September 2018
Shelton Harbor Sediment Cleanup Unit
Oakland Bay and Shelton Harbor Sediments Cleanup Site (Cleanup Site ID: 13007)

Shelton Harbor Interim Action Basis of Design Report

Prepared for Simpson Timber Company

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ABBREVIATIONS

µg/kg	micrograms per kilogram
Agreed Order	2017 Agreed Order DE 14091
BGID	below-grate inlet device
BMP	best management practices
BODR	Shelton Harbor Basis of Design Report
cm	centimeter
Corps	U.S. Army Corps of Engineers
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSWGP	Construction Stormwater General Permit
D_{15}	fifteenth percentile grain-size diameter
D_{25}	twenty-fifth percentile grain size diameter
D_{50}	median grain size
D_{75}	seventy-fifth percentile grain size
D_{85}	eighty-fifth percentile drain-size
EBK	empirical bayesian kriging
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System
IA	Interim Action
IAP	*Shelton Harbor Interim Action Plan*
mg/kg	milligrams per kilogram
MLLW	mean lower low water
MTCA	Model Toxics Control Act
NAD 83	North American Datum of 1983
ng/kg	nanograms per kilogram
OC	organic carbon
OMMP	Operations, Maintenance, and Monitoring Plan
PCB	polychlorinated biphenyl
PDI	pre-remedial design investigation
RAL	remedial action level
Restoration Project	Oakland Bay Habitat Restoration Project
SCO	sediment cleanup objective
SCU	Sediment Cleanup Unit
Simpson	Simpson Timber Company
SMA	sediment management area
SMS	Sediment Management Standards

SWAC	surface weighted average concentration
SWPPP	stormwater pollution prevention plan
TBT	tributyltin
TEQ	toxic equivalence quotient
TESC	Temporary erosion and sediment control
WAC	Washington Administrative Code
WDNR	Washington State Department of Natural Resources

1 Introduction

This *Shelton Harbor Basis of Design Report* (BODR) describes the engineering design basis for cleanup of portions of the Shelton Harbor Sediment Cleanup Unit (SCU) within the Oakland Bay and Shelton Harbor Sediments Cleanup Site (Ecology Cleanup Site ID 13007; Figure 1-1). The Shelton Harbor SCU (Figure 1-2) was delineated by the Washington State Department of Ecology (Ecology) in accordance with the Washington State Sediment Management Standards (SMS; 173 204-500(4)(a)), as further described in the 2017 Agreed Order DE 14091 (Agreed Order) between Ecology and the Simpson Timber Company (Simpson).

An interim action is a remedial action partially addressing the cleanup of a site, as provided under the Washington State Model Toxics Control Act (MTCA) regulation (Washington Administrative Code [WAC] 173-340-430) and the Agreed Order. This Interim Action (IA) is being performed to expedite cleanup of the northern Shelton Harbor SCU in advance of the northern Oakland Bay Habitat Restoration Project (Restoration Project), which is occurring in the same area (Figure 1-2). Sediment cleanup actions in other portions of the Shelton Harbor SCU will be addressed in a forthcoming SCU-wide Cleanup Action Plan, currently targeted to be prepared in 2019.

This BODR refines the interim actions presented in the *Shelton Harbor Interim Action Plan* (IAP; Anchor QEA 2018a) based on additional data collected during a pre-design investigation (Appendix A) and additional engineering analysis presented in this report. The IA is being permitted through the Nationwide 38 Permit process led by the U.S. Army Corps of Engineers (Corps) and will comply the requirements of MTCA; SMS; and local, state, and federal applicable or relevant and appropriate requirements. Simpson will implement this BODR to satisfy the requirements of the Agreed Order.

1.1 Site Background

Like the rest of Puget Sound, the Shelton Harbor area was glaciated and carved out during the last ice age. Shelton Harbor, Oakland Bay, and Hammersley Inlet are likely the remnants of a subglacial channel formed during the most recent glacial retreat (Herrera and Ecology & Environment 2010). The current bathymetry of the Shelton Harbor area is depicted in Figure 1-2. Watershed inputs from Goldsborough Creek and Shelton Creek, along with algal (e.g., phytoplankton) production within Oakland Bay, contribute sediments to Shelton Harbor. Sands transported through Goldsborough and Shelton Creeks deposit in the relatively large intertidal delta near the creek mouth in north Shelton Harbor, while finer sediment (silt and clay) is transported into deeper water areas of the SCU.

The non-Native American Shelton area economy was built around the forest products industry and paper manufacturing, farming, dairying, and ranching as well as shellfish aquaculture, including oyster cultivation. Industrial development in Shelton Harbor began with sawmill operations in the late 1800s, which continue to this day. In general, waterfront industrial operations peaked in the 1950s and 1960s and have declined since that period, like other areas of Puget Sound.

A wide range of historical sources including industrial facilities may have released hazardous substances or wood debris to sediments in Shelton Harbor, based on their scale, nature of operations, and years of operation. More detailed descriptions of historical sources are provided in the "Summary of Existing Information and Identification of Data Gaps Technical Memorandum" (Herrera 2008). As discussed in Herrera and Ecology & Environment (2010), historical sources of contamination to Shelton Harbor could have included wood debris, wood burning and hog fuel boiler operations, pulp mill and bleaching operations, sawmill facilities, wastewater discharges from industrial sources as well as public-owned treatment works, vessel maintenance and repair, and other operations. Historical transport pathways may have included currents and tidal fluctuations, aerial deposition, and stormwater runoff. Sediment studies indicate that concentrations of contaminants in sediments require remedial actions under MTCA/SMS.

1.2 Oakland Bay Habitat Restoration Project

The Squaxin Island Tribe, South Puget Sound Salmon Enhancement Group, Simpson, Port of Shelton, and other project partners are currently designing and permitting the Restoration Project within the northern portion of Shelton Harbor to address Shelton Harbor habitat impacts, with the objective of facilitating greater salmon runs. The overall goals of the Restoration Project include the following (Anchor QEA 2017a):

- Provide aquatic habitat and hydraulic complexity.
- Promote aggradation and complex flow paths.
- Restore estuary functions and facilitate natural processes.
- Improve habitat conditions at the mouths of Goldsborough and Shelton creeks.

The initial phase of the Restoration Project (2017) installed engineered log jams within Goldsborough Creek to slow and reverse an upstream channel incision. Based on the current project proposal, the next phase of the Restoration Project will place clean fill along the western shoreline of the estuary adjacent to Sierra Pacific Industries properties to restore saltwater wetland habitat (e.g., salt marsh) and enhance riparian areas. Following phases of the Restoration Project will include constructing additional salt marsh lobes in northern Shelton Harbor and rerouting the mouth of Shelton Creek into a new lagoon, as depicted in Figure 1-3.

The IA described in this document will be performed prior to the implementation of the Restoration Project and will be compatible with the future restoration plans. However, the IA will not be dependent on the Restoration Project to be protective and meet MTCA/SMS requirements in the northern Shelton Harbor SCU.

1.3 Purpose of the Interim Action

The purpose of this IA is to remediate sediments within northern portions of the Shelton Harbor SCU to meet the cleanup standards established in the IAP. The following cleanup components will be performed:

- Capping sediment with contaminant concentrations elevated above remedial action levels (RALs) to meet cleanup standards within northern portions of the Shelton Harbor SCU
- Removal of piles within capping areas to maintain cap stability

The purpose of this BODR is to document the design criteria for the IA components. The BODR has the following sections:

- Section 2: Development of Interim Action Capping Areas
- Section 3: Capping Design
- Section 4: Pile Removal Design
- Section 5: Site Preparation, Staging/Stockpiling Area, and Other Construction Elements
- Section 6: Compliance Monitoring
- Section 7: Implementation Schedule
- Section 8: References

Additional detail is presented in the following appendices:

- Appendix A: Pre-Design Investigation Data Report
- Appendix B: Geotechnical Evaluations
- Appendix C: Cap Stability Design
- Appendix D: Construction Quality Assurance Plan
- Appendix E: Water Quality Monitoring Plan
- Appendix F: Drawings
- Appendix G: Cost Estimate
- Appendix H: WDNR Derelict Creosote Piling Removal Best Management Practices for Pile Removal and Disposal

2 Development of Interim Action Capping Areas

2.1 Cleanup Standards and Remedial Action Levels

The goal of interim actions in north Shelton Harbor is to meet and maintain the site-specific cleanup standards (i.e., cleanup levels at the point of compliance) within a northeastern portion of the Shelton Harbor SCU. The cleanup standards were developed in the IAP and presented in Table 2-1 for the contaminants of concern identified for the IA: benthic toxicity, dioxin/furan toxic equivalence quotient (TEQ), carcinogenic polycyclic aromatic hydrocarbon (cPAH) TEQ, copper, and tributyltin (TBT). The vertical point of compliance is in the biologically active zone, identified as the upper 10 centimeters (cm) of sediment. Horizontally, compliance is measured based on the exposure area consistent with the exposure pathway for each contaminant. For benthic toxicity, copper and TBT compliance is measured based on point-concentrations exceeding the cleanup level (for protection of the benthic community). For dioxin/furan TEQ and cPAH TEQ, compliance is measured based on surface weighted average concentrations (SWACs) exceeding the cleanup levels for protection of human health and upper trophic-level wildlife.

Table 2-1
Shelton Harbor SCU Cleanup Levels, Points of Compliance, and Remedial Action Levels

Site-Specific Sediment Action Levels	Toxicity from Wood Debris Degradation	Dioxin/Furan TEQ ng/kg	cPAH TEQ µg/kg	Copper mg/kg	TBT mg/kg OC
Sediment Cleanup Level	SCO Bioassay Criteria[a]	19[b]	52[b]	390[a]	7.5[a]
Remedial Action Level[c]	SCO Bioassay Criteria	42	Not Required	390	7.5

Notes:
a. Sample-specific point of compliance in the top 10 cm
b. SWAC-based point of compliance in the top 10 cm
c. RALs are designed to be met in sample-specific point locations in the top 10 cm

RALs are the point-based concentrations that require remediation to achieve the cleanup levels within the SCU. For benthic toxicity, copper, and TBT, the RALs are equal to the cleanup levels. For dioxin/furan TEQ and cPAH TEQ, the RALs were developed in the IAP to meet the cleanup levels on an SCU-wide basis. For dioxin/furan TEQ, the RAL is 42 nanograms per kilogram (ng/kg), and for cPAH TEQ, the cleanup levels are met in the current condition (no RAL is needed). Using more recent sampling data, the dioxin/furan RAL may be refined as needed during development of the SCU-wide Cleanup Action Plan.

2.2 Pre-Design Investigation Results and Capping Area Determination

The IAP originally proposed three capping areas (Sediment Management Area [SMA]-1, SMA-2, and SMA-3) based on data available during IAP development. Subsequently, a pre-design investigation was performed in April and May 2018 to refine the capping areas presented in the IAP. Pre-design investigation data were merged with other recent data to obtain the most accurate representation of current conditions within the SCU. For example, this BODR used the most recent chemical analysis results for stations sampled more than once since 2008, along with interpolation methods described in Appendix A. The pre-design investigation data are also presented in Appendix A. The data selection and interpolation methods are described in the following section.

2.2.1 SCU-Wide Data and Interpolation Method

For the purposes of the BODR, the data were compiled from historical sources and samples collected in accordance with the 2017 Remedial Investigation/Feasibility Study Work Plan (Anchor QEA 2017b) and *Pre-Remedial Design Investigation Work Plan* (Anchor QEA 2018b) as follows:

- Where no new samples were collected in 2017/2018, historical results were included from the following sources:
    - Ecology's 2008 results reported in 2010 Oakland Bay Sediment Characterization Report (Herrera and Ecology & Environment 2010)
    - Ecology's 2013 results reported in *Dioxin in Surface Water Sources to Oakland Bay (Mason County)* (Ecology 2013)
    - 2011 Puget Sound Ambient Monitoring Data queried from EIM
- For the 2017 Remedial Investigation/Feasibility Study Work Plan samples, only the 2017 Retest Results as described in Appendix A.
- Pre-remedial design investigation (PDI) results are reported in Appendix A.

These data were loaded into a geographic information system (GIS) for geospatial data modeling, and each PDI replicate result was included in the interpolation (no averaging) while the PDI homogenate duplicate results from SMA1-SG08, SMA2-SG14, and SMA3-SG01 were averaged. After evaluating various data models, empirical bayesian kriging (EBK) was selected and applied in GIS to contour dioxin/furan concentrations across the SCU including the IA area (Figure 2-1). EBK contouring uses iterations of semivariograms, rather than a single semivariogram in standard kriging, to interpolate concentration distributions within the SCU and IA area. While EBK was the selected model for the purpose of the BODR, other models such as inverse distance weighting or standard kriging may be selected in the future to inform similar evaluations in support of the final remedial investigation/feasibility study process.

2.2.2 Comparison to RALs

Validated data for cPAH TEQ, copper, and TBT from the pre-design investigation were all below RALs and thus these chemicals are not cleanup drivers for the IA. However, the pre-design investigation data revealed that remediation areas within the SCU required to meet the dioxin/furan RAL of 42 ng/kg TEQ expanded beyond the preliminary footprints identified in the IAP. Ecology and Simpson have agreed to focus the interim actions on an expanded SMA-1 in the near term to best coordinate with the next phase of the Restoration Project, which is slated to begin in late 2018 and partially overlaps SMA-1. To take advantage of construction efficiencies, SMA-2 will be addressed during the same construction season as SMA-1. Cleanup construction in SMA-1 and SMA-2 will be completed before the habitat planned for those areas is built. Subject to funding agreements and regulatory approvals, IA in SMA-3 is possible during the 2019 in-water construction window.

SMA-1 consists of capping areas A, B, and C (Figure 2-1) in the northern portion of the Shelton Harbor SCU with surface sediment dioxin/furan concentrations that exceed the 42 ng/kg TEQ RAL based on the conceptual site model. SMA-2 consists of capping area D that targets a cluster of sampling locations that exceed the RAL. Unlike SMA-1, the extent of SMA-2 (capping area D) is not based on the interpolated dioxin/furan concentrations, due to lack of data density in the location.

2.2.3 RAL Hill-Topping Evaluation

As discussed in Section 2.1, an RAL of 42 ng/kg for dioxin/furan TEQ was developed in the IAP to achieve the cleanup level of 19 ng/kg throughout the SCU. The RAL was developed by "hill-topping," whereby the areas with the highest values are sequentially replaced with post-remedy sediment concentrations (assumed to be one-half the practical quantitation limit) to calculate the post-IA SWAC.

For this BODR, the hill-topping evaluation was revisited with the new data for a smaller IA SWAC area within the SCU, to demonstrate that the RAL of 42 ng/kg will meet cleanup standards within this area *(area shown within dashed line on Figure 2-1)*. The EBK model interpolated surface was exported from GIS for six concentration bins in the 36.9-acre IA SWAC area to calculate the post-remediation SWAC for various RALs (Table 2-2 and Figure 2-2). These updated hill-topping calculations confirmed that a dioxin/furan TEQ RAL of 42 ng/kg would achieve the cleanup level of 19 ng/kg as a SWAC in the IA SWAC Area. This RAL is used to delineate the capping areas in SMA-1 (A, B, and C) with additional physical considerations discussed in the following section.

Table 2-2
Dioxin/Furan Hill-Topping Evaluation for the Interim Action SWAC Area

RAL (µg/kg)	Remediation Area (Acres)	Resulting SWAC (µg/kg)
None	0.0	40
84	2.3	30
42	9.0	19
19	27.3	5.2
10	35.2	2.7
5	36.5	2.5

Notes:
The interim action SWAC area is 36.9 acres.

The RAL evaluation for the rest of the SCU will be revisited in a future document.

2.2.4 Physical Conceptual Site Model

One limitation of the GIS interpolated concentration surface is that it does not consider the physical processes of the harbor, such as topographic and hydrodynamic features. For this reason, the SMA-1 capping areas were further refined for this IA based on physical features within the tideflat, including offsets from the Shelton Creek channel that extends into clean sediments (see additional discussion below), as well as other features such as berms, bulkheads, and depressions that locally influence sediment deposition patterns. In some areas, the cap extends beyond the interpolated 42 ng/kg contour to capture an entire feature (e.g., capping area A was expanded to encompass the entire western log pond), and in other areas, the cap excludes interpolated exceedances in light of a feature (e.g., capping areas A and B do not cover the Shelton Creek channel as discussed in additional detail below). The four IA capping areas were delineated for this IA as follows:

- **Capping Area A (Former Western Log Pond):**
    - Western boundary: Sierra Pacific shoreline bank
    - Northern boundary: Shelton Creek berm
    - Eastern boundary: Shelton Creek drainage channel
    - Southern boundary: contoured RAL exceedance, smoothed to follow bathymetry
- **Capping Area B (Former Eastern Log Pond):**
    - Western boundary: Shelton Creek drainage channel
    - Northern boundary: shoreline bulkhead
    - Northeastern boundary: former eastern log pond, smoothed to follow bathymetry
    - Southeastern boundary: contoured RAL exceedance, smoothed to follow bathymetry
    - Southwestern boundary: Shelton Creek drainage channel

- **Capping Area C (Southern Tideflat Lobe):**
  - Northern boundary: Shelton Creek drainage channel
  - Southeastern boundary: Goldsborough Creek drainage channel
  - Southwestern boundary: contoured RAL exceedance, smoothed to follow bathymetry
- **Capping Area D (Former City Shoreline Wastewater Outfall):**
  - Rectangular boundary delineated by sample locations in the former wastewater discharge area that exceed the RAL (Interpolated dioxin/furan TEQ concentrations in the area between capping areas B and D are uncertain and were not relied upon to develop this IA; see below.)

