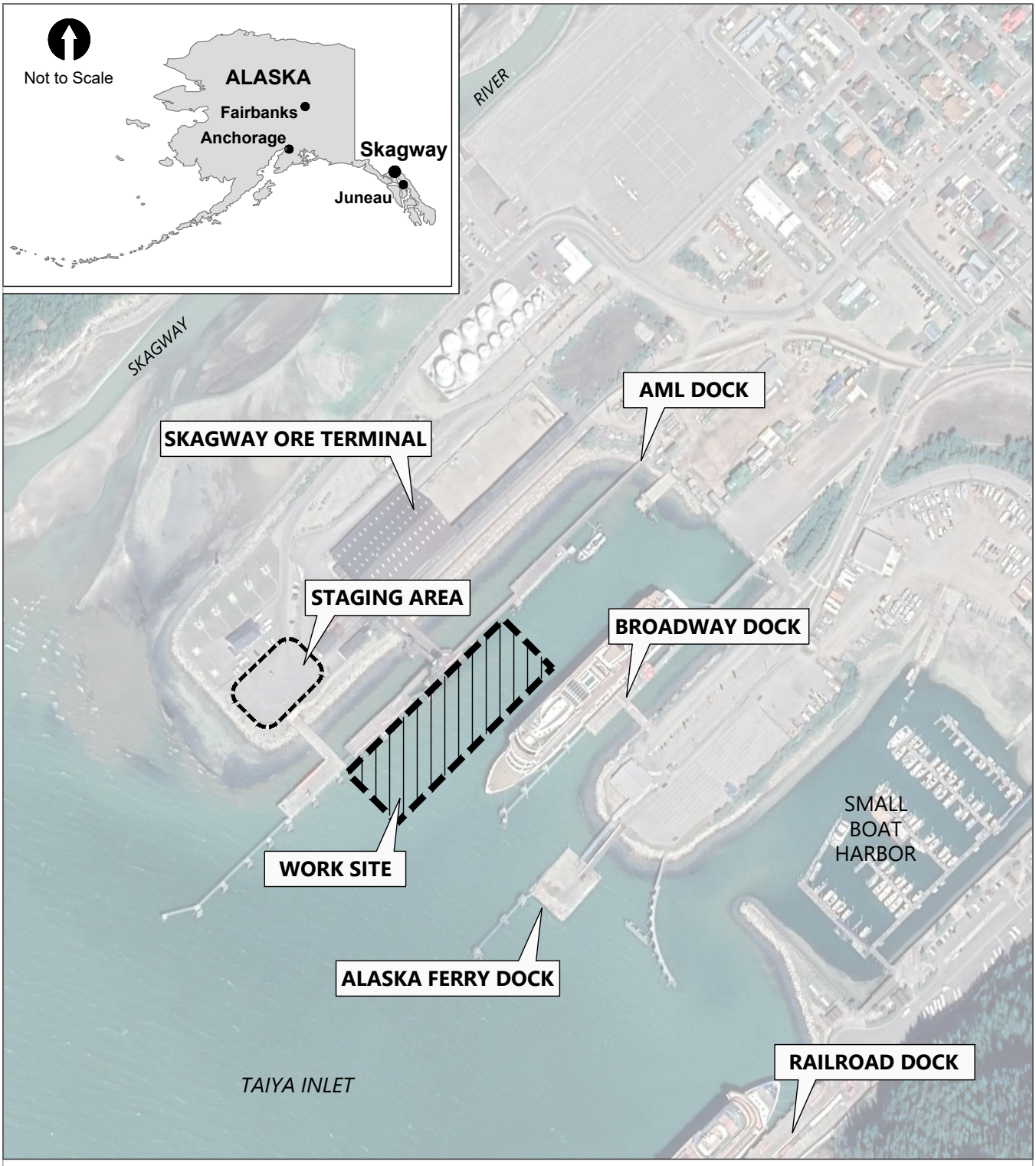
Golder (Golder Associates Ltd.), 2018. *Skagway Ore Basin Risk Assessment*. Submitted to White Pass & Yukon Railway. Report Number: 1657231-006-R-Rev0. 25 January 2018.

Hart Crowser, 2019. *Draft 30 Percent Geotechnical Engineering Design Study, Skagway Ore Dock Improvements, Skagway, Alaska*. Prepared for KPFF Consulting Engineers. 19407-01. May 8, 2019.

NOAA (National Oceanic and Atmospheric Administration), 2002. United States Coast Pilot 8, Alaska: Dixon Entrance to Cape Spencer. 2019 (41st) Edition.

Washington State Department of Ecology, 2019. *Sediment Cleanup User's Manual*. Available at: https://fortress.wa.gov/ecy/publications/SummaryPages/1209057.html. December 2019.

Figures



SOURCE: Google Earth Pro, 2019
HORIZONTAL DATUM: Alaska State Plane, Zone 1, North American Datum of 1983 (NAD83), U.S. Survey Feet
VERTICAL DATUM: Mean Lower Low Water (MLLW)
NOTE: Survey monument locations to be provided by WPYR (Pending).

0 400
Feet

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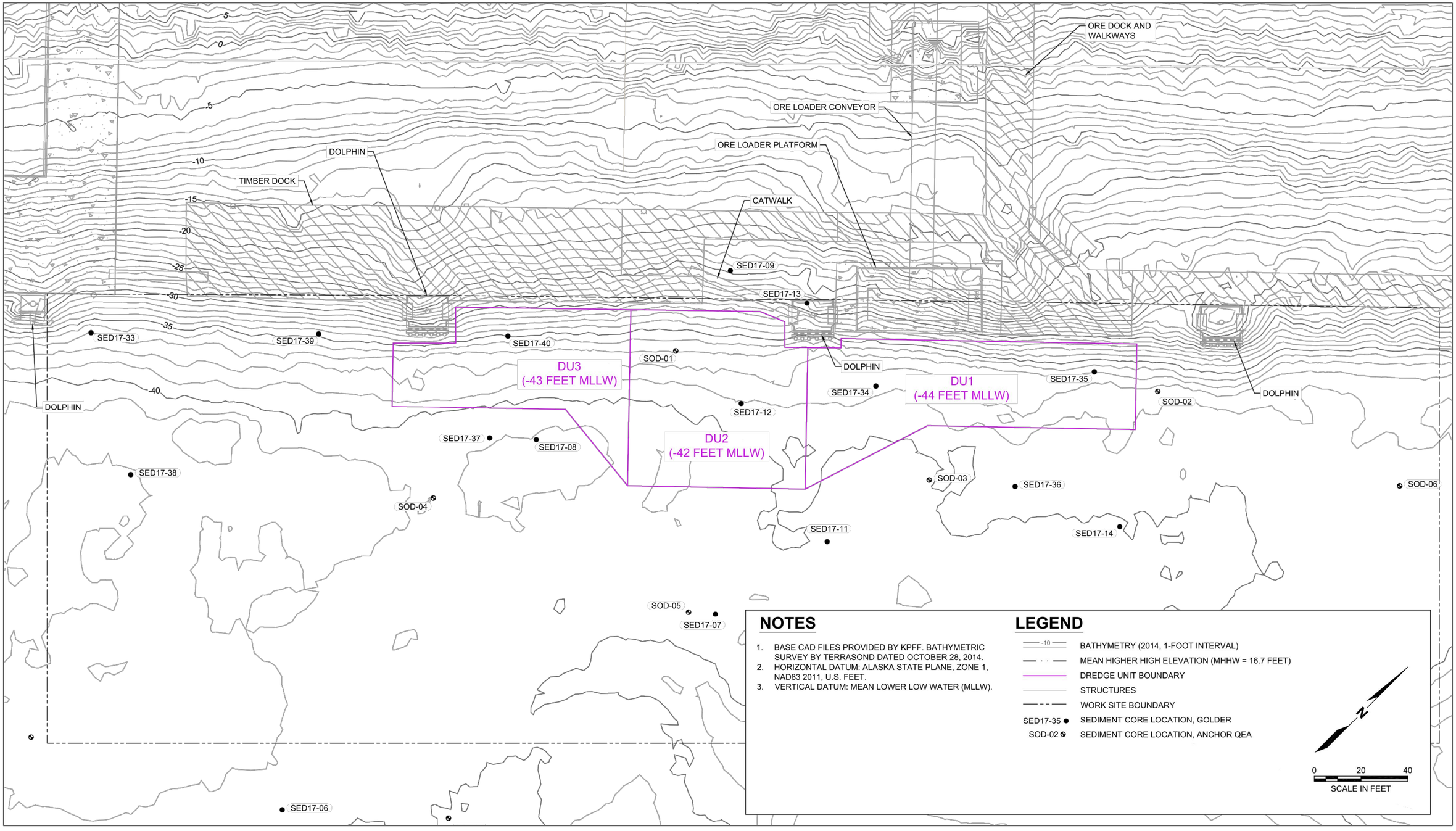
Filepath: K:\Projects\0159-KPFF Consulting Engineers\Ore Terminal Remediation Support\Construction Plans\0159-BODR-001 (VICINITY).dwg Figure 1

ANCHOR QEA

Figure 1
Project Area and Site Features

Basis of Design Report
Skagway Ore Terminal Sediment Remediation Project



NOTES

1. BASE CAD FILES PROVIDED BY KPFF. BATHYMETRIC SURVEY BY TERRASOND DATED OCTOBER 28, 2014.
2. HORIZONTAL DATUM: ALASKA STATE PLANE, ZONE 1, NAD83 2011, U.S. FEET.
3. VERTICAL DATUM: MEAN LOWER LOW WATER (MLLW).

LEGEND

- -10 — BATHYMETRY (2014, 1-FOOT INTERVAL)
- MEAN HIGHER HIGH ELEVATION (MHHW = 16.7 FEET)
- DREDGE UNIT BOUNDARY
- STRUCTURES
- WORK SITE BOUNDARY
- SED17-35 ● SEDIMENT CORE LOCATION, GOLDER
- SOD-02 ⊗ SEDIMENT CORE LOCATION, ANCHOR QEA