Because of relatively low sediment contaminant concentrations (well below RALs) in the tidal channel(s) of Shelton and Goldsborough creeks, no caps are needed in these SMA-1 channel areas. An offset from these drainage channels has been incorporated into IA cap designs to maintain existing creek and bank conditions, as shown in Figures 2-3 and 2-4. The interpolated dioxin/furan TEQ concentration surface depicted in Figure 2-1 shows apparent RAL exceedances within the Shelton and Goldsborough creeks drainage channels; however, the interpolation algorithm does not take the physical features of the mudflat into account (e.g., the channels are below the depth of recent contaminated sediment deposits). All surface sediment samples collected from within the creek beds upstream and downstream of the IA capping areas are well below the RALs. In addition, core SH-03 collected adjacent to the Shelton Creek drainage channel indicates that the contaminated sediment is roughly 2 feet thick, which is shallower than the amount that the creek bed has incised through the soft sediment of the mudflat. Historical satellite imagery shows that the creek bed has remained in the same location in the tideflat for at least the last 25 years and is therefore expected to remain in the same location into the future, unless modified by construction.[1]

As discussed in Section 3.4, post-construction monitoring of IA caps will include sampling and chemical analysis of surface sediments within and between from each capping area (including between capping areas B and D) to verify cap protectiveness, and to verify that SWAC objectives throughout the IA area have been achieved (Table 2-1). Contingency actions will be performed as needed based on the results of the monitoring. A detailed post-construction Operations, Maintenance, and Monitoring Plan (OMMP) describing long-term physical and chemical monitoring and potential contingency measures will be prepared as part of the IA construction completion report.

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[1] Note that the creek bed may be moved as part of the Restoration Project. However, the creek location and shoreline modifications will not interfere with the protectiveness of the sediment cap. The current creek bed could require filling, should the creek bed be moved as part of the Restoration Project.

3 Capping Design

This section describes cap designs for SMA-1 developed in accordance with the following detailed U.S. Environmental Protection Agency (EPA) and Corps guidance for in situ capping:

- *Guidance for Subaqueous Dredged Material Capping* (Palermo et al. 1998a)
- *Assessment and Remediation of Contaminated Sediments (ARCS) Program Guidance for In Situ Subaqueous Capping of Contaminated Sediments* (Palermo et al. 1998b)
- Corps Coastal Engineering Manual (Corps 2002)

These documents provide detailed procedures for cap design. Importantly, caps designed following the EPA and Corps guidance have been demonstrated to be protective of human health and the environment (EPA 2005). Consistent with EPA and Corps guidance, the cap design was developed considering the following:

- Chemical isolation and bioturbation
- Erosion protection
- Consolidation (geotechnical evaluation)
- Cap monitoring and maintenance

In addition, the cap design considers the habitat function of the cap surface by approximating, to the extent practicable, the conditions of the existing mudflat. In particular, the cap surface includes fine-grained material that may undergo some movement during high-velocity wind events. This capping design considers the potential movement of surficial cap material, and how the cleanup objectives can be met using a cap that is in dynamic equilibrium with shoreline conditions. The cap design is discussed in the following sections.

3.1 Chemical Isolation

The chemical isolation design element of the cap was based on the contaminant transport and chemical isolation analysis presented in Section 4.2.1 of the IAP. This analysis was performed using the steady-state Reible model (Lampert and Reible 2009) to simulate the fate and transport of dioxins/furans (dissolved and sorbed phases) under the processes of bioturbation, advection, diffusion, dispersion, biodegradation, and exchange with the overlying surface water. Dioxin/furan congeners were modeled separately and then recombined to estimate the TEQ in the biologically active zone (upper 10 cm) of the cap. The model also accounts for additional initial porewater flux due to consolidation of the softer silty sand sediments that underlie the cap. A 6-inch cap isolation layer was modeled (including the biologically active zone thickness), for four scenarios that bound the anticipated conditions in Shelton Harbor, resulting in long-term dioxin/furan TEQ concentrations of 0.0000022 to 19 ng/kg in the biologically active zone (top 10 cm) of the cap, depending on the assumptions used. Therefore, using conservative assumptions (e.g., relatively low total organic carbon (OC) content in sand/gravel cap materials (0.1%), no sedimentation, high advection rate (Darcy flux [1 cm per day] and an underlying dioxin/furan TEQ of 287 ng/kg)[2], the model showed that a 6-inch sand/gravel cap isolation layer will maintain long-term dioxin/furan TEQ concentrations below the regional background dioxin/furan TEQ of 19 ng/kg in the biologically active zone (top 10 cm) of the cap. As noted below, additional cap thickness for armoring and filtering will provide further protectiveness beyond the design thickness.

Under the anticipated future conditions in Shelton Harbor (e.g., input of relatively low sediment concentrations from Goldsborough and Shelton Creeks), long-term surface sediment dioxin/furan TEQ concentrations throughout the Shelton Harbor SCU are anticipated to recover to below regional background concentrations even in the absence of remediation. The IA described in this BODR has been designed to accelerate natural recovery of the SCU, while concurrently ensuring that subsurface contaminated sediment deposits are protectively isolated from the surface biologically active zone.

3.2 Erosion Protection

A detailed erosion protection analysis is presented in Appendix C of this BODR, which identifies appropriate armor sizes to maintain long-term cap stability. Within the capping area, the design peak erosive forces are primarily associated with the breaking of waves during a high wind event occurring during an assumed low-tide condition. Because the IA capping areas are entirely intertidal, all areas of the cap are assumed to be subjected to breaking waves at various stages of the tidal cycle. Because the capping area is intertidal, sea level rise will not increase breaking wave forces on the cap.

3.2.1 Wind/Wave Analysis

Wave conditions in the capping area were based on wind hind-casting for 10-year recurrence interval events based on wind from the Shelton airport (Sanderson Field Airport) from 1999 to 2016 (100-year recurrence interval events are predicted to be of a similar magnitude). The wave hindcast was completed using predicted wind speeds of 16 miles per hour from 30- to 60-degree (northeast) directions, which represent the most important trajectories of wave attack at inner Shelton Harbor. Nearshore wave heights for the 10-year recurrence interval were evaluated using a wave transformation model to optimize armor rock size for that event. Evaluation of required material sizes and cap layer thickness for stability under predicted wind waves was done using the methodology outlined in the Corps Coastal Engineering manual, as discussed in Appendix C of this BODR.

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[2] The dioxin TEQ concentration of 287 ng/kg used in cap modeling was from the highest surface sample concentration from the 2017 RI sampling. When reanalyzed, this sample result was 413 ng/kg dioxin TEQ (see Appendix A). However, the chemical isolation analysis is still considered conservative because of the compounding effect of conservative parameter assumptions (e.g., no sedimentation and high Darcy flux) and because of additional cap thickness beyond the isolation layer, which will further improve the isolation function of the cap.

3.2.2 Other Sources of Erosion

In addition to wind-generated waves, other sources of erosion were considered for analysis. The flow of Shelton Creek is a source of erosion through the tideflat in the capping area, as shown by bathymetric elevations (Figure 1-2). As discussed above, sediment samples from within the creek are below RALs, and therefore the creek drainage through the mudflat will not be capped. Based on historical satellite imagery and visual observation, the current alignment of the creek across the tide flat has remained stable over time, in part due to constructed berms within the tideflat. For these reasons, the existing banks will remain in place, and the cap will be offset from the creek.

The IA capping area is no longer a working waterfront, and vessel traffic is limited to small vessels (e.g., recreational crafts). Therefore, a propeller wash evaluation was not necessary for this analysis. However, detailed propeller wash analyses performed at other sediment cleanup sites in Puget Sound (e.g., Port Gamble, Anchor QEA 2015) reveal that protection against potential erosional forces from typical recreational vessels likely to enter intertidal areas of the northern Shelton Harbor SCU requires a median grain size (D_{50}) that is smaller than that identified in Appendix C for protection from breaking waves. Thus, the cap designs developed herein are protective of breaking waves and are also protective of potential propeller wash conditions.

Tidal currents are minimal in inner Shelton Harbor because of the terminal location within Oakland Bay. However, some localized erosion from tidal currents could occur within drainage features. Erosion from tidal drainage was not modeled because of the complexity of the localized flows.

3.2.3 Material Grain Size Selection

As part of cap design, the gravel armor layer will require an underlying sand filter layer to restrict the movement of fine grained material through the armor. A standard methodology for determining the grain size of adjacent layers is for the fifteenth percentile grain-size diameter (D_{15}) of the coarse-grained layer to be less than four times the eighty-fifth percentile grain-size diameter (D_{85}) of the fine-grained layer (Terzaghi 1948). The Terzaghi criterion was developed for a uniform material with a narrow range of grain sizes. Using the Terzaghi criterion in the IA area, a three-layer cap could be required due to fine-grained size of native sediments.

In Shelton Harbor, a blended filter and armor layer is preferred for several reasons. First, the existing surface sediments are primarily fine grained, so increasing the amount of fine-grained material within the cap surface layer is expected to provide habitat benefit over an armor-only surface layer. Second, a blended armor and filter layer will be more constructible and efficient for the contractor to build. Finally, broadly graded material is readily available near Shelton and therefore reduces environmental impacts from construction.

Wright et. al. (2001) studied the use of a blended filter and armor layer in capping design. The document discusses that researchers have found that for sandy clays and silts, the Terzaghi criterion is conservative due to the cohesiveness of fine-grained material (such as native sediments). In addition, broadly graded cap materials self-armor under waves, whereby the finer-grained material at the surface of the cap is removed until the surface material consists of all coarse-grained material, effectively armoring the remaining finer grained material in the lower horizons of the cap. The potential limitation of using broadly graded material for capping is that some finer grained material may winnow from the surface of the cap; short-term erosion may be observed in localized areas.

Based on these considerations, a blended filter and armor cap is proposed. Because of the potential for movement of finer materials, post-construction monitoring will be performed to verify that the cap continues to be protective. In particular, visual monitoring and bathymetric surveys will be performed, focusing on the following areas that are more likely to show signs of movement:

- The edges of the cap
- Tidal drainage pathways where localized tidal currents may occur
- Cap material placed near Shelton Creek

3.3 Geotechnical Design Criteria

The geotechnical design criteria were developed based on guidance from various technical references (Duncan and Wright 2005; WSDOT 2011). Appendix B describes the soil and sediment data utilized for development of geotechnical engineering soil properties for analyses, the methodologies employed, and the results and conclusions of the geotechnical engineering evaluations.

Within the IA capping area, the major geotechnical concern comes from placing aggregate material over native soft sediments. Placing material too quickly could result in the failure of underlying soft sediment, resulting in a mudwave forming adjacent to the cap, and reducing the strength of the subgrade sediments. The shear strength and compaction of underlying native sediments were evaluated in Appendix B, with the finding that placing material in maximum 18-inch-thick lifts will minimize the chance for disturbance of native material. The geotechnical analysis also established a maximum lift thickness for the Restoration Project such that the cap will be stable during and after additional sand and gravel placement.

3.4 Cap Monitoring and Maintenance

The IA cap will be monitored to verify continued protectiveness. Monitoring will include periodic bathymetric surveys and visual inspections for comparison with as-built conditions, along with chemical monitoring. If monitoring reveals potential reductions in cap thickness to below cap design criteria or recontamination of the cap surface, follow-on sampling would be performed to characterize cap conditions and determine appropriate contingency actions as needed.

Post-construction monitoring of IA caps will include physical survey methods (e.g., bathymetry) to monitor the integrity, surface elevation, and thickness of the caps, beginning in Year 1 following completion of construction, continuing in Years 2 and 3, and thereafter once every 5 years for periodic review process, unless Ecology agrees otherwise based on the monitoring results. Survey methods will be similar between the pre-design investigation, as-built, and each long-term monitoring survey to allow detailed comparisons. Changes in bathymetry will be evaluated to identify areas of net settlement, erosion, or deposition relative to post-construction conditions. A potential cap area of concern for potential settlement or erosion will be identified when the apparent total cap thickness relative to as-built conditions is less than the minimum specification defined in this BODR. A potential cap area of concern may trigger visual inspection of the cap surface and/or probing in that area to more accurately characterize the in-place cap layer thickness. Focused follow-on surface sediment chemical monitoring may be performed in targeted cap areas identified by the physical surveys to further evaluate the protectiveness of the caps.

In addition, post-construction monitoring of IA caps will include sampling and chemical analysis of surface sediments within and between each capping area to verify cap protectiveness and to verify that SWAC objectives throughout the IA area have been achieved (Table 2-1). Chemical monitoring will be performed on a similar schedule as physical monitoring.

Cap repairs will be performed as needed based on the results of the monitoring. As discussed above, the cap is designed to be compatible with the Restoration Project occurring in the same area. However, the cap design is not reliant on the Restoration Project to be protective. The implementation of the Restoration Project could affect the method, timing, and frequency of monitoring, as determined by Ecology.

A detailed post-construction OMMP describing long-term physical and chemical monitoring and potential contingency measures will be prepared as part of the IA construction completion report.

3.5 Summary of Cap Design Criteria

Based on the site-specific cap design analyses summarized above, cap design consists of a broadly graded material with a seventy-fifth percentile grain size (D_{75}) of about 1.3 inches and a twenty-fifth percentile grain size (D_{25}) of about 0.2 inch to serve the combined purposes of the isolation layer, filter layer, and armor layer. The total cap design thickness will be a minimum of 18 inches to account for the following:

- 12-inch thickness to provide armoring. 12 inches of material with a D_{75} of 1.3 inches is functionally equivalent to 6 inches of material with a D_{50} of 1.3 inches, consistent with armor requirements described above. The finer-grained surficial component of this capping material may winnow under wave action.

- 6-inch thickness to provide chemical isolation and filtering. Consistent with the contaminant transport model, 6 inches will provide chemical isolation over the long-term, and provide a 6-inch filter layer to support the overlying armor.

To account for the movement of blended capping material during storm events, up to an additional 12 inches of cap material will be placed during construction as follows:

- An additional 6-inch thickness will be required to account for potential mobilization of finer grained cap material and the potential for winnowing of finer-grained material within the cap.
- A further additional overplacement allowance of up to 6 inches will be provided to the contractor to account for equipment accuracy, for a total cap thickness of 24 to 30 inches.

The separate functions and related thicknesses are described for consistency with the capping analysis. As previously discussed, the cap will be constructed as a single, broadly graded layer of material to concurrently provide the isolation, filter, and armor functions.

Prior to placement, a representative sample of capping material will be analyzed to verify that the material meets capping criteria. In addition to grain size distributions, capping material will be analyzed for metals, semivolatile organic compounds (including cPAHs and polychlorinated biphenyls [PCBs]), and dioxins/furans. During construction, in addition to meeting the water quality criteria discussed below, the cap will be placed in maximum 18-inch-thick lifts to avoid disturbance to underlying sediment. Following placement, cap monitoring and maintenance will be performed as summarized in Section 3.4.

4 Pile Removal Design

Creosote-treated and untreated piles will be removed from IA capping areas; this work will occur before capping actions to maximize control of pile removal residuals.

4.1 Timber Pile Removal and Demolition

Piles that are identified for removal are shown in Figure 4-1. The piles have historically been used for log rafting activities and lighting. Approximately 23 piles will be removed as part of the IA, as follows:

- Approximately 4 timber piles in the Former West Log Pond
- Approximately 19 timber piles in the Former East Log Pond (Associated electrical wires will also be demolished.)

Pile counts were developed from bathymetric surveys, aerial photographs, and visual observations. An estimated 20 tons of creosote-treated piles will be removed and disposed of off site at a permitted landfill. Piles stubs from piles that have been broken at grade will not require removal and will be capped.

4.2 Removal Methods and Best Management Practices

Piles will be removed using best efforts, equipment preferences, and best management practices (BMPs) that have been developed and implemented throughout Puget Sound. Removal of creosote-treated wood from Puget Sound has been a major focus of Washington State Department of Natural Resources (WDNR) over the last 10 years. As a result of these considerable demolition experiences and detailed evaluations of construction releases, WDNR has refined its creosote removal BMPs to improve the overall effectiveness and practicability of the removal program. For these reasons, this project will use the BMPs in "Washington Department of Natural Resources Derelict Creosote Piling Removal Best Management Practices for Pile Removal & Disposal" as updated in 2017. These are included in Appendix H and will be part of the pile removal specifications. In summary, these include BMPs for the following:

- Methods of pile removal (including a hierarchical list of pile extraction methods with vibratory extraction as the preferred method)
- Barge operations, work surface, and containment BMPs to minimize any releases to the water during pile handling
- Debris capture in water BMPs to capture debris within a boomed area
- Disposal BMPs to ensure that creosote-treated piles and construction residue are disposed of in a manner consistent with regulations
- Resuspension/turbidity BMPs to minimize impacts to water quality (In addition to these BMPs, the project will also follow the requirements of a site-specific water quality protection plan to be developed by the contractor and approved by Ecology, which includes monitoring and

contingency actions for meeting water quality criteria during pile removal as well as capping operations.)
- Project oversight BMPs to ensure that other BMPs are being followed
- Cultural resources BMPs to ensure that any encountered artifacts or human remains are handled in a manner consistent with laws and regulations. (While the IA does not include ground-disturbing construction activities that have the potential to affect potential cultural resources, site-specific cultural resource protection protocols may be included as appropriate under forthcoming Nationwide 38 Permit conditions for the IA.)