N

0 20 40
SCALE IN FEET

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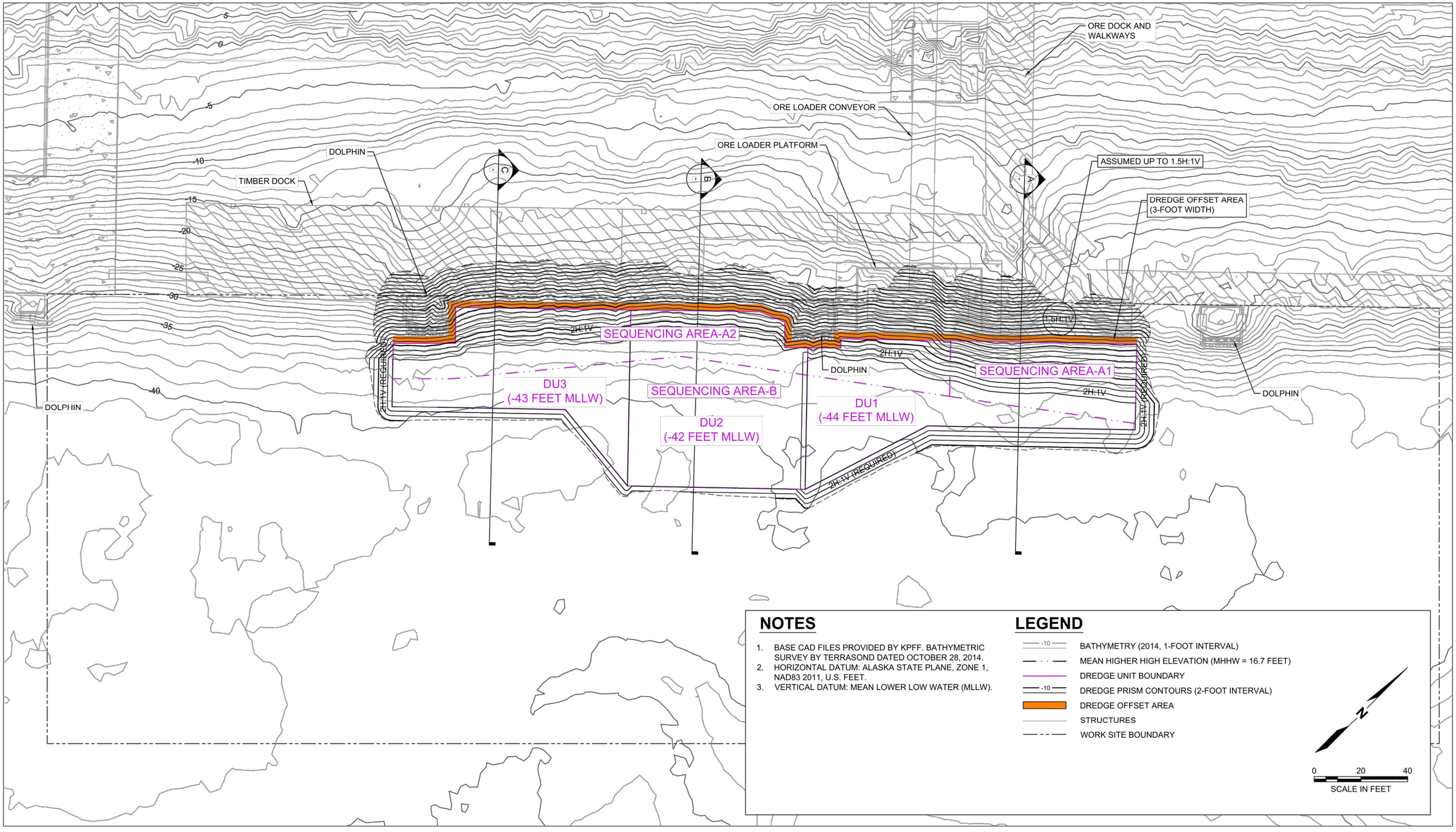
Filepath: K:\Projects\0159-KPFF Consulting Engineers\Ore Terminal Remediation Support\Construction Plans\0159-BODR-002 (PLANS).dwg Figure 2

ANCHOR QEA

Figure 2
Existing Site Conditions

Basis of Design Report
Skagway Ore Terminal Sediment Remediation Project



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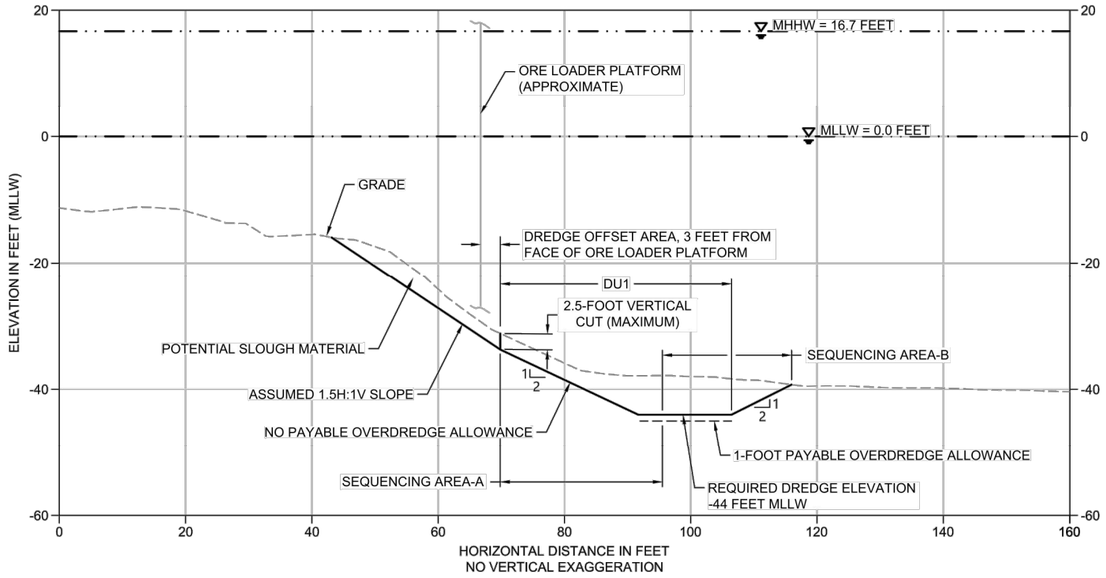
Filepath: K:\Projects\0159-KPFF Consulting Engineers\Ore Terminal Remediation Support\Construction Plans\0159-BODR-002 (PLANS).dwg Figure 3

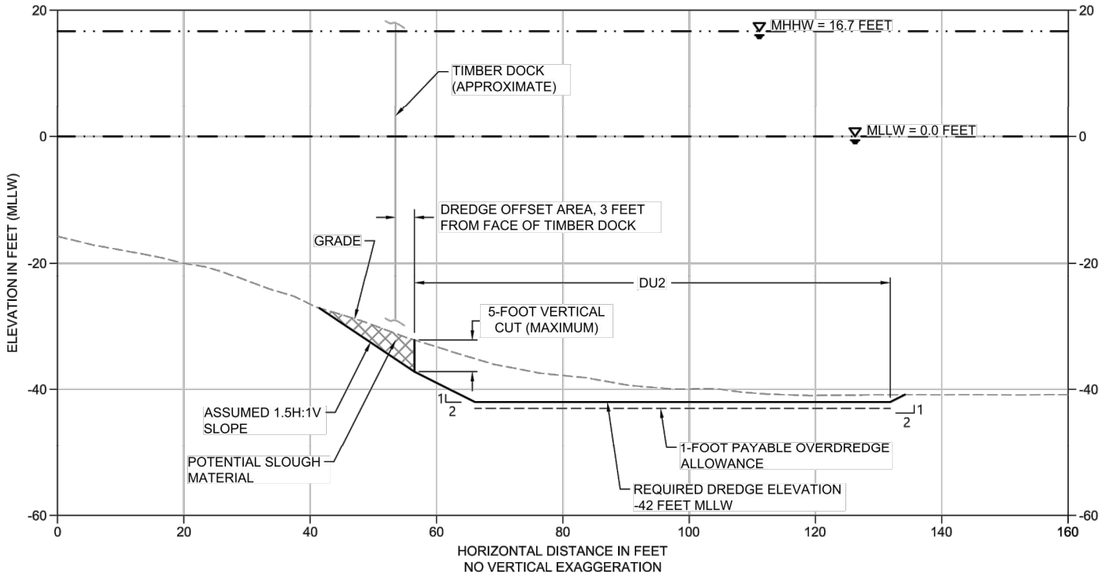
ANCHOR QEA

Figure 3
Required Dredging Plan

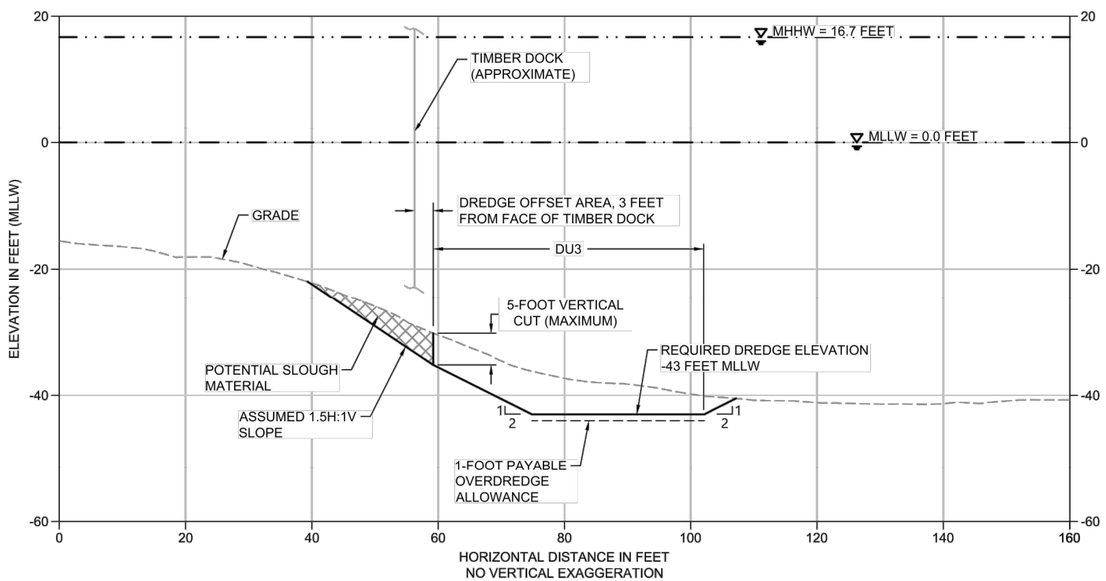
Basis of Design Report
Skagway Ore Terminal Sediment Remediation Project