As an exception to the WDNR BMPs, for the IA, should all removal methods fail, then the pile may be cut at mudline because all pile removal areas will be capped. Any debris from cutting (e.g., sawdust) will be contained and disposed of along with the cutoff portion of the pile. In addition, for wires and electrical infrastructure associated with lighting, the contractor will be required to take extra care to ensure that demolition debris does not enter the water. See Appendix H for a full list of BMPs for pile removal.

4.3 Pile Removal Debris Offload, Transport, and Disposal

Creosote-treated debris and demolition materials will be disposed in a permitted landfill or recycled in accordance with appropriate regulations. Final transportation to the disposal or recycling facility may occur by barge, rail, or truck, depending on the selected facility and the transportation logistics selected by the contractor. Examples of permitted landfills that have historically managed creosote-treated debris include the Waste Management landfills in Wenatchee, Washington, and Arlington, Oregon; the Allied Waste facility located in Roosevelt, Washington; and the Cowlitz County facility located in Castle Rock, Washington. Other facilities may be utilized for material disposal or recycling, provided that they meet relevant permitting requirements.

The contractor will be required to transport creosote-treated debris from the IA area to the landfill or recycling facility. The contractor will be responsible for providing an appropriate offload facility and the transportation logistics to move this debris from the demolition areas to the disposal site. This may include use of the staging areas as shown in Figure 4-2, or alternative locations. The contractor will be required to barge or haul debris to the designated offload point. Transloading, staging, stockpiling, and dewatering methods will comply with the BMPs summarized in Section 5. Transportation between the offload point and the final disposal or recycling site may include barge, truck, or rail transportation, or a combination thereof.

5 Site Preparation, Staging/Stockpiling Areas, and Other Construction Elements

5.1 Marine Water Quality Protection

The contractor will be required to develop an Environmental Protection Plan, which will include site-specific considerations and will outline the Contractor BMPs during placement and pile removal activities. The Environmental Protection Plan will be subject to Ecology approval. The initial water quality BMPs are in Appendix E. Simpson will perform water quality monitoring.

5.2 Potential Upland Staging and Stockpiling Areas

The work will require mobilization of land-based equipment such as backhoes, shore-based cranes, loaders, and other equipment. The work may also require the stockpiling of clean sand in preparation for transloading and water-based placement.

Two potential upland staging/stockpiling areas have been identified for the project as shown in Figure 4-2. The first staging/stockpiling area is on Simpson property at the Former Log Handling Facility. The second is on Sierra Pacific Industries property adjacent to operations. Other staging/stockpiling area(s) may be used by the contractor in coordination with Simpson, provided that they meet the design criterial in this section. Staging/stockpiling areas that contribute to a total area of 1 acre or more of upland staging, must receive coverage under state of Washington Construction Stormwater General Permit (CSWGP).

The final selection of temporary upland stockpile and transloading locations will depend on construction and logistical considerations. For example, if material is moved to and from the site by truck, then a transload area will be constructed to efficiently handle such activities. If material is moved to and from the site by barge, then the transload area will primarily be for staging operations.

5.2.1 Simpson Former Log Handling Facility

The Simpson Former Log Handling Facility upland will be made available to the contractor for use in staging equipment and materials for the cleanup project, for access to the shoreline work, and for temporary stockpiling and transloading cap materials and/or creosote pile debris for shipment (as necessary). A CSWGP will be obtained by Simpson prior to the project which will need to be followed. The work area is approximately 1 acre.

If practicable, the contractor may load from the existing bulkhead. However, the contractor will need to conduct a structural assessment that the bulkhead is in suitable condition for their intended use. Barges may load from within the Former East Log Pond.

The contractor may need to drive temporary piles during construction (e.g., to keep barges or conveyors in place).

5.2.2 Sierra Pacific Industries

The Sierra Pacific Industries Mill Site may be available for upland staging and stockpiling. The Restoration Project is currently planning to use the Sierra Pacific Industries shoreline for access to the tideflat, and the upland area may be made available for this project as well. If so, the CSWGP coverage for that area would need to be transferred to Simpson.

If practicable, the contractor may load from the existing shoreline to the Former West Log Pond. However, the contractor will need to conduct a structural assessment to ensure that the shoreline is in suitable condition for their intended use.

5.3 Temporary Site Controls

Upland temporary facilities will be controlled by the contractor with respect to safety, noise, dust, security, stormwater runoff, and traffic. The construction site will be closed to the public at all times. The contractor will be responsible for site security at the upland staging areas. The contractor will also be responsible for daily housekeeping, and will need to maintain a spill kit on site to control and contain any equipment leakage that could occur. The contractor will control fugitive dust from the stockpile and staging areas using appropriate BMPs, and the tracking of soil or dust off site will be controlled.

Temporary erosion and sediment control (TESC) BMPs will be employed to prevent pollution of air and water and control, respond to, and dispose of eroded sediment and turbid water during construction. TESC BMPs will be employed in all work areas, equipment and material storage areas, stockpiles, transloading, and haul areas.

Where barge offloading and loading operations are conducted, spill containment measures will be required to ensure that all sediment and water from loading and offloading operations are fully contained and water generated from upland handling of demolition materials can be captured and managed.

Specific temporary clean sand stockpile configuration will be at the discretion of the contractor. However, the temporary stockpile areas will be appropriately contained to prevent uncontrolled runoff from leaving the area. Methods for containing the stockpiles will be described in the construction work plan, which will be a required contractor submittal and will detail operations, including setup and breakdown, stormwater management, and maintenance and cleaning of upland work areas.

In summary, the following requirements will govern the operation of the upland staging area:

- The temporary staging and stockpiling area will be constructed in accordance with the Construction Drawings and Specifications and will include perimeter containment to prevent the release of unfiltered runoff from the temporary staging and stockpiling area.
- The upland staging area will be isolated from surface water using standard erosion and sedimentation controls, such as filter fence barriers and/or lined ecology block walls or berms.
- Catch basins beneath sand stockpiles will be sealed.
- Other catch basins within the upland staging area but not directly beneath stockpiles will be protected with a below-grate inlet device (BGID) to collect sediment and debris from stormwater prior to discharge. The BGID will be inspected and maintained on a regular basis.
- The contractor will be required to maintain a clean upland staging area to prevent vehicles from tracking material off site
- Equipment will be fueled in a designated area that separates fueling operations and protects the environment from accidental spills during fueling.

These requirements may be revised as necessary based on the CSWGP. The contractor will maintain a spill kit on-site in the event 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. If creosote-treated wood debris are offloaded in the transload area, then WDNR BMPs will be followed (Appendix H). In particular, the area will be lined and contained, water discharges from the lined area will be prohibited, and all debris will be disposed of off site.

Final permitting documents may require additional environmental considerations that will be included as part of the final design.

5.4 Construction Stormwater Water Management

A CSWGP will be obtained for the upland staging/stockpile area on the Simpson Former Log Handing Facility. In addition, the contractor will prepare a stormwater pollution prevention plan (SWPPP) that meets conditions of the permit and describes the BMPs that will be employed to minimize generated waters and ensure compliance with applicable water quality criteria and discharge requirements. The objectives of the SWPPP are as follows:

- Identify potential sources of pollution that may be reasonably expected to affect the quality of stormwater discharge from the work area.
- Describe and ensure implementation of practices that will be used to reduce the pollutants in stormwater discharge from the work area.
- Ensure compliance with terms of the state of Washington general permit for construction stormwater discharges as applicable.
- Identify applicable BMPs for stormwater management.

The contractor will install and operate an appropriate system for management of construction water generated during the work. The contractor will use structural devices, such as hay bales, silt fences, and catch basin inserts, to filter or divert stormwater as needed.

For the Simpson Former Log Handling Facility site, the primary stormwater management tool for the sand stockpile area will be infiltration. Construction stormwater will be directed to an existing vegetated swale to the north and east portion of the site where stormwater will be allowed to infiltrate. For the Sierra Pacific Industries property, stormwater management will be performed consistent with the CSWGP to be obtained for that area through transfer of coverage from Sierra Pacific Industries.

In the event that infiltration alone cannot accommodate water from the stockpile area, stormwater will be directed to a catchment basin on site or directly to the shoreline, if permissible under the CSWGP. The SWPPP will detail the procedures to follow if discharge to surface water is necessary, including BMPs, storage requirements, and sampling/acceptance criteria.

5.5 In-Water Work Window

In-water construction activities will be performed consistent with allowable work windows established in coordination with state and federal resource agencies and tribes. Final work windows will be specified in the issued permits for the project, based on the presence of several fish species of concern. Work windows were also established in coordination with tribes to minimize potential impacts to tribal shellfish and finfish harvesting.

The proposed in-water work window for this project is July 16 to February 14.

5.6 Hours of Operation

The temporary staging/stockpile area is zoned Neighborhood Residential; however, the site is bordered by a rail line, highway SR3, and the marina, and is adjacent to land zoned General Commercial. Construction activities are likely to occur between 7 a.m. and 10 p.m., 6 days per week, but could occur up to 24 hours per day, 7 days per week, to meet the required project schedule. City of Shelton ordinances (Chapter 9.18) require no construction noise between 10 p.m. and 7 a.m. on weekdays and 10 p.m. and 9 a.m. on weekends. If it becomes necessary to work later or earlier than these hours to accommodate project schedule or tidal factors, Simpson will work with the City of Shelton to determine potential mitigating measures.

5.7 Haul Routes

Traffic impacts associated with cleanup project construction activities will be mitigated to the extent practicable. This will include limiting barge transport through Shelton Harbor to the extent practicable and, where appropriate, transporting construction materials to and from the site using designated truck haul routes. Flaggers will be used if necessary to ensure traffic safety.

Delivery of clean aggregate materials would require approximately 1,000 to 2,000 truck and trailer trips. The actual number of trips needed will be dictated by the size of the trucks used, and whether additional capacity can be provided with dump truck trailers (also known as “pups”). Haul routes will be developed in the construction work plan, and a City of Shelton Right of Way – Heavy Haul Permit will be obtained by Simpson prior to construction.

5.8 Project Datums

The horizontal datum that will be used is Washington State Plane North Zone, North American Datum of 1983 (NAD 83), measured in units of feet.

The vertical datum is National Ocean Survey mean lower low water (MLLW), and the nearest National Oceanic and Atmospheric Administration subordinate station is No. 9446628, located in Oakland Bay, Washington.

6 Compliance Monitoring

Compliance monitoring and contingency responses (as needed) will be implemented in accordance with WAC 173-340-410, Compliance Monitoring Requirements. Simpson will comply with detailed requirements in the *Construction Quality Assurance Plan* (Appendix D). As discussed in Section 3.4, a detailed post-construction OMMP describing long-term physical and chemical monitoring and potential contingency measures will be prepared as part of the IA construction completion report. The objective of the OMMP is to confirm that cleanup standards have been achieved, and also to confirm the long-term effectiveness of interim actions at the site. The OMMP will detail the duration and frequency of monitoring, the trigger for contingency response actions, and the rationale for terminating monitoring. The three types of compliance monitoring to be conducted are as follows:

- Protection monitoring to confirm that human health and the environment are adequately protected during the construction period of the cleanup action
- Performance monitoring to confirm that the interim action has attained cleanup standards and other performance standards
- Confirmation monitoring to confirm the long-term effectiveness of the interim action once performance standards have been attained

For the IA, the major components for meeting these MTCA components are water quality monitoring, construction quality assurance monitoring, and post-construction monitoring as described in the following sections.

6.1 Water Quality Monitoring

Water quality monitoring will be conducted by Simpson to ensure compliance with federal, state, and local regulations pertaining to water quality. Appendix E presents the detailed water quality monitoring plan for the project, including the timing of monitoring, the means and methods of monitoring, and contingency actions that will be required should water quality standards be exceeded.

6.2 Construction Quality Assurance Monitoring

Construction quality assurance monitoring is monitoring to confirm that the work has been performed in conformance with the drawing and specifications. The methods and procedures for construction quality assurance monitoring are detailed in the *Construction Quality Assurance Plan* in Appendix D. The project management structure includes a Contractor Construction Quality Control Supervisor who will be responsible for verifying that appropriate quality control measures are implemented during construction. In addition, Simpson will designate a Construction Quality Assurance Officer to observe and inspect the work and to maintain the integrity of the data generated during the project.

An important component of the project is determining the thickness of the cap placement. As summarized in Appendix D, multiple lines of evidence may be used to assess cap thickness, including the following:

- The Contractor will be required to track the volume and/or weight of cap material placed on a daily basis and to make this information available to Simpson as part of their daily reports.
- The Contractor will be required to conduct bathymetric surveys before and after cap construction to assess material coverage across the area.
- For in-water placement, the Contractor will use an electronic tracking method (e.g., bucket maps), to assess material coverage across the placement area. The Contractor will be required to make this information available to Simpson.
- Simpson will perform cap probing and/or coring, if needed, to verify that the cap has been placed to the specified thickness.

Other components of the construction quality assurance program are detailed in Appendix D.

6.3 Post-Construction Monitoring

As discussed in Section 3.4, the IA cap will be monitored to verify continued protectiveness. Monitoring will include periodic physical and chemical monitoring. Details of operation, monitoring, maintenance, and contingency actions will be developed as part of the OMMP prepared as part of the IA construction completion report.

7 Implementation Schedule

This section provides an overview of the anticipated implementation schedule for cleanup construction activities at the site, including associated monitoring and institutional controls.

The demolition and capping activities described in this BODR are anticipated to be completed within a single construction season. The targeted start date for construction is during fall 2018, subject to final permitting approvals, and be completed by February 15, 2019.

The project work windows, as defined in the final project permits, will govern most in-water work activities. However, some work within the site may be appropriately initiated prior to the opening of these in-water work windows. Likewise, some work activities may continue after closure of these in-water work windows. Activities that are not subject to in-water work restrictions may include some or all of the following examples:

- Preparation or removal of upland staging and stockpile areas
- Removal of nearshore structures located within project work areas

As practicable, pile demolition, processing, and debris disposal will be performed before capping to reduce the chance of disturbing the cap during pile removal. Pile removal is expected to last several weeks. Capping will subsequently cover the areas that have been disturbed by pile removal, with capping lasting several months.

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Figures

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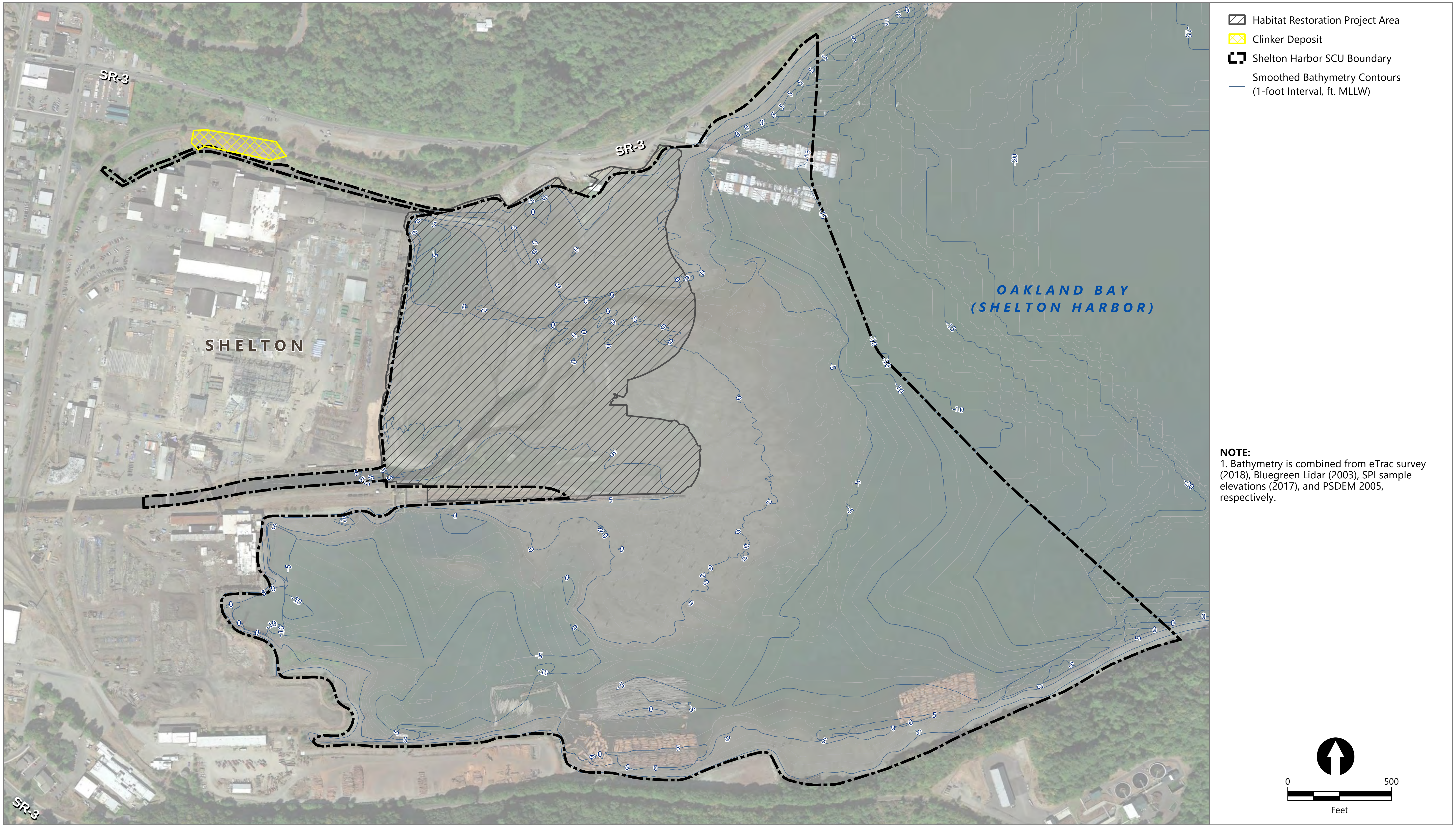
Figure 1-1
Oakland Bay and Shelton Harbor Sediments Cleanup Site
Shelton Harbor Interim Action Engineering Basis of Design Report
Oakland Bay and Shelton Harbor Sediments Cleanup Site



NOTE:
1. Bathymetry is combined from eTrac survey (2018), Bluegreen Lidar (2003), SPI sample elevations (2017), and PSDEM 2005, respectively.