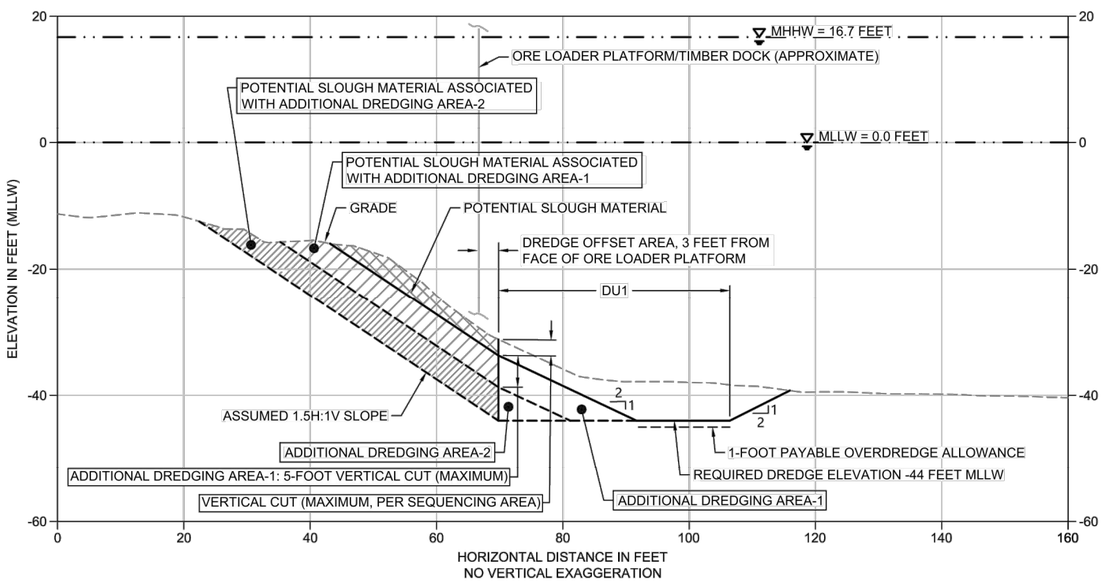
SECTION A



SECTION B



SECTION C



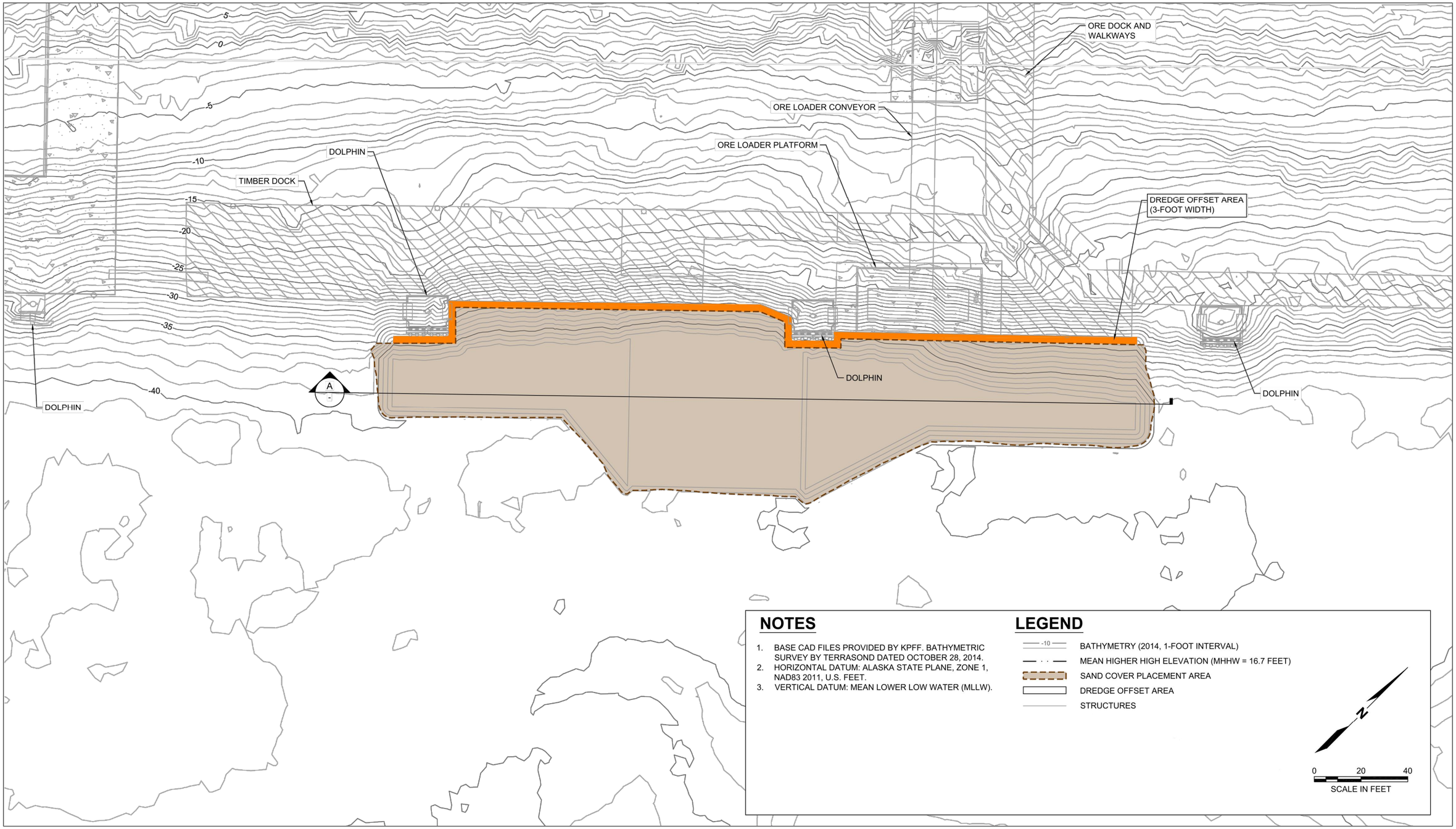
TYPICAL ADDITIONAL DREDGING SECTION, AS DIRECTED

Publish Date: 2019/12/17 1:51 PM | User: dholmer
Filepath: K:\Projects\0159-KPFF Consulting Engineers\Ore Terminal Remediation Support\Construction Plans\0159-BODR-002 (PLANS).dwg Figure 4