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Figure 1-2
Shelton Harbor Sediment Cleanup Unit and Bathymetry
Shelton Harbor Interim Action Engineering Basis of Design Report
Oakland Bay and Shelton Harbor Sediments Cleanup Site

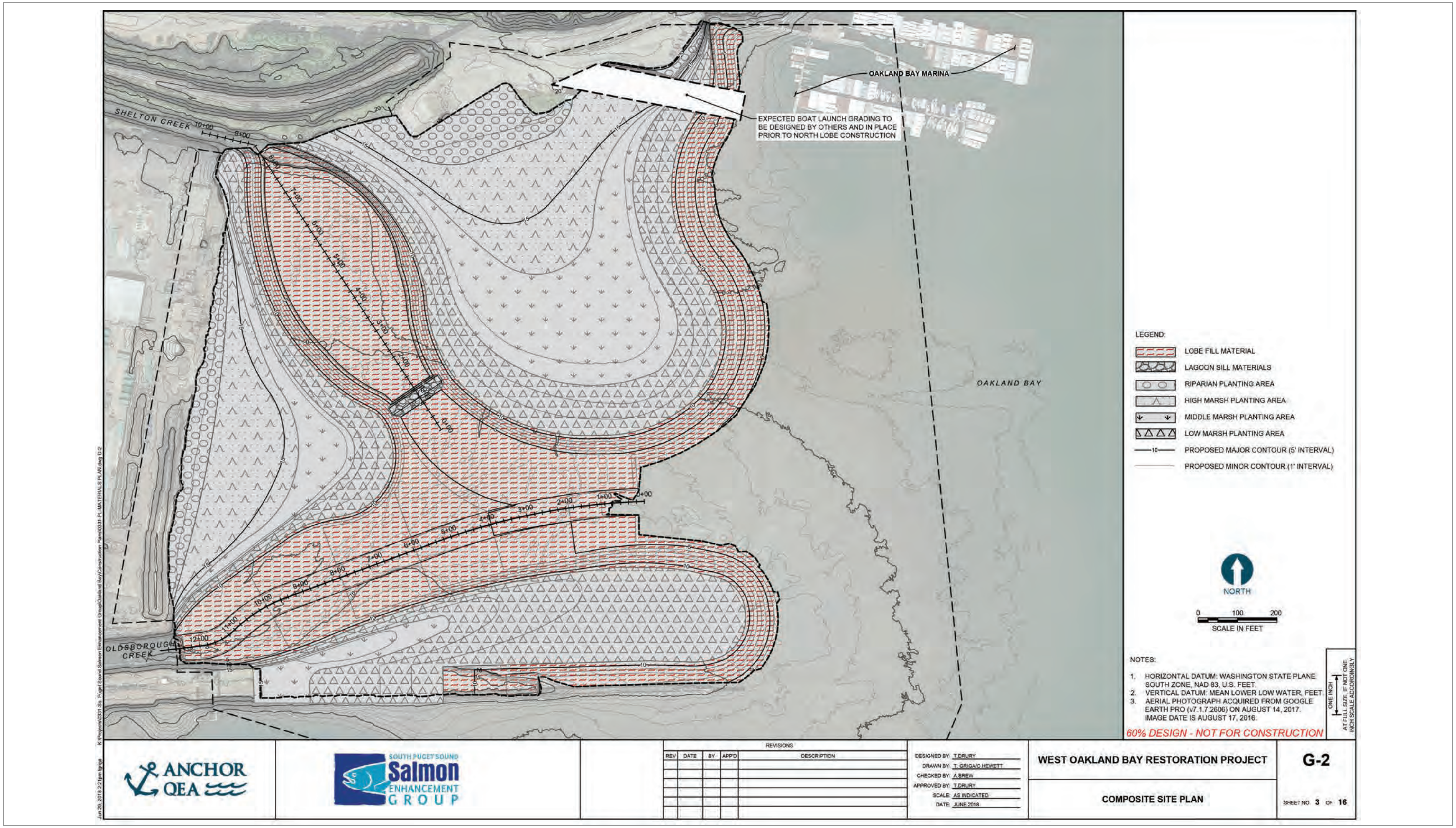

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Figure 1-3

North Shelton Harbor Habitat Restoration Project

Shelton Harbor Interim Action Engineering Basis of Design Report
Oakland Bay and Shelton Harbor Sediments Cleanup Site

NOTES:

1.2018 Dioxin/TEQ data is non-validated and subject to change pending validation results.

2. Background orthoimagery provided by Google Earth.

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Figure 2-1

Shelton Harbor Surface Sediment Dioxin/Furan TEQ

Shelton Harbor Interim Action Engineering Basis of Design Report
Oakland Bay and Shelton Harbor Sediments Cleanup Site

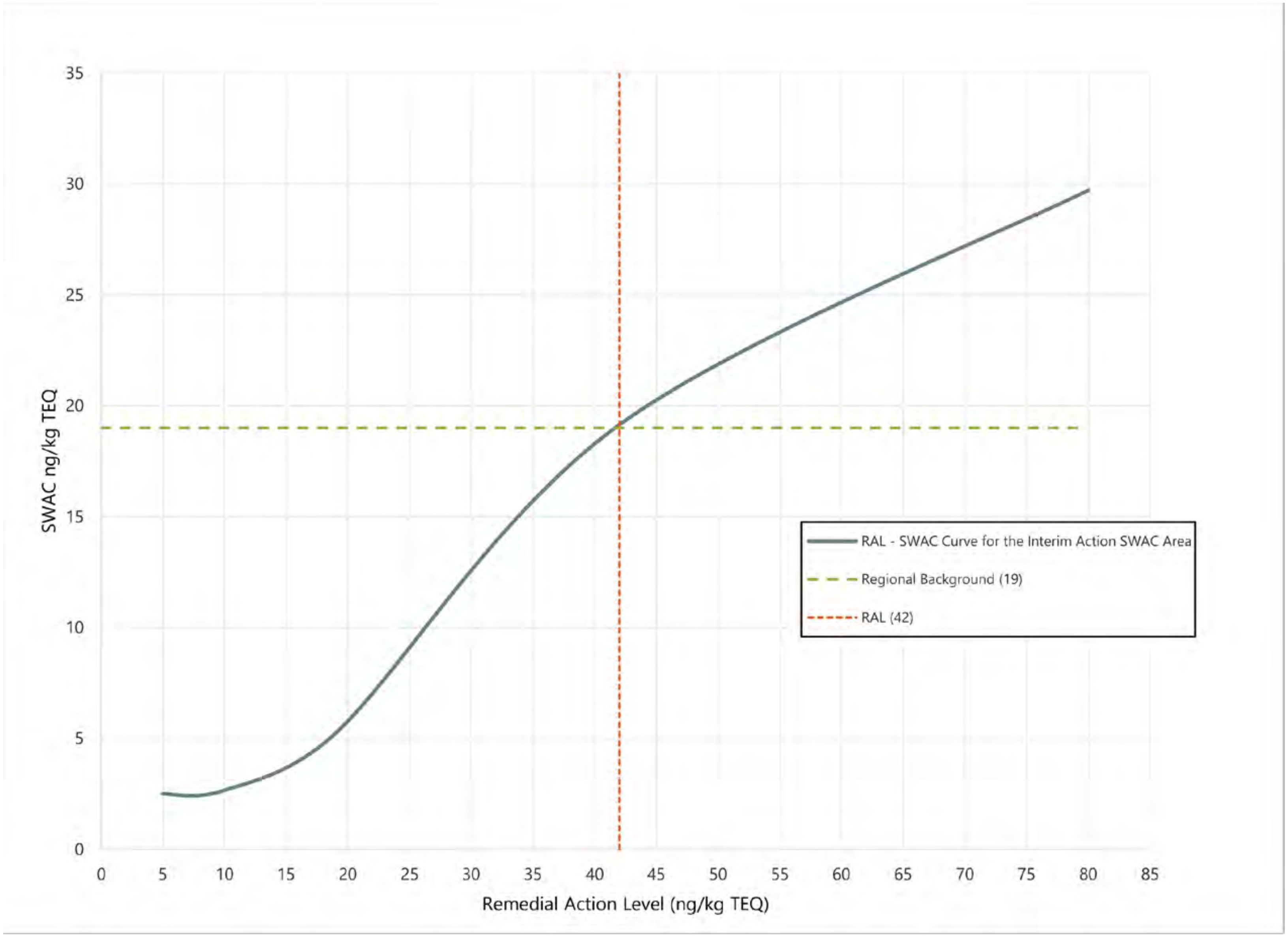

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Figure 2-2

Dioxin/Furan Hill-Topping Curve

Shelton Harbor Interim Action Engineering Basis of Design Report
Oakland Bay and Shelton Harbor Sediments Cleanup Site

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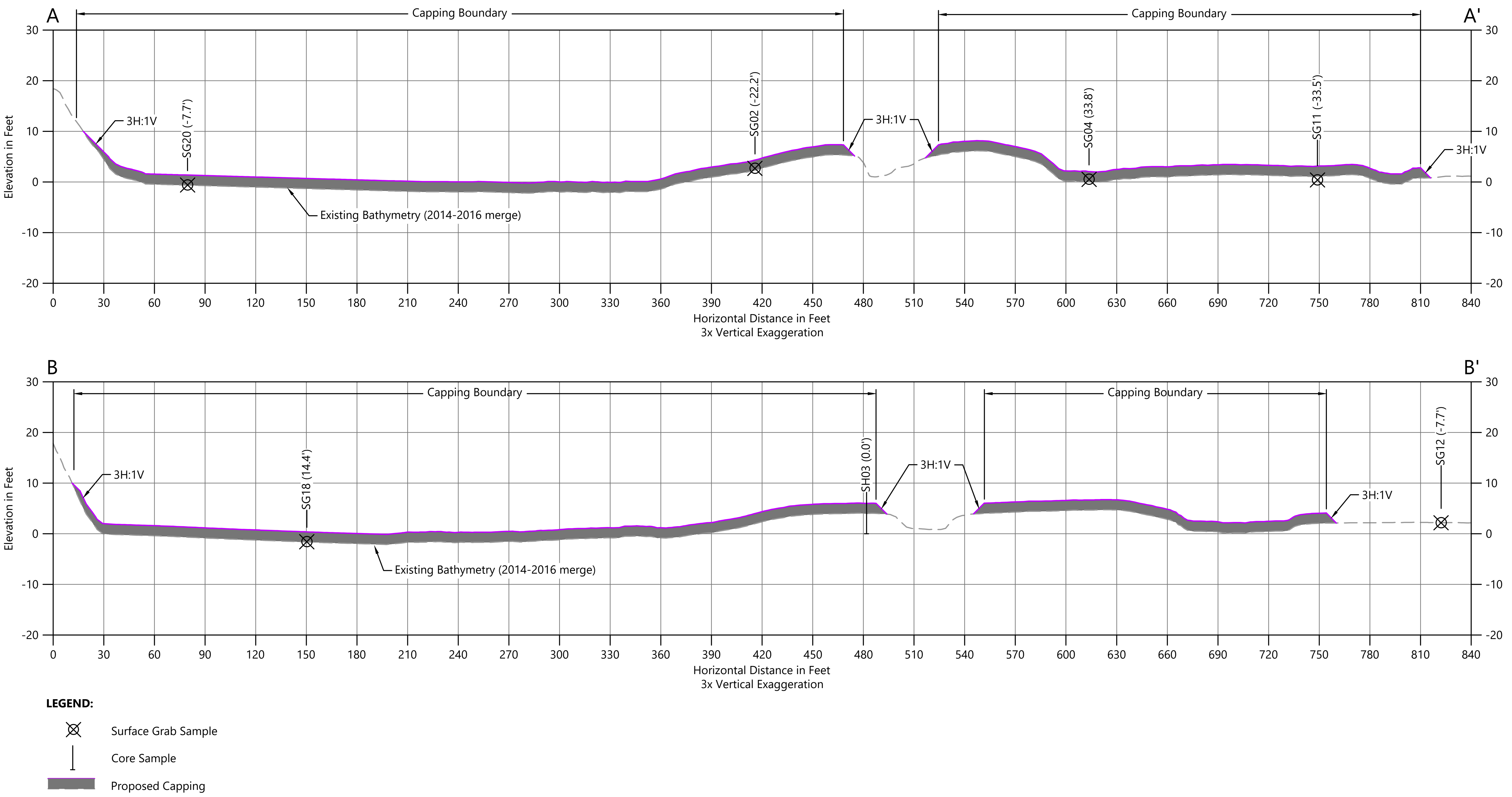
Figure 2-3
Capping Areas
Shelton Harbor Interim Action Engineering Basis of Design Report
Oakland Bay and Shelton Harbor Sediments Cleanup Site



NOTE:
The Cap design will be refined in subsequent design documents.

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Filepath: K:\Projects\0008-Simpson Timber Company\Shelton Harbor Sediment Remediation\0008-RP-002 Cross Sections.dwg Figure 2-4

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Figure 2-4
Cap Design Cross Section

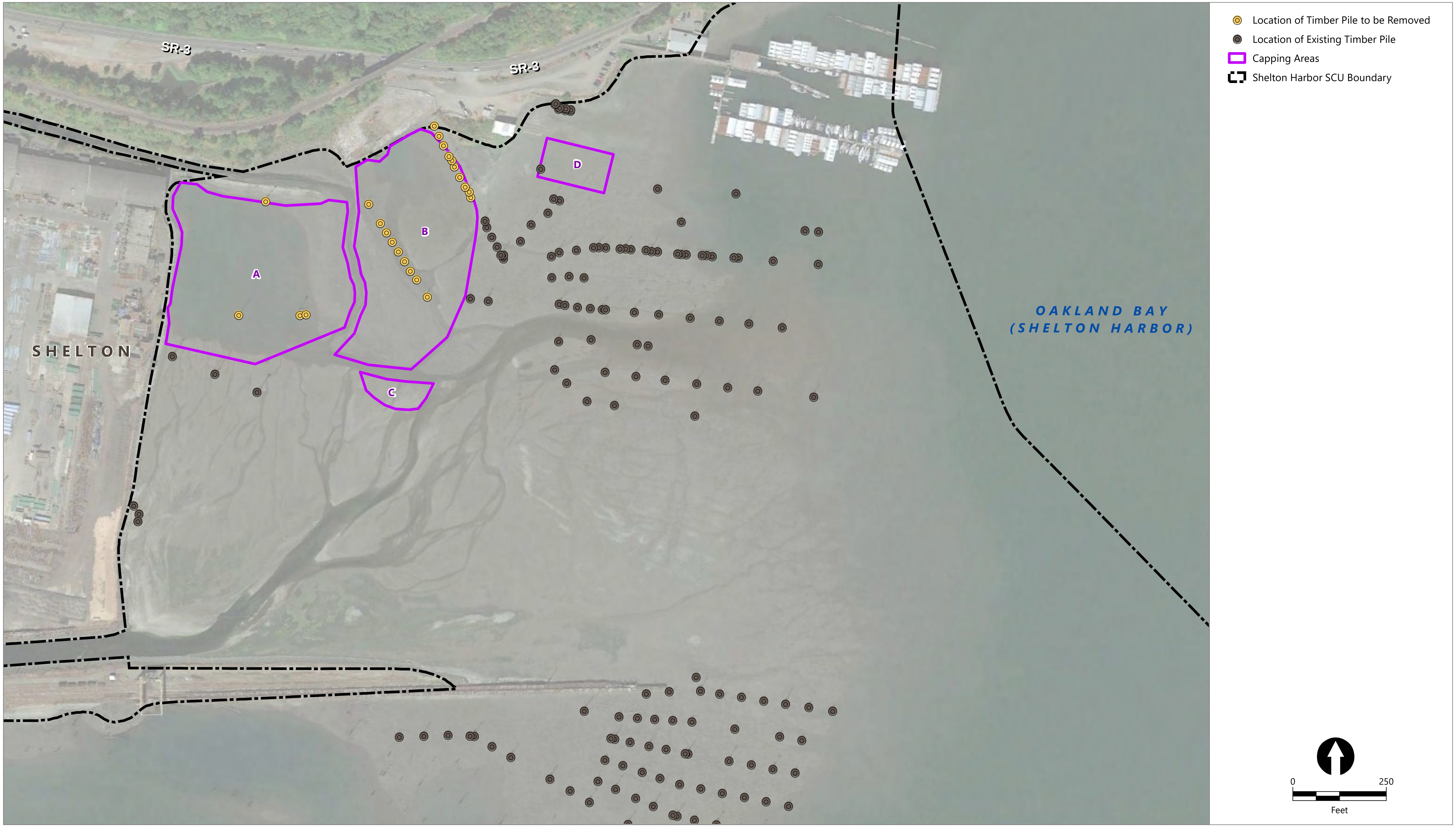

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Figure 4-1
Timber Pile Removal Areas
Shelton Harbor Interim Action Engineering Basis of Design Report
Oakland Bay and Shelton Harbor Sediments Cleanup Site

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Figure 4-2

Potential Construction Staging Areas

Shelton Harbor Interim Action Engineering Basis of Design Report
Oakland Bay and Shelton Harbor Sediments Cleanup Site

Appendix A*

Pre-Design Investigation Data Report

*Due to large file size, Appendix A is provided as a separate document

Appendix B

Geotechnical Evaluations

September 2018
Shelton Harbor Sediment Cleanup Unit
Oakland Bay and Shelton Harbor Sediments Cleanup Site (Cleanup Site ID: 13007)

Appendix B: Geotechnical Evaluation

Prepared for
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1 Introduction and Project Understanding

Simpson Timber Company (Simpson) will be addressing the cleanup of portions of the Shelton Harbor Sediment Cleanup Unit (SCU) within the Oakland Bay and Shelton Harbor Sediments Cleanup Site (Figure B-1). Currently, an Interim Action (IA) will be performed to partially address the overall cleanup action and expedite cleanup of northern Shelton Harbor in advance of the northern Oakland Bay Habitat Restoration Project (Anchor QEA 2017). The Oakland Bay Habitat Restoration Project is composed of the Squaxin Island Tribe, South Puget Sound Salmon Enhancement Group, Simpson, Port of Shelton, and other project partners. The project will address Shelton Harbor habitat impacts, with the objective of facilitating greater salmon runs.