ANCHOR QEA

Figure 4
Dredging Cross Sections

Basis of Design Report
Skagway Ore Terminal Sediment Remediation Project



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Filepath: K:\Projects\0159-KPFF Consulting Engineers\Ore Terminal Remediation Support\Construction Plans\0159-BODR-002 (PLANS).dwg Figure 5

ANCHOR QEA

Figure 5
Material Placement Plan

Basis of Design Report
Skagway Ore Terminal Sediment Remediation Project

Appendix A
KPFF Structural Analysis

Memo - Draft

1601 Fifth Avenue, Suite 1300
Seattle, WA 98101
(206) 382-0600

To:	**Tyler Rose, WPYR**	Date:	**2019.12.17**
From:	**Robert Riley, PE, SE, KPFF**	Job No.	**1800156**
Subject:	**Ore Dock Remediation Design – 75%**	File No.	
	Existing Structures Structural Check		

KPFF understands that The White Pass & Yukon Route Company intends to perform a sediment remediation dredging project in Skagway, Alaska in the vicinity of the existing ship loader wharf. This dredge is aimed at removing contaminates in the soils in front of several structures as described below:

- The "Timber Dock" – is 40' wide by 177' long constructed in the early 1980's, consisting of timber piles at bents that are 11 feet on center, with pile spacing at 12 feet along each bent. The dock has diagonal cross-bracing between piles that extends down about 10 feet from the top of the deck in each direction.
- Mooring & Berthing Dolphins – Three mooring and berthing dolphins exist at the face of the proposed dredge footprint. Each of the dolphins consist of concrete caps supported on steel piles that were built in the early 1980's. The two dolphins to the South of the Ore Loader have fender panels that are supported by two steel piles. The third dolphin to the North of the Ore Loader has timber fender piles forming the fender panel.
- The "Ore Loader Platform" Wharf - A steel and concrete wharf supporting a large boom spout and conveyor system used to load various bulk materials onto ships at the berth. This structure is supported by steel piles that were installed in the early 1990's to supplement the original steel piling that is deteriorated. Nearly all of the piles supporting the ore loader are battered.
- The "Ore Dock and Walkways" – A timber dock supported on timber piles and several steel piles that were used to replace deteriorated timber piles.

See the attached **Photos 1 & 2** showing these structures.

KPFF is working with Anchor QEA, who is developing the dredge prism design drawings, specifications and basis of design report, to complete this work. The proposed dredge prism includes significant vertical cuts at the face of the wharf (up to 15 feet). In order to determine the feasibility of such cuts, KPFF engaged with geotechnical engineer Hart Crowser to define lateral soil pressures on the pile structures as a result of a vertical cut at the face of the structure and to estimate the under dock soil

movement as a result of the cut. A memo from Hart Crowser summarizing their recommendations is attached.

KPFF used the information contained in Hart Crowser's memo to conduct a structural engineering analysis of the existing structures to assess the maximum depth of a dredge cut that could be removed without causing overloading of the existing piles. The piles were modeled in Lpile to determine the effects of the soil loads on the piles and to estimate the potential pile deflections. The resultant structural loads were checked to determine the resulting demand to capacity ratios on the piles to verify they were less than 1.0 (equivalent to 100%).

The proposed design dredge varies in depth along the face of each structure. KPFF and Hart Crowser found that the dredge cut will need to be done in a manner that does not create a situation where there is more than 5 feet of unbalanced soil height loading any pile at any given time. If a cut is performed that generates a greater than 5 foot tall unbalanced soil height on the pile, it was found that the resulting active soil pressures from the slope movement would be very large and cannot be resisted by the timber piles supporting the Ore Dock or the South Dock. Due to the existing underpier slope bathometry, some areas will need to have an initial cut into the slope of as little as 2.5 feet.

Even with a 5 foot unbalanced height on the timber dock structures, if the soil does not slough and an unbalanced soil load remains on the timber piles, the allowable dock live load should be temporarily load restricted in the vicinity of the affected piles to 20 pounds per square foot maximum. Once the soil sloughs and becomes balanced again, the load restrictions can be lifted.

In addition, KPFF determined that high loads from a large under-pier slope displacement caused by a significant vertical cut at the face of the Ore Loader Platform could cause the Ore Loader to displace several inches waterward at the top of the Loader. This displacement could cause unwanted damage to the Ore Loader conveyor systems.

Therefore, we recommend limiting the vertical dredge cut in order to minimize the risk of damage to the Ore Loading equipment. The project specifications and procedures should be modified to limit the vertical cut to ensure a maximum of 5 feet of unbalanced soil at the first row of piles at any given time, letting the resulting under-pier slope slough on its own.

It is not recommended to use an excavator or other mechanical means of pulling or pushing the under-pier soil downslope due to the high concentration of piles, battered piles and bracing under the dock that could be damaged by these activities. The attached **Photo 2** shows the existing conditions for reference.

We recommend a dredging sequence that allows a vertical cut, located 3 feet clear of the face of dock, as a first pass at the dredge. If the underpier slope then sloughs to a 2:1 slope or less, then a second pass with a 5 foot vertical cut could be accomplished. However, if after the first pass the underpier slope stays at a slope steeper than 2:1, then no additional dredging should be completed, as there is a risk of leaving an unbalanced soil height of more than 5 feet against the piling. These sequencing

requirements should be included with the dredge design documents and will need to be actively managed during construction by the design team and contractor.

Table 1 below summarizes the demand to capacity results for the piles in each structure type.

Table 1: Pile Demands with 5 feet of soil pressures

	Ore Loader Platform Steel Pile	Dolphin Steel Fender	Dolphin Steel Pile	Timber Dock & Ore Dock and Walkways	Timber Dolphin Fender
Diameter (in)	28	20	24	12(top), 8(bottom)	12(top), 8(bottom)
Unbraced Length (ft)	105	80	115	82	80
Eff. Length Factor, K	1.2	1.2	1.2	0.8	0.8
Equivalent fluid unit weight, γ (pcf)	35	35	35	35	35
Calculated axial load (kips)	47.3	0.0	42.5	7.4*	0.0
Allowable Dredge Cut at Dock Face (ft)	5	5	5	5	5
Shear DC (%)	0.9	0.9	0.8	8.8	5.7
Moment DC (%)	1.8	2.1	1.8	4.1	6.0
Axial DC (%)	11.1	0.0	25.2	88.6	0.0
Combined Axial and Moment DC (%)	**7.4**	**2.1**	**26.8**	**97.8**	**6.0**

*Maximum Live load is 21psf for a timber pile retaining 5’ of soil.

(DC – Demand/Capacity) – Less than 100% is acceptable

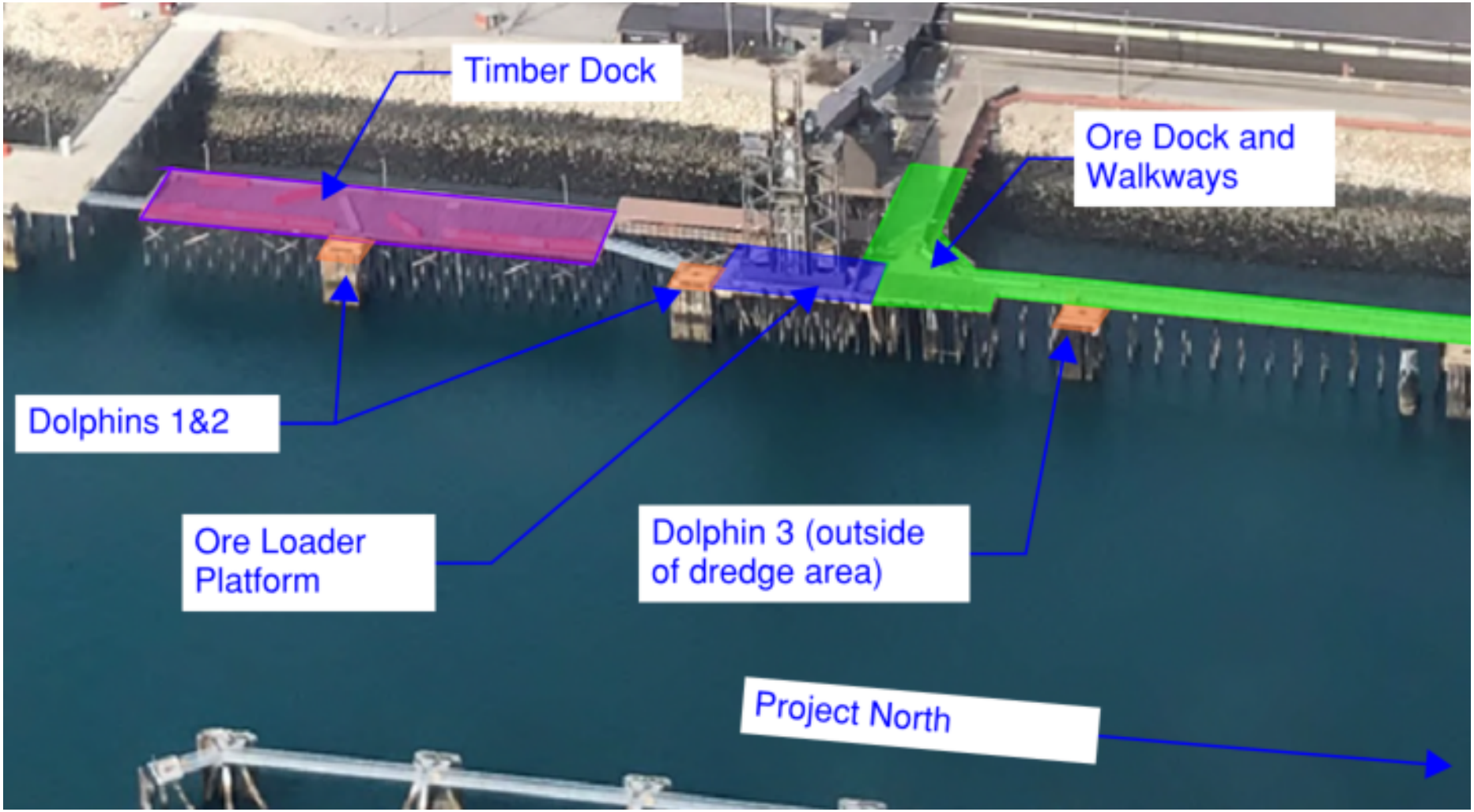
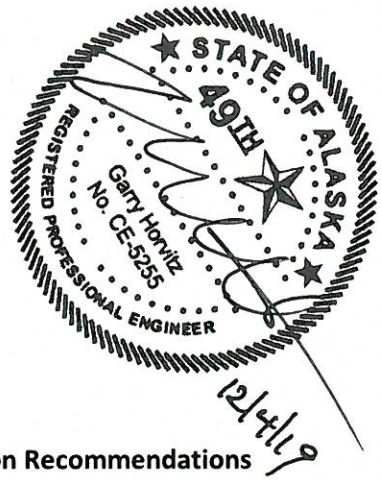


Photo 1: Site Isometric View

Photo 2: Site at Water Level



MEMORANDUM

DATE: December 4, 2019

TO: Bob Riley, PE, SE, Ed DeBroeck, PE, DBIA, KPFF

FROM: Garry Horvitz, PE, Brice Exley, PE, Hart Crowser, Inc.