The subject IA is composed of two areas referred to as Sediment Management Area (SMA)-1 and SMA-2 in the Shelton Harbor Interim Action Plan (Anchor QEA 2018). SMA-3 is an IA area located in southern Shelton Harbor, and will be addressed in future construction seasons. Discussion of explorations and testing done at locations within SMA-3 are included in this appendix, but no geotechnical evaluations were performed for SMA-3. The current IA is composed of sub-areas A, B, and C within SMA-1, and sub-area D, which is SMA-2. Please see Figure B-1.

This technical appendix describes geotechnical engineering field work and evaluations performed in support of the cleanup project. This appendix is a component of the Basis of Design Report (BODR) for the Shelton Harbor IA (Anchor QEA 2018) and describes analyses of project elements described elsewhere in the BODR. Analyses are based on geologic and geotechnical information generated during past site investigations in and nearby the project area, as well as recent field investigations conducted April 28 through May 2, 2018, in support of the remedial design (see main body and other appendices of the BODR).

The following geotechnical data and evaluations are described in this appendix:

- Geotechnical field investigation
- Generalized subsurface conditions
- Bearing capacity of subgrade
- Settlement and consolidation of subgrades due to cap placement

2 Field Investigation

The field investigation consisted of the following tasks:

- Collect sediment undrained shear strength data within SMA-1 and SMA-2 using the in situ vane shear test (VST).
- Drill 2 hollow-stem auger borings in the upland area of SMA-3.
- Collect 11 push cores.
- Collect representative soil samples for laboratory testing to support geotechnical engineering evaluations.

The locations of the geotechnical push cores, drilled borings, and VSTs are on Figure B-1. All depths discussed within this report are with respect to the ground surface/mudline at the time of drilling, testing, and coring, and elevations provided are in mean lower low water datum (MLLW).

2.1 Upland Geotechnical Borings

Anchor QEA advanced two soil borings in the upland area on April 25, 2018. The approximate exploration locations are noted on Figure B-2. The upland borings were drilled with hollow-stem augers, and standard penetration tests per ASTM International (ASTM) D1586 were performed at approximate 5-foot intervals using a standard split spoon sampler. Explorations were completed to depths of 40 feet below ground surface, and groundwater was encountered at elevations noted in Table 1. The borings are in an area where groundwater elevation is tidally influenced but is also subject to season fluctuation as well. Thus the data presented in Table 1 are considered a snapshot, and actual elevations are expected to vary.

Table 1
Groundwater Elevations in Upland Borings

Boring	Depth to Groundwater*, feet	Groundwater Elevation (MLLW), feet
SPT-01	15	19.4
SPT-02	12.5	19.7

Note:
*At time of drilling

During drilling, all soil cuttings and samples were observed by an Anchor QEA representative. Drilled explorations were backfilled by Anchor QEA's drilling subcontractor with bentonite chips. Soil cuttings and unused samples generated by drilling were collected by the drilling subcontractor in steel drums and disposed of by Simpson.

Field logs denoting visual classification and field notes were prepared for each exploration and are presented in Attachment B-1.

Subsamples from these explorations were collected to perform the following soil index tests:

- ASTM D854 Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D6913 Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- ASTM D7928 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

A general summary of the laboratory test results is in Attachment B-2.

2.2 Vane Shear Tests

Eleven VSTs were performed to measure undrained shear strength characteristics of the near-surface sediments within the three SMAs. Tests were conducted at approximately 1-foot intervals to depths of about 3 feet below the mudline or until refusal was encountered. VSTs were conducted in general accordance with ASTM D2573 Standard Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils.

The measured in situ shear strength values vary from 167 pounds per square foot (psf) to 439 psf for peak undrained shear strength, and 104 to 209 psf for residual shear strength. A summary of the test results is in Attachment B-1. These results were used for stability and bearing capacity analyses in Section 4.1 of this report.

2.3 Push Core Sampling and Consolidation Testing

Eleven push core samples were collected at approximately the same locations as the VSTs. The cores were sampled to depths ranging from 0.5 to 5.3 feet below the mudline, at which point refusal was met. Logs of the push cores are in Attachment B-1.

Subsamples from these push cores were collected to conduct laboratory characterization tests as noted in Section 2.1, as well as tests noted in the following list. Consolidation testing results are presented within the laboratory report in Attachment B-3. This information was used for subgrade settlement analysis presented in Section 4.2 of this report.

- ASTM D2974 Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D2435 Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading

2.4 Summary of Laboratory Results

Laboratory testing for the chemical and geotechnical samples was contracted through Analytical Resources, Incorporated, and geotechnical tests were performed by Materials Testing and Consulting, Inc., of Burlington, Washington. Sample processing and testing were done in general conformance with current ASTM standards. A summary of the results and the laboratory test report are in Attachment B-2 and Attachment B-3, respectively.

3 Generalized Subsurface Conditions

This section describes site subsurface conditions based on observations during the investigation as well as data collected by others in the general vicinity.

The bathymetry of Shelton Harbor is generally flat with a mounded rise between the A and B cap areas of SMA-1 (Figure B-1 and Figure B-3). The western slope of the Cap A area ranges from about 1.7 horizontal to 1 vertical (1.7H:1V) to 3H:1V.

The sediments sampled are sandy to very sandy silt with varying amounts of shells, gravel, and some areas of significant wood debris (SMA1-PC02A/B and SMA2-PC02). One push core (SMA2-PC02) encountered a layer of slightly sandy, silty gravel overlying the sandy silt. The underlying geologic unit within the project area is classified as "Vashon recessional outwash," which is a mixture of glacial outwash sand and gravel along with localized areas of silt, clay, and peat (Schasse et al. 2003; Herrera and Ecology 2010). This unit was encountered in the upland borings drilled in SMA-3.

4 Geotechnical Engineering Recommendations

4.1 Bearing Capacity of Cap Subgrades

As described in Section 3 of the BODR (Anchor QEA 2018), a granular cap of 24 to 36 inches in thickness (with an overplacement of up to 6 inches) will be placed over cap sub-areas A, B, C, and D (Figures B-1 and B-2).

Bearing capacity of the subgrade to support this cap was calculated assuming a mat foundation to model the cap surcharge (Das 1995), and assuming a uniform sediment layer. The presence of buried organics, including woody debris, was considered in the evaluation. Woody materials tend to increase the shear strength (and hence bearing capacity) of soils because of the random interlocking of woody fibers within the soil matrix. However, because wood can degrade over time, the shear strength that was used in this evaluation was not increased to account for the presence of woody material, and the evaluation assumed there was no presence of woody material.

The dimensions of the mat foundation are the same as the dimensions of the cap sub-areas A, B, C, and D (Anchor QEA 2018). The subgrade sediment layer thickness was conservatively assumed to be equal to the thickest recovered sediment layer from the push cores. This estimated thickness correlates with soil information noted in other reports (E3RA 2007; Herrera and Ecology 2010; Maul, Foster & Alongi 2007). The lowest recorded peak undrained shear strength value of 167 psf was used for the analysis; the allowable bearing capacity will be about 309 psf (q_{all}) with a factor of safety of 3. The evaluation of bearing capacity is provided in Attachment B-4.

4.2 Subgrade Consolidation Settlement

Select samples were subjected to one-dimensional consolidation tests to evaluate the compressibility of the subgrade sediment subjected to cap loads. A consolidation evaluation of the subgrade was done using information from the nearest representative geotechnical cores. Based on the most current bathymetric survey data and information from other sources (E3RA 2007; Herrera and Ecology 2010), the thickness of the compressible subgrade layer may be 5 to 5.3 feet. A thickness of 5.3 feet was used for evaluation. The potential degradation of buried organics, including woody debris, was not expressly evaluated in the consolidation settlement estimate because the degradation process is very slow and expected changes in sediment volume are expected to be negligible. Further, based on Anchor QEA's experience and observations from capping at other woody debris sites, organic degradation is not anticipated to materially change the surface elevation of the cap.

Based on the laboratory results and proposed cap design, consolidation may be about 12 inches. To estimate the time for consolidation to occur, time-rate information from consolidation tests was used along with a general assumption of single-drainage for the sediment layer. Time rate estimates were based on the maximum estimated consolidation and an average compressible soil layer thickness. It is estimated that 90% consolidation will be achieved a little over 30 days after cap placement. The evaluation is in Attachment B-5.

5 References

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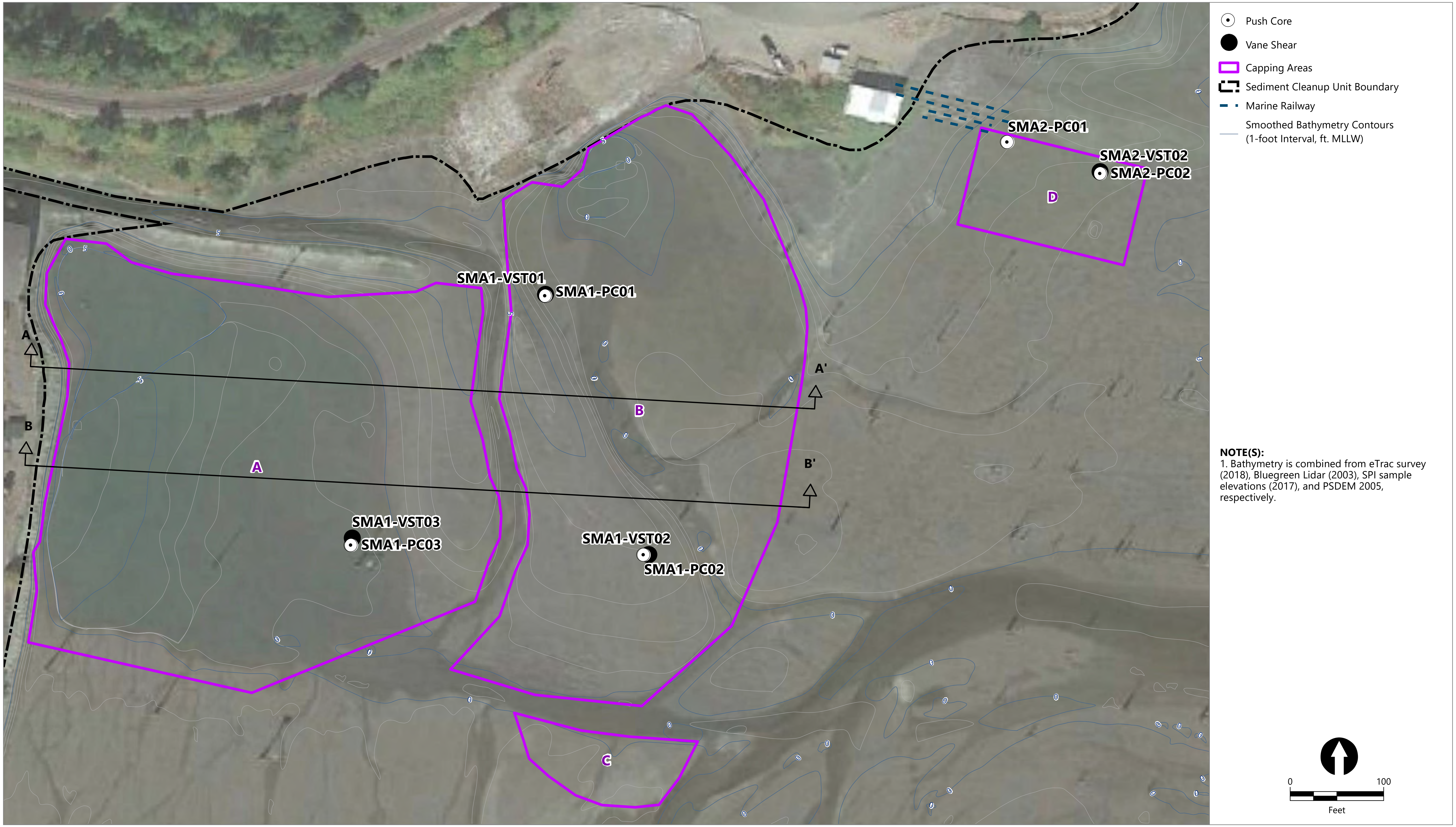
Maul, Foster & Alongi, 2007. Marina Bulkhead Replacement (Plans), Port of Shelton, Shelton, Washington. June 2007.

Schasse, H.W, Logan, R.L., Polenz, M., and T.J. Walsh, 2003. Geologic Map of the Shelton 7.5-minute Quadrangle, Mason and Thurston Counties, Washington. Washington Division of Geology and Earth Resource, Open File Report 2003-24. Washington State Department of Natural Resources. 2003.

Figures



NOTE(S):
1. Bathymetry is combined from eTrac survey (2018), Bluegreen Lidar (2003), SPI sample elevations (2017), and PSDEM 2005, respectively.

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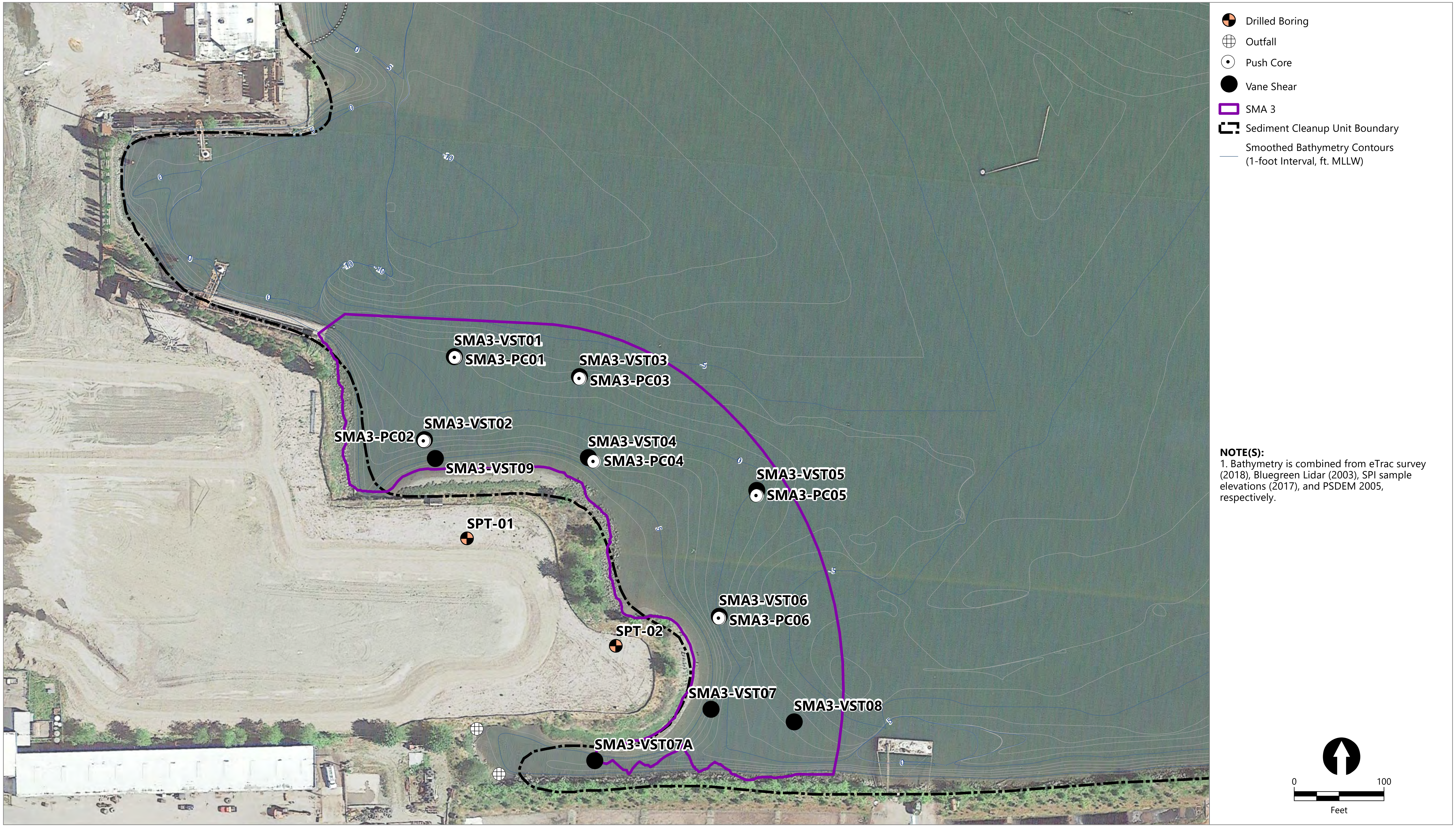
Figure B-1
Geotechnical Sample Locations for SMA-1 and SMA-2
Appendix B: Geotechnical Evaluation
Oakland Bay and Shelton Harbor Sediments Cleanup Site



NOTE(S):
1. Bathymetry is combined from eTrac survey (2018), Bluegreen Lidar (2003), SPI sample elevations (2017), and PSDEM 2005, respectively.