RE: **Skagway Ore Dock Environmental Dredging Excavation Recommendations**
19407-01

This memorandum presents our recommendations for the proposed dredging operation at the base of the Ore Dock Loader.

Soil Loads on Existing Piles

We understand the current proposed operation involves dredging at the base of the existing offshore slope in the vicinity of the Ore Dock Loader. This destabilization of the slope from the dredging will likely result in movement of surficial soils along the slope to the depths being cut. The excavation will likely create an unbalanced load, inducing a lateral soil load on the piles supporting the Ore Dock.

To estimate this load, we recommend applying an at-rest earth pressure on the piles equal to an equivalent fluid unit weight of 35 pounds per cubic foot over the retained soil height following dredging. The assumed soil height should be equal to the full vertical height of the cut. However, there is significant uncertainty associated with the soil load described above, as the loads could be significantly higher. For example, if one assumes that a wedge of soil is restrained by the individual pile, then it is reasonable to assume that some portion of the soil mass between piles will be flowing downhill and therefore impart some level of a lateral "drag load" on the wedge of retained soil. The magnitude of these loads is very difficult, if not impossible, to predict and there is risk associated with this approach for significant heights of cut. Therefore, based on previous experience, we recommend limiting the retained soil height to a maximum of 5 feet. During, and for at least one day following dredging, we recommend optical survey of the piles to observe and react to potential deformation of the structure associated with the dredging operation.

In addition, project specifications should be written in such a way as to recognize that the dredged cut may "stand" for some period of time and then will flow at a later time. Therefore, it may be necessary to do a second or third "sweep" of the edge of the dredge prism to account for post-dredge sloughing.

We completed this work in general accordance with our contract dated March 7, 2019, and signed on March 8, 2019. This memorandum is for the exclusive use of SSA Marine, KPFF, and their design consultants and construction contractors for specific application to the subject project and site. We performed our work in general accordance with geotechnical engineering practices accepted for work done in the same or similar localities, related to the nature of the work we accomplished here, and done at the time our services were performed. No other warranty, express or implied, is made.

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Appendix B
Clean Sand Cover Chemistry Requirements

Appendix B
Clean Sand Cover Chemistry Requirements

Chemical	Required Reporting Limits	Maximum Level
Conventional Sediment Parameters		
Grain size (%)	1%	N/A
Total solids (%)	0.1% (wet weight)	N/A
Total organic carbon (%)	1%	N/A
Metals (mg/kg dw)		
Arsenic	0.2	57
Cadmium	0.2	5.1
Chromium	0.5	260
Copper	0.5	390
Lead	1.0	450
Mercury	0.05	0.41
Silver	0.2	6.1
Zinc	4.0	410
PCBs (µg/kg dw)		
Total PCBs (Aroclors)	10	130
Polycyclic Aromatic Hydrocarbons (µg/kg)		
Naphthalene	20	2,100
Acenaphthylene	20	1,300
Acenaphthene	20	500
Fluorene	20	540
Phenanthrene	20	1,500
Anthracene	20	960
2-Methylnaphthalene	20	670
Total LPAH	N/A	5,200
Fluoranthene	20	1,700
Pyrene	20	2,600
Benzo(a)anthracene	20	1,300
Chrysene	20	1,400
Benzo(a)pyrene	20	1,600
Indeno(1,2,3-Cd)pyrene	20	600
Dibenzo(a,h)anthracene	20	230
Benzo(g,h,i)perylene	20	670
Total benzofluoranthenes	20	3,200
Total HPAH	N/A	12,000

Chemical	Required Reporting Limits	Maximum Level
Chlorinated Organics (µg/kg)		
1,4-Dichlorobenzene	20	110
1,2-Dichlorobenzene	20	35
1,2,4-Trichlorobenzene	20	31
Hexachlorobenzene	20	22
Hexachlorobutadiene	5	11
Pentachlorophenol	100	360
Phthalates (µg/kg)		
Dimethyl phthalate	N/A	71
Diethyl phthalate	N/A	200
Di-n-butyl phthalate	N/A	1,400
Butylbenzyl phthalate	N/A	63
Bis(2-Ethylhexyl) phthalate	N/A	1,300
Di-n-octyl phthalate	N/A	6,200
Organic Chemicals (µg/kg)		
Phenol	20	420
2-Methylphenol	20	63
4-Methylphenol	20	670
2,4-Dimethylphenol	20	29
Benzyl alcohol	20	57
Benzoic acid	200	650
Dibenzofuran	20	540
N-nitrosodiphenylamine	10	28

Notes:
µg/kg – micrograms per kilogram
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg – milligrams per kilogram
N/A – not applicable
ng/kg – nanograms per kilogram
TEQ – toxic equivalence quotient

Table taken from Washington State Department of Ecology Sediment Cleanup User's Manual II, Table 8-1 - Marine and freshwater sediment chemical criteria for protection of the benthic community, Marine Sediment Apparent Effects Thresholds, Sediment Cleanup Objectives.