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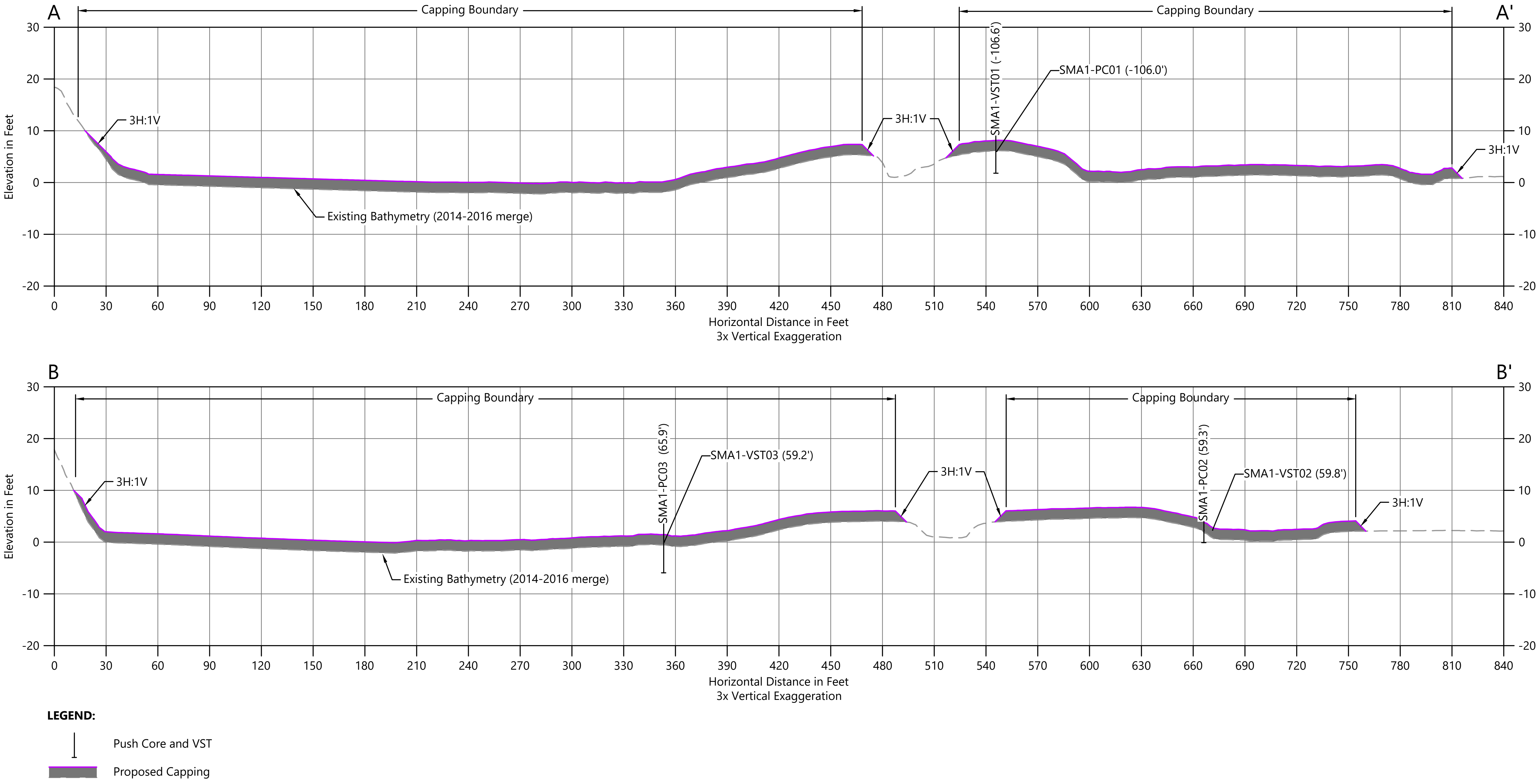
Figure B-2
Geotechnical Sample Locations for SMA-3
Appendix B: Geotechnical Evaluation
Oakland Bay and Shelton Harbor Sediments Cleanup Site



NOTE:
The Cap design will be refined in subsequent design documents.

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Filepath: K:\Projects\0008-Simpson Timber Company\Shelton Harbor Sediment Remediation\0008-RP-002 Cross Sections.dwg Figure B-3

Figure B-3
Cap Design Cross Section

Appendix B: Geotechnical Evaluation
Oakland Bay and Shelton Harbor Sediments Cleanup Site

Attachment B-1

Vane Shear Tests, Push Core Logs, and Drilled Boring Logs

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ANCHOR QEA

Vane Shear Log Form

Project: 110008-01.03
Location: Shelton Harbor, WA
Technician: J. Taylor
Date: 5/1/2018

Vane Diameter	Vane constant (α)
16mm (0.63")	2
20mm (0.78")	1
25.4mm (1")	0.5
65mm (2.56")	0.029

$S_U = \alpha \times$ Scale

Horizontal Datum:

	Test Location ID	Coordinates		Test Time	Water Depth in feet	Test Depth below Mudline in feet	Vane Diameter in mm	Vane Scale Reading in kPa	Undrained Shear Strength (S_U)		Test Type		Notes
		Easting	Northing						in kPa	in lbs/ft²	Peak [P] Residual [R]		
SMA-1	VST-02	47.212362	123.089334	845	11.8'	0.3		N/A	—	—	P	R	si SAND. No test
"	VST-01	47.213115	123.089815	940	9.1	1	25.4	16	8	167	[✓ P]	R	
						1		10	5	104	P	[✓ R]	
						2		34	17	355	[✓ P]	R	
						2		18	9	188	P	[✓ R]	
						2.7		42	21	439	[✓ P]	R	
						2.7		20	10	209	P	[✓ R]	
"	VST-03	47.212382	123.090613	1128	7.3	1	25.4	32	16	334	[✓ P]	R	
						1		14	7	146	P	[✓ R]	
						2		30	15	313	[✓ P]	R	
						2		18	9	188	P	[✓ R]	
						2.7		34	17	355	[✓ P]	R	
						2.7		14	7	146	P	[✓ R]	
SMA-3	VST-06	47.206758	123.09265	1329	1.8	1	25.4	12	6	125	[✓ P]	R	
						1		8	4	84	P	[✓ R]	
						2		22	11	230	[✓ P]	R	
						2		6	3	63	P	[✓ R]	
						2.7		38	19	399	[✓ P]	R	
						2.7		6	3	63	P	[✓ R]	
"	VST-03			1411	2.9	1	25.4	12	6	125	[✓ P]	R	
						1	/	10	5	104	P	[✓ R]	

Note - 1 kPa = 20.89 psf

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Vane Shear Log Form

Project: 110008-01.03
Location: Shelton Harbor, WA
Technician: J. TAYLOR
Date: 5/1/18

Vane Diameter	Vane constant (α)
16mm (0.63")	2
20mm (0.78")	1
25.4mm (1")	0.5
65mm (2.56")	0.029

$S_U = \alpha \times$ Scale

ANCHOR QEA

Horizontal Datum:

	Test Location ID	Coordinates		Test Time	Water Depth in feet	Test Depth below Mudline in feet	Vane Diameter in mm	Vane Scale Reading in kPa	Undrained Shear Strength (S_U)		Test Type	Notes
		Easting	Northing						in kPa	in lbs/ft^2	Peak [P] Residual [R]	
SMA-3	VST-03			1411	2.9	2	25.4	12	6	125	[✓ P] R	
						2		4	2	42	P [✓ R]	
						3		20	10	209	[✓ P] R	
						3		10	5	104	P [✓ R]	
	VST-01			1440		1	25.4	12	6	125	[✓ P] R	
						1		8	4	84	P [✓ R]	
						2		12	6	125	[✓ P] R	
						2		6	3	63	P [✓ R]	
						3.5		20	10	209	[✓ P] R	
						3.5		10	5	104	P [✓ R]	
	VST-08			1519	1.2	~~4.24~~ 1	25.4	22	11	230	[✓ P] R	
						1		10	5	104	P [✓ R]	
						2		18	9	188	[✓ P] R	
						2		8	4	84	P [✓ R]	
						2.5		40	20	418	[✓ P] R	
						2.5		12	6	125	P [✓ R]	
MA-2	VST-01			1630				N/A	—	—	P R	No reading. gravel, shells etc.
											P R	
											P R	
											P R	
											P R	

Note - 1 kPa = 20.89 psf

Vane Shear Log Form

Project: 110008-01.03

Location: Shelton Harbor, WA

Technician: J. Taylor

Date: 5/2/18

Vane Diameter	Vane constant (α)
16mm (0.63")	2
20mm (0.78")	1
25.4mm (1")	0.5
65mm (2.56")	0.029

page 1/1

$S_U = \alpha \times \text{Scale}$

ANCHOR QEA

Horizontal Datum:

	Test Location ID	Coordinates		Test Time	Water Depth in feet	Test Depth below Mudline in feet	Vane Diameter in mm	Vane Scale Reading in kPa	Undrained Shear Strength (S_U)		Test Type Peak [P] Residual [R]		Notes	
		Easting	Northing						in kPa	in lbs/ft²				
SMA-3	VST-07			848	8.3	0.5		N/A	—	—	P	R	granular soil /	
	VST-07A			900	8.0	N/A		N/A	—	—	P	R	no penetration, granular	
	VST-04			924	7.7	/		N/A	—	—	P	R	unable to penetrate, granular	
	VST-02			1021	8.5	/		N/A	—	—	P	R	" " "	"
	VST-~~04~~ 09			1030	3.5	/		N/A	—	—	P	R	" "	"
~~SMA6~~	VST-~~04~~ 05			1042	8.8	/		N/A	—	—	P	R	" "	"
SMA-2	VST-02			1150	4.3	/		N/A	—	—	P	R	" "	"
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		
											P	R		

Note - 1 kPa = 20.89 psf

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor
Job No. 110008-01.03
No. of Sections: 1
Drive Length:
Recovery: 4.125'
% Recovery:
Notes:

Station ID: PDI-SMA1-PC01
Date/Time: 5/2/18
Core Logged By: JCT 5/2/18
Attempt #: push
Type of Core ☑ ~~Mudmole~~ ☐ Vibracore ☐ Diver Core
Diameter of Core (inches) 3 (OD)
Core Quality ☐ Good ☑ Fair ☐ Poor ☑ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	Classification and Remarks (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
1 2 3 4				dk.gray vsiS - fine sandy Si mottled coloring (black) to 1.25', some 1.25' discontinuous "pockets" of seperation/voids noted @ 1.25' black mottling not noted @ 2' continuous seperation of sample, and discontinuous pockets/voids noted from this depth to bottom of core Bottom @ 4.125'			dark gray and black (mottled) sandy SILT (MH-OH). Mottling grades out at 1.25ft bml.	

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: 110008-01.03
Job No.
No. of Sections: 1/2
Drive Length:
Recovery: A => 2.4' ; B => 1.8'
% Recovery:
Notes:

Station ID: SMA1-PC02A / B
Date/Time:
Core Logged By: JCT 5/2/18
Attempt #:
Type of Core ☒ ~~Mudmole~~ push ☐ Vibracore ☐ Diver Core
Diameter of Core (inches) 3 (OD)
Core Quality ☐ Good ☒ Fair ☐ Poor ☒ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
				dk gray w/ blk mottling, vsi fine S - fine sandy SILT w/ some wood pieces				
				0.75' @ : blk mottling grades out				
1								
				1.6'				
2				reddish wood debris possibly intermixed w/ siS - sSi				
3				2.4' Bottom of sample				
				* note: there was a ~0.5' void within the core. PC02A is above the void PC02B is below the void				

dark gray and black (mottled) sandy organic SILT (OH) with some wood pieces noted. Mottling grades out at 0.75ft bml.

@ 1.6ft bml becomes gravelly and significant increase in wood debris

38.4% organics

Sediment Core Processing Log

ANCHOR QEA

Job: 110008-01.03 5
Job No. Shelton
No. of Sections: 2/2
Drive Length:
Recovery: 1.8'
% Recovery:
Notes:

Station ID: SMA1-PC02B
Date/Time:
Core Logged By: JGT 5/2/18
Attempt #: push
Type of Core ☒ Mudmole ☐ Vibracore ☐ Diver Core
Diameter of Core (inches) 3 (OD)
Core Quality ☐ Good ☒ Fair ☒ Poor ☒ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
				gray w/ blk mottling vsi, fines - fine sandy SI w/ ~1.5" fine sand intrusion (mixing?)				
				0.5 @ 0.5' blk mottling grades out				
				1 @ 1' significant wood debris noted				
				Bottom of sample 1.8'				
				* see note on SMA1-PC02A				

gray and black (mottled) sandy SILT (MH). Mottling grades out at 0.5ft bml. Significant wood debris noted from 1 ft bml to BOH.

42.8% organics

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor

Job No. 110008-01.03

No. of Sections:

Drive Length: 5.3'

Recovery:

% Recovery:

Notes:

Station ID: PDI-SMA1-PC03

Date/Time:

Core Logged By: JZT 5/2/18

Attempt #:

Type of Core ☒ ~~Mudmole~~ Push ☐ Vibracore ☐ Diver Core

Diameter of Core (inches) 3(OD)

Core Quality ☐ Good ☒ Fair ☐ Poor ☒ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	Classification and Remarks (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
				very dk gray/black w/ gray mottling v. si, fine S – fine sandy SILT			dark gray and black mottled slighty sandy SILT (MH), grading to gray at 3.2ft bml.	
1								
2								
3				3.2' @ 3.2' color grades to gray and some discontinuous pockets noted				
4								
5				BoS 5.3' ↑ sample				
6								

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor

Job No. 110008-01.03

No. of Sections:

Drive Length:

Recovery: ~1' (grab)

% Recovery:

Notes:

Station ID: SMA2-PC01 (grab)

Date/Time: 5/2/18

Core Logged By: JLT 5/2/18

Attempt #: push

Type of Core ☑ ~~Mudmole~~ ☐ Vibracore ☐ Diver Core

Diameter of Core (inches)

Core Quality ☐ Good ☐ Fair ☑ Poor ☑ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
	0		0.5'	gray, sl. sandy, clayey SI - si C w/ gravel & poss shells noted				

gray very sandy SILT (MH) with shells

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor
Job No. 160008-01.03
No. of Sections:
Drive Length: 3.1'
Recovery:
% Recovery:
Notes:

Station ID: SMA2-PC02
Date/Time:
Core Logged By: JCT 5/2/18
Attempt #:
Type of Core ☒ ~~Mudmole~~ push ☐ Vibracore ☐ Diver Core
Diameter of Core (inches) 3 (OD)
Core Quality ☐ Good ☒ Fair ☐ Poor ☒ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	covered ngth (ft)	PID	ample	Summary Sketch
		0.5'	grav	fine sand grading to gray & blk v.si fine S - fine sandy SILT	gray and black, slightly sandy, silty GRAVEL			
1				1.3' significant wood debris (~50%-70%) intermixed w/ gray vsiS - sSi			gravelly, sandy SILT (MH) with significant wood debris	
2				32% organics				
3				3.1' Bottom of sample				

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor
Job No. 110008-01.03
No. of Sections:
Drive Length: /
Recovery: 4.5'
% Recovery:
Notes:

Station ID: PDI-SMA3-PC01
Date/Time:
Core Logged By: JCH 5/2/18
Attempt #: push
Type of Core ☒ Mudmole ☐ Vibracore ☐ Diver Core
Diameter of Core (inches) 3 (OD)
Core Quality ☐ Good ☒ Fair ☐ Poor ☐ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	Classification and Remarks (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
1 2 3 4 5				blk/dk gray vsi, fine S - fines SiLT pocket (continuous) @ 1.2' 1.8' @ 1.8' becomes gray (no blk) & some voids noted 3.5' (continuous pocket) 4.5' Bottom of sample			dk gray and black. very sandy to sandy SILT. @ grades to gray 1.8ft bml	

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor
Job No. 110008-01.03
No. of Sections:
Drive Length:
Recovery: 1.2'
% Recovery:
Notes:

Station ID: SMA3-PC02
Date/Time: 5/2/18
Core Logged By: JCH 5/2/18
Attempt #:
Type of Core ☑ ~~Mudmole~~ push ☐ Vibracore ☐ Diver Core
Diameter of Core (inches) 3 (OD)
Core Quality ☐ Good ☑ Fair ☐ Poor ☑ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
				Brown, si fine SAND				
1				BOH 1.2'				

brown, very sandy GRAVEL

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor

Job No. 110008-01.03

No. of Sections:

Drive Length: 5.4'

Recovery:

% Recovery:

Notes:

Station ID: SMA3-PC03

Date/Time: 5/2/18

Core Logged By: JCT 5/2/18

Attempt #:

Type of Core ☑ ~~Mudmole~~ push ☐ Vibracore ☐ Diver Core

Diameter of Core (inches) 3 (OD)

Core Quality ☐ Good ☐ Fair ☐ Poor ☑ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
				dk gray/blk vsi, fine S - fine sandy Si				
1								
				1.75 @ 1.75' grades to gray & a continuous pocket/void noted				
2								
				2.7' @ 2.7' continuous pocket/void noted. Discrete voids noted to BOH			dark gray and black, slightly sandy SILT (MH)	
3								
4								
5								
				BOH 5.4'				
6								

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor
Job No. 110008-01.03
No. of Sections:
Drive Length:
Recovery: 2.2'
% Recovery:
Notes:

Station ID: SMA3-PC04
Date/Time:
Core Logged By: JCT 5/2/18
Attempt #:
Type of Core ☑ ~~Mudmole~~ Push ☐ Vibracore ☐ Diver Core
Diameter of Core (inches) 3 (OD)
Core Quality ☐ Good ☑ Fair ☐ Poor ☑ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	Classification and Remarks (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
				brown/gray vsi fine S	brown and gray, silty, very gravelly SAND			
1								
				@1.6' continuous void/pocket noted				
2				A 2.17' (or 2.2') Bolt				
3								

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor

Job No. 110008-01.03

No. of Sections:

Drive Length:

Recovery: 3.54'

% Recovery:

Notes:

Station ID: SMA3-PC05

Date/Time:

Core Logged By: JCG 5/2/18

Attempt #:

Type of Core ☑ ~~Mudmole~~ push ☐ Vibracore ☐ Diver Core

Diameter of Core (inches) 3 (OD)

Core Quality ☐ Good ☑ Fair ☐ Poor ☑ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	Classification and Remarks (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
				dk gray, fine sandy SILT w/ discontinuous voids/pockets throughout				
1				from 0.8'-1.3' color turns gray-black				
2								
3				BOTH 3.5'				
4								

dark gray, sandy to very sandy SILT (MH) gading to gray/black @ 0.8ft to 1.3 ft bml.

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

Job: Shelton Harbor
Job No. 110008-01.03
No. of Sections:
Drive Length:
Recovery: 2.1'
% Recovery:
Notes:

Station ID: SMA-PC06 #1
Date/Time:
Core Logged By: JCT 5/2/18
Attempt #: push
Type of Core ☑ ~~Mudmole~~ ☐ Vibracore ☐ Diver Core
Diameter of Core (inches) 3 (OD)
Core Quality ☐ Good ☑ Fair ☐ Poor ☑ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
				dk gray / blk sandy fine ~~&~~ SiLt				
1				dark gray and black sandy, very silty GRAVEL				
2				2.1' BOH				
3								

Page 1 of 1

Sediment Core Processing Log

ANCHOR QEA

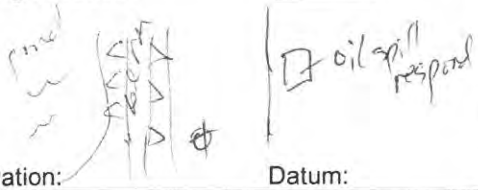
Job: Shelton Harbor
Job No. 110008-01.03
No. of Sections:
Drive Length:
Recovery: 1.1'
% Recovery:
Notes:

Station ID: SMA3-PC06 #2
Date/Time:
Core Logged By: JCT, 5/2/18
Attempt #: Push
Type of Core ☑ Mudmole ☐ Vibracore ☐ Diver Core
Diameter of Core (inches) 3 (OD)
Core Quality ☐ Good ☑ Fair ☐ Poor ☑ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch
1 2				Brown sSi w/ discrete voids/pockets @ BOH 1.1' brown, silty, sandy GRAVEL				

Page 1 of 1

Boring Location:



Elevation:
Datum:

Boring SP-01
Date 4/25/~~18~~18
Sheet 1 of 2
Job Shelton Harbor
Job No. 110008-01103
Logged By JCT
Weather Sunny, 80s
Drilled By Holocene
Drill Type/ Method HSA
Sampling Method SPT
Bottom of Boring
GW (ATD) 15'
Hammer Eff. (%)
Penetration Sampler SS

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	SAMPLE Type	SAMPLE Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrag, slag, etc.
						0		16" recovery brn
						1		8" moist, sl.gS w/ bark, shell pieces, roots over 8" brn, moist, sl.si/no si,
						2		~~f-g~~ g-S (f-m) sl.g S (MC)
						3		
				S	1	*	8	12" recovery
						4	10	brn, moist-wet, sl.si, sl.g-g S
							14	(gravel to 1.25") (MC & GSD)
						5		
						6		
						7		poorly graded Gravel wth silt and sand
						8		
				S	2	*	8	
						9	22	
							17	
						10		
						11		
						12		2" gravel over 2" sandy
						13		dk gray, wet, sl.s Silt w/ slight HC odor
				S	3	*	1	~~[illegible]~~ (4" recovery) (MC)
						14	1	
							1	
						15		∇ ATD
						16		
						17		
						18		12" 9" recovery (MC & GSD)
				S	4	*	4	wet, brn coarse S grading
						19	15	to f-MG over 3" sl.si, sG-gS
							14	
						20		

Notes: START 1140

ANCHOR QEA

Boring Location:

Elevation: Datum:

Boring SPT-01 Date 4/25/18 Sheet 2 of 2
Job Shelton Harbor Job No. 110008-01.03
Logged By JCT Weather Sunny, 80s
Drilled By Holocene
Drill Type/ Method HSA
Sampling Method SPT
Bottom of Boring
GW (ATD) 15'
Hammer Eff. (%)
Penetration Sampler SS

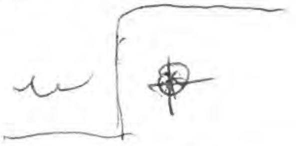
SIZE (%) G Max.	SIZE (%) S Range	SIZE (%) F Att. Limits	PID or other	SAMPLE Type	SAMPLE Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrag, slag, etc.
						20		
						21		
						22		11" recovery
				S	5	23	3 7 10	4" wet, brn med S over ~~4~~ 4" , brn, wet med G over ~~3"~~ 3" brn, wet, sl. si, SG (mc, GSD)
						24		
						25		well-graded SAND with gravel
						26		
						27		
						28		10" recovery
				S	6	29	4 14 14	wet, brn, f-m S grading to ~~wet~~ sl. s, med G. (small wood fiber noted) (mc & GSD)
						30		
						31		
						32		
				S	7	33	5 7 14	wet, brn, med S (mc, gsd)
						34		
						35		
						36		
						37		
				S	8	38	4 9 13	wet, brn, med S to sl. si, med S (mc)
						39		
						40		

Notes:

BOH 1240
Break 1240-
Backfill

ANCHOR QEA

Boring Location:



Elevation: Datum:

Boring SPT-02 Date 4/25/18 Sheet 1 of 2
Job Shelton Harbor Job No. 110008-01.03
Logged By JCT Weather sunny, low 80s
Drilled By Holocene
Drill Type/ Method HSA
Sampling Method SPT
Bottom of Boring
GW (ATD) 12.5'
Hammer Eff. (%)
Penetration Sampler SS

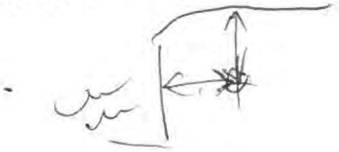
SIZE (%)			PID or other	SAMPLE		SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrag, slag, etc.
G	S	F		Type	Number			
Max.	Range	Att. Limits						
						0		4" dk.brn sl.si S (topsoil) w/ bark/wood over 5" dk.brn. sl.g, sl.si S (moist) over 3" gray, dry sl.g S over dk.gray sl.s S w/bark (mc)
						1		
						2		
						3		
				S	1	* 4	9 8 5	
						5		silty SAND with gravel
						6		
						7		
						8		4" dk.brn, moist, sl.g-s, sl.c, S over dk.gray. moist, gS (gsP, mc)
				S	2	* 9	5 9 10	
						10		
						11		
						12		∇ ATD
						13		
				S	3	* 14	4 4 5	4" recovery, wet, sl.s-s G (mc)(g~~rad~~)
						15		
						16		
						17		well-graded GRAVEL with sand
						18		
				S	4	* 19	10 15	8", wet, dk.gray, gS-sG over (mc)
						20	17	4" brn, wet, sl~~.si G~~ sl.S, sG-gS grad)

Notes:

START 0945

ANCHOR
QEA

Boring Location:



Elevation: Datum:

Boring SPT-02 Date 4/25/18

Sheet 2 of ~~2~~ 2

Job

Job No. 110008-01.03

Logged By JCT

Weather sunny, 80s

Drilled By Holocene

Drill Type/ Method HSA

Sampling Method SPT

Bottom of Boring

GW (ATD) 12.5'

Hammer Eff. (%)

Penetration Sampler SS

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	SAMPLE Type	Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrag, slag, etc.
						20		
						21		
						22		
						23		
				S	5	24	18 19 27	wet, dk brn, sl.g - g (fine g) S (mc) w/ poss. roots or fine bark & gravel in toe
						25		
						26		
						27		well-graded SAND with gravel
						28		
				S	6	29	15 16 17	10" wet, dk brn/gray med S grading to wet gray ~~Ad~~ f-m sG (mc grad)
						30		
						31		
						32		
						33		
				S	7	34	7 17 19	~~8"~~ 2" wet, dark brn, med S over 6" wet, brn, sl. S - sG (mc, ~~grad~~)
						35		
						36		well-graded SAND with gravel
						37		
						38		
				S	8	39	11 44 16	10" recovery 4" wet, dk ~~d~~brn, f-m S grading to sandy, f-m G (mc, grad)
						40		

Notes:

STOP 1052 BOH 40'

CLEANUP 1052 - 1115

ANCHOR QEA

Attachment B-2

Laboratory Results of Index Tests

Attachment B-2
Laboratory Results of Index Tests

Exploration	Sample Depth (feet)	Description	Percent Passing #200 Sieve (%)	Specific Gravity	Organic Content (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index
SMA1-PC01	0–2	sandy silt	75.4	2.39	—	127	86	56.6	29.5
SMA1-PC01	2–4.125	—	—	—	—	108.7	—	—	—
SMA1-PC02A	0–1.5	sandy silt	72.6	—	—	113.1	76.1	58.5	17.6
SMA1-PC02A	1.6–2.4	gravelly, sandy silt with wood debris	50.0	—	38.4	121.3	—	—	—
SMA1-PC02B	0.5–1	sandy silt	78.2	2.32		100.8	77.1	56.6	20.5
SMA1-PC02B	1–1.8	sandy silt with wood debris	53.2	—	42.8	114.7	—	—	—
SMA1-PC03	0–2	—	—	—	—	111.5	—	—	—
SMA1-PC03	2–5.3	slightly sandy silt	90.1	2.53	—	133.4	85	56.2	28.8
SMA2-PC01 (grab)	0–0.5	very sandy silt	66.7	2.59	—	99.2	55.5	39.2	16.3
SMA2-PC02	0–0.5	slightly sandy, silty gravel	22.8	—	—	117.5	—	—	—
SMA2-PC02	0.5–1.25	gravelly, sandy silt	63.8	—	—	111.3	64.8	41.2	23.5
SMA2-PC02	1.25–2	gravelly, sandy silt with wood debris	41.5	—	32.0	88.0	—	—	—
SMA3-PC01	0–1.8	—	—	—	—	193.9	—	—	—
SMA3-PC01	1.8–3	very sandy silt	67.2	2.14	—	192.3	95.8	79.9	15.8
SMA3-PC01	3–4.5	sandy silt	79.8	—	—	144.6	82.1	58.3	23.8
SMA3-PC02	0–1.2	very sandy gravel	3.6	2.7	—	17.2	—	—	—
SMA3-PC03	0–1.7	—	—	—	—	148.6	—	—	—
SMA3-PC03	1.7–5.4	slightly sandy silt	87.8	2.45	—	120.2	61.8	46.4	15.4
SMA3-PC04	0–1	very gravelly, silty sand	15.5	2.64	—	29.0	—	—	—
SMA3-PC04	1–2.2	very gravelly, silty sand	16.6	2.66	—	40.2	—	—	—
SMA3-PC05	0–0.8	very sandy silt	67.8	2.25	—	158.4	78.8	56.7	22.1
SMA3-PC05	0.8–1.25	sandy silt	73.2	2.21	—	161.4	80.8	57.9	22.9
SMA3-PC05	1.25–3.5	—	—	—	—	128.7	—	—	—
SMA3-PC06 (Top #1)*	0–2.1	very silty, sandy gravel	36.9	—	—	99.6	79.2	56.1	23.0

Attachment B-2
Laboratory Results of Index Tests

Exploration	Sample Depth (feet)	Description	Percent Passing #200 Sieve (%)	Specific Gravity	Organic Content (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index
SMA3-PC06 (Top #2)*	2.1 – 3.2	silty, sandy gravel	14.8	2.46	—	34.4	—	—	—
SPT01-S1	—	—	—	—	—	9.7	—	—	—
SPT01-S2	—	poorly graded gravel with silt and sand	7.3	—	—	18.1	—	—	—
SPT01-S3	—	—	—	—	—	54.0	—	—	—
SPT01-S4	—	—	**	—	—	14.2	—	—	—
SPT01-S5	—	well-graded sand with gravel	2.6	—	—	19.6	—	—	—
SPT01-S6	—	well-graded sand with gravel	2.1	—	—	16.9	—	—	—
SPT01-S7	—	—	**	—	—	26.7	—	—	—
SPT01-S8	—	—	—	—	—	20.6	—	—	—
SPT02-S1	—	—	—	—	—	59.4	—	—	—
SPT02-S2	—	silty sand with gravel	12.5	—	—	15.3	—	—	—
SPT02-S3	—	—	—	—	—	25.9	—	—	—
SPT02-S4	—	well-graded gravel with sand	4.5	—	—	27.3	—	—	—
SPT02-S5	—	—	—	—	—	18.3	—	—	—
SPT02-S6	—	well-graded sand with gravel	4.3	—	—	14.4	—	—	—
SPT02-S7	—	—	—	—	—	21.3	—	—	—
SPT02-S8	—	well-graded sand with gravel	3.1	—	—	17.9	—	—	—

Notes:
*These samples are the top and bottom portions of a core that had a large void separating the two sample portions
**: results are pending
PC: Push Core Sample
SPT: Drilled Boring Sample

Attachment B-3

Laboratory Reports

Analytical Resources, Incorporated
Analytical Chemists and Consultants

19 July 2018

Cheronne Oreiro
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101

RE: Simpson Shelton Harbor

Please find enclosed sample receipt documentation and analytical results for samples from the project referenced above.

Sample analyses were performed according to ARI's Quality Assurance Plan and any provided project specific Quality Assurance Plan. Each analytical section of this report has been approved and reviewed by an analytical peer, the appropriate Laboratory Supervisor or qualified substitute, and a technical reviewer.

Should you have any questions or problems, please feel free to contact us at your convenience.

Associated Work Order(s)	Associated SDG ID(s)
18E0251	N/A

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed in the enclose Narrative. ARI, an accredited laboratory, certifies that the report results for which ARI is accredited meets all the requirements of the accrediting body. A list of certified analyses, accreditations, and expiration dates is included in this report.

Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his/her designee, as verified by the following signature.

Analytical Resources, Inc.

Cert# 100006

PJLA Testing
Accreditation # 66169

18E0251

Chain of Custody Record and Laboratory Analysis Request COC#

ANCHOR QEA

Date: 5/9/2018
Laboratory : ARI
Project Name: Shelton Harbor Remediation
Project Number: 110008-01.03
Project Contact: Cheronne Oreiro
Phone Number: (206) 287-9130
Shipment Method: Courier

					Sediment and Field QC							
Line	**Field Sample ID**	**Collection Date/Time**	**Matrix**	**No. of Containers**	**Moisture content**	**Plasticity Indices**	**Grain Size Distribution**	**Loss on Ignition**	**Specific Gravity**	**1-D Consolidation**	**Unconfined Undrained triaxial**	**Comments**
1	**PDI-SMA1-PC01-0-2-180502**	5/2/2018 - 1120	SE		x	x	x		x			
2	**PDI-SMA1-PC01-2-bottom-180502**	5/2/2018 - 1120	SE		x					x		
3	**PDI-SMA1-PC02A-0-1.5-180501**	5/1/2018 - 0755	SE		x	x	x					
4	**PDI-SMA1-PC02A-1.6-bottom-180501**	5/1/2018 - 0755	SE		x		x	x				
5	**PDI-SMA1-PC02B-0.5-1-180501**	5/1/2018 - 0755	SE		x	x	x		x			
6	**PDI-SMA1-PC02B-1-bottom-180501**	5/1/2018 - 0755	SE		x		x	x				
7	**PDI-SMA1-PC03-0-2-180501**	5/1/2018 - 1100	SE		x					x		
8	**PDI-SMA1-PC03-2-bottom-180501**	5/1/2018 - 1100	SE		x	x	x		x			
9	**PDI-SMA2-PC01-0-bottom-180502**	5/2/2018 - 1120	SE		x	x	x		x			
10	**PDI-SMA2-PC02-0-0.5-180502**	5/2/2018 - 1100	SE		x		x					
11	**PDI-SMA2-PC02-0.5-1.25-180502**	5/2/2018 - 1100	SE		x	x	x					
12	**PDI-SMA2-PC02-1.25-2-180502**	5/2/2018 - 1100	SE		x		x	x				
13	**PDI-SMA3-PC01-0-1.8-180501**	5/1/2018 - 1430	SE		x					x		
14	**PDI-SMA3-PC01-1.8-3-180501**	5/1/2018 - 1430	SE		x	x	x		x			
15	**PDI-SMA3-PC01-3-bottom-180501**	5/1/2018 - 1430	SE		x	x	x					

1 See project SQAPP for analyte lists and test methods

2 Email sample confirmation report to labdata@anchorqea.com

Additional notes/comments:

Relinquished By:	Company: Anchor QEA LLC.	Received By:	Company:
Signature/Printed Name	Date/Time	Signature/Printed Name	Date/Time
Relinquished By:	Company:	Received By:	Company:
Signature/Printed Name	Date/Time	Signature/Printed Name	Date/Time

Distribution: A copy will be made for the laboratory and client. The Project file will retain the original.

Page ______ of _____

18E0251

Chain of Custody Record and Laboratory Analysis Request

COC#

ANCHOR QEA

Date: 5/9/2018
Laboratory : ARI
Project Name: Shelton Harbor Remediation
Project Number: 110008-01.03
Project Contact: Cheronne Oreiro
Phone Number: (206) 287-9130
Shipment Method: Courier

Line	Field Sample ID	Collection Date/Time	Matrix	No. of Containers	Sediment and Field QC																		Comments
					Moisture content	Plasticity Indices	Grain Size Distribution	Loss on Ignition	Specific Gravity	1-D Consolidation	Unconfined Undrained triaxial												
1	PDI-SMA3-PC02-0-1.2-180502	5/2/2018 - 1010	SE		x		x		x														
2	PDI-SMA3-PC03-0-1.7-180501	5/1/2018 - 1400	SE		x					x													
3	PDI-SMA3-PC03-1.7-bottom-180501	5/1/2018 - 1400	SE		x	x	x		x														
4	PDI-SMA3-PC04-0-1-180430	4/30/2018 - 1300	SE		x		x		x														
5	PDI-SMA3-PC04-1-bottom-180430	4/30/2018 - 1300	SE		x	x	x		x														
6	PDI-SMA3-PC05-0-0.8-180430	4/30/2018 - 1150	SE		x	x	x		x														
7	PDI-SMA3-PC05-0.8-1.25-180430	4/30/2018 - 1150	SE		x	x	x		x														
8	PDI-SMA3-PC05-1.25-bottom-180430	4/30/2018 - 1150	SE		x					x													
9	PDI-SMA3-PC06-TOP-0-bottom-180501	5/1/2018 1300	SE		x	x	x			x													Core is labeled PDI-SMA3-PC06 #1
10	PDI-SMA3-PC06-BOT-0-bottom-180501	5/1/2018 1300	SE		x	x	x		x														Core is labeled PDI-SMA3-PC06 #2
11			SE																				
12			SE																				
13			SE																				
14			SE																				
15			SE																				

1 See project SQAPP for analyte lists and test methods

2 Email sample confirmation report to labdata@anchorqea.com

Additional notes/comments:

Relinquished By: Company: Anchor QEA LLC.
Signature/Printed Name Date/Time

Received By: Company:
Signature/Printed Name Date/Time

Relinquished By: Company:
Signature/Printed Name Date/Time

Received By: Company:
Signature/Printed Name Date/Time

Distribution: A copy will be made for the laboratory and client. The Project file will retain the original.

Page ______ of _____

Analytical Report

Anchor QEA, LLC	Project: Simpson Shelton Harbor	
720 Olive Way, Suite 1900	Project Number: 110008-01.03	**Reported:**
Seattle WA, 98101	Project Manager: Cheronne Oreiro	19-Jul-2018 16:46

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
PDI-SMA1-PC01-0-2-180502	18E0251-01	Solid	02-May-2018 11:20	03-May-2018 11:18
PDI-SMA1-PC01-2-bottom-180502	18E0251-02	Solid	02-May-2018 11:20	03-May-2018 11:18
PDI-SMA1-PC02A-0-1.5-180501	18E0251-03	Solid	01-May-2018 07:55	03-May-2018 11:18
PDI-SMA1-PC02A-1.6-bottom-180501	18E0251-04	Solid	01-May-2018 07:55	03-May-2018 11:18
PDI-SMA1-PC02B-0.5-1-180501	18E0251-05	Solid	01-May-2018 07:55	03-May-2018 11:18
PDI-SMA1-PC02B-1-bottom-180501	18E0251-06	Solid	01-May-2018 07:55	03-May-2018 11:18
PDI-SMA1-PC03-0-2-180501	18E0251-07	Solid	01-May-2018 11:00	03-May-2018 11:18
PDI-SMA1-PC03-2-bottom-180501	18E0251-08	Solid	01-May-2018 11:00	03-May-2018 11:18
PDI-SMA2-PC01-0-bottom-180502	18E0251-09	Solid	02-May-2018 11:20	03-May-2018 11:18
PDI-SMA2-PC02-0-0.5-180502	18E0251-10	Solid	02-May-2018 11:00	03-May-2018 11:18
PDI-SMA2-PC02-0.5-1.25-180502	18E0251-11	Solid	02-May-2018 11:00	03-May-2018 11:18
PDI-SMA2-PC02-1.25-2-180502	18E0251-12	Solid	02-May-2018 11:00	03-May-2018 11:18
PDI-SMA3-PC01-0-1.8-180501	18E0251-13	Solid	01-May-2018 14:30	03-May-2018 11:18
PDI-SMA3-PC01-1.8-3-180501	18E0251-14	Solid	01-May-2018 14:30	03-May-2018 11:18
PDI-SMA3-PC01-3-bottom-180501	18E0251-15	Solid	01-May-2018 14:30	03-May-2018 11:18
PDI-SMA3-PC02-0-1.2-180502	18E0251-16	Solid	02-May-2018 10:10	03-May-2018 11:18
PDI-SMA3-PC03-0-1.7-180501	18E0251-17	Solid	01-May-2018 14:00	03-May-2018 11:18
PDI-SMA3-PC03-1.7-bottom-180501	18E0251-18	Solid	01-May-2018 14:00	03-May-2018 11:18
PDI-SMA3-PC04-0-1-180430	18E0251-19	Solid	30-Apr-2018 13:00	03-May-2018 11:18
PDI-SMA3-PC04-1-bottom-180430	18E0251-20	Solid	30-Apr-2018 13:00	03-May-2018 11:18
PDI-SMA3-PC05-0-0.8-180430	18E0251-21	Solid	30-Apr-2018 11:50	03-May-2018 11:18
PDI-SMA3-PC05-0.8-1.25-180430	18E0251-22	Solid	30-Apr-2018 11:50	03-May-2018 11:18
PDI-SMA3-PC05-1.25-bottom-180430	18E0251-23	Solid	30-Apr-2018 11:50	03-May-2018 11:18
PDI-SMA3-PC06-TOP-0-bottom-180501	18E0251-24	Solid	01-May-2018 13:00	03-May-2018 11:18
PDI-SMA3-PC06-BOT-0-bottom-180501	18E0251-25	Solid	01-May-2018 13:00	03-May-2018 11:18

Anchor QEA, LLC	Project: Simpson Shelton Harbor	
720 Olive Way, Suite 1900	Project Number: 110008-01.03	**Reported:**
Seattle WA, 98101	Project Manager: Cheronne Oreiro	19-Jul-2018 16:46

Case Narrative

Sample receipt

Samples as listed on the preceding page were pulled from archive May 17, 2018 under ARI work order 18E0251. For details regarding sample receipt, please refer to the Cooler Receipt Form.

Geotechnical Parameters

The samples were submitted to Materials Testing & Consulting, Inc. (MTC) for various geotechnical analyses. The MTC report is included here in its entirety.

18E0096

Chain of Custody Record & Laboratory Analysis Request

ANCHOR QEA

Laboratory Number:

Date: 5/3/2018

Project Name: Shelton Harbor

Project Number: 110008-01.03

Project Manager: Nathan Soccorsy

Phone Number: (206) 287-9130

Shipment Method: Courier

Line	Field Sample ID	Collection Date/Time	Matrix	No. of Containers	Hold	Comments/Preservation
1	SMA2-PC02-180502	5/2/2018 1100	Sed	1	X	Anchor QEA will provide
2	SMA2-PC01-180502	1120		1	X	instruction on further
3	SMA1-PC01-180502	0730		1	X	analysis.
4	SMA1-PC02-180501	5/1/2018 0755		2	X	A & B are duplicate cores
5	SMA1-PC03-180501	1100		1	X	
6	SMA3-PC01-180501	5/1/2018 1430		1	X	
7	SMA3-PC02-180502	5/2/2018 1010		1	X	
8	SMA3-PC03-180501	5/1/2018 1400		1	X	
9	SMA3-PC04-180430	4/30/2018 1300		1	X	
10	SMA3-PC05-180430	4/30/2018 1150		1	X	
11	SMA3-PC06-180501	5/1/2018 1300		2	X	#1 is top #2 is bottom
12						
13						
14						
15						

Notes: All samples start with "PDI-"
If a core has a #1 & #2, those are two sections of the same core with #1 being the top & #2 being the bottom
If a core has a A & B, those are duplicate cores

Relinquished By: / EI: Patmont Company: Anchor QEA, LLC
Signature/Printed Name Date/Time 5/3/2018 1345

Received By: Stephanie Fisher Company: ARI
Signature/Printed Name Date/Time 5/3/18 1345

Relinquished By: Company:
Signature/Printed Name Date/Time

Received By: Company:
Signature/Printed Name Date/Time

Distribution: A copy will be made for the laboratory and client. The Project file will retain the original.

Page____of_____

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Cooler Receipt Form

ARI Client: Anchor Qea

Project Name: Shelton Harbor

COC No(s): ____________ NA

Delivered by: Fed-Ex UPS Courier [✓ Hand Delivered] Other: ______

Assigned ARI Job No: 18E0096

Tracking No: ____________ [✓ NA]

Preliminary Examination Phase:

Were intact, properly signed and dated custody seals attached to the outside of to cooler?	YES	[✓ NO]
Were custody papers included with the cooler?	[✓ YES]	NO
Were custody papers properly filled out (ink, signed, etc.)	[✓ YES]	NO

Temperature of Cooler(s) (°C) (recommended 2.0-6.0 °C for chemistry) 17.7
Time: 1345

If cooler temperature is out of compliance fill out form 00070F — Temp Gun ID#: D002565

Cooler Accepted by: Sef Date: 5/3/18 Time: 1345

Complete custody forms and attach all shipping documents

Log-In Phase:

Was a temperature blank included in the cooler?		YES	[✓ NO]
What kind of packing material was used? ... Bubble Wrap [✓ Wet Ice] Gel Packs Baggies Foam Block Paper Other: ______			
Was sufficient ice used (if appropriate)?	NA	YES	[✓ NO]
Were all bottles sealed in individual plastic bags?		YES	[✓ NO]
Did all bottles arrive in good condition (unbroken)?		[✓ YES]	NO
Were all bottle labels complete and legible?		YES	[✓ NO]
Did the number of containers listed on COC match with the number of containers received?		[✓ YES]	NO
Did all bottle labels and tags agree with custody papers?		YES	[✓ NO]
Were all bottles used correct for the requested analyses?		[✓ YES]	NO
Do any of the analyses (bottles) require preservation? (attach preservation sheet, excluding VOCs)...	[✓ NA]	YES	NO
Were all VOC vials free of air bubbles?	[✓ NA]	YES	NO
Was sufficient amount of sample sent in each bottle?		[✓ YES]	NO
Date VOC Trip Blank was made at ARI..	[✓ NA]	______	

Was Sample Split by ARI : [✓ NA] YES Date/Time: ______ Equipment: ______ Split by: ______

Samples Logged by: BF Date: 5/4/18 Time: ~~15~~ 1736 BF

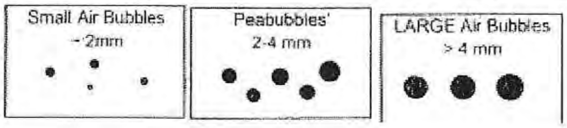
***** Notify Project Manager of discrepancies or concerns *****

Sample ID on Bottle	Sample ID on COC	Sample ID on Bottle	Sample ID on COC

Additional Notes, Discrepancies, & Resolutions:

Labels missing sample times

By: Date:



Small → "sm" (< 2 mm)
Peabubbles → "pb" (2 to < 4 mm)
Large → "lg" (4 to < 6 mm)
Headspace → "hs" (> 6 mm)

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Cooler Temperature Compliance Form

ARI Work Order: 18E0096

Cooler#: ______ **Temperature(°C):** 19.7

Sample ID	Bottle Count	Bottle Type
Samples received		
above 6°		

Cooler#: ______ **Temperature(°C):** ______

Sample ID	Bottle Count	Bottle Type

Cooler#: ______ **Temperature(°C):** ______

Sample ID	Bottle Count	Bottle Type

Cooler#: ______ **Temperature(°C):** ______

Sample ID	Bottle Count	Bottle Type

Completed by: Set Date: 5/3/18 Time: 1345

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client : Analytical Resources, Inc.
Source: Multiple
MTC Sample#: Multiple

Date Received: May 21, 2018
Sampled By: Others
Date Tested: June 20, 2018
Tested By: B. Goble

CASE NARRATIVE

1. Twenty samples were submitted for grain size distribution according to ASTM D422. The samples were prepared according to ASTM D421. Correlating specific gravity results were used in the hyrdometer calculations. An assumed specific gravity of 2.65 was used in the hydrometer calculations, if specific gravity testing was not requested on a sample. A standard milkshake mixer type device was used to disperse the fine fraction sample for one minute.
2. Twelve samples were submitted for specific gravity determination according to ASTM D854.
3. Fourteen samples were submitted for Atterberg limits according to ASTM D4318.
4. Twenty five samples were submitted for submitted for moisture content determination according to ASTM D2216.
5. Three samples were submitted for loss on ignition according to ASTM D2974.
6. Three samples were analyzed for soil classification according to ASTM D2487.
7. Six samples were submitted for one dimensional consolidation according to ASTM D2435. Sample, PDI-SMA3-PC06-TOP-0-bottom-180501 was not viable for consolidation testing. The sample contained a large amount of gravel and mussels. An intact consolidation sample could not be obtained. Five samples were subcontracted to HWA Geosciences. Please see attached results.
8. The data is provided in summary tables and plots.
9. There were no noted anomalies in this project.

Reviewed by:

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Date Received: May 21, 2018
Date Tested: June 20, 2018

Client: Analytical Resources, Inc.

Sampled by: Others
Tested by: B. Goble

Percent Finer (Passing) Than the Indicated Size - ASTM D422

Sieve Size (microns)	3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4 (4750)	#10 (2000)	#20 (850)	#40 (425)	#60 (250)	#100 (150)	#200 (75)	32	22	13	9	7	3.2	1.3
PDI-SMA1-PC01-0-2-180502	100.0	100.0	100.0	100.0	100.0	100.0	99.1	98.8	97.9	94.7	90.3	86.6	82.8	75.4	26.7	19.3	11.9	8.9	8.9	3.0	3.0
PDI-SMA1-PC02A-0-1.5-180501	100.0	100.0	100.0	100.0	100.0	98.8	97.5	96.1	93.7	89.0	84.3	79.7	76.4	72.6	30.1	22.0	16.0	12.0	8.0	5.0	4.0
PDI-SMA1-PC02A-1.6-bottom-180501	100.0	100.0	92.0	87.3	86.4	82.1	79.6	72.3	68.0	62.3	57.9	54.8	52.7	50.0	31.3	26.1	19.2	13.9	8.7	5.2	4.4
PDI-SMA1-PC02B-0.5-1-180501	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.4	96.8	93.7	89.9	86.2	83.1	78.2	41.2	28.2	21.7	15.2	10.8	6.5	5.4
PDI-SMA1-PC02B-1-bottom-180501	100.0	100.0	100.0	100.0	97.4	92.9	90.9	86.4	81.2	70.7	64.1	59.6	56.6	53.2	27.6	16.5	13.8	11.0	8.3	5.5	5.5
PDI-SMA1-PC03-2-bottom-180501	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.6	99.4	97.8	95.7	94.4	93.2	90.1	13.3	6.7	6.7	5.0	3.3	0.0	0.0
PDI-SMA2-PC01-0-bottom-180502	100.0	100.0	100.0	100.0	98.0	98.0	98.0	93.9	89.7	85.2	80.8	77.1	74.1	66.7	26.6	18.5	13.9	11.5	9.2	4.6	4.6
PDI-SMA2-PC02-0-0.5-180502	100.0	100.0	43.4	43.4	43.4	43.0	42.2	41.2	39.4	37.7	36.1	33.9	31.3	22.8	9.3	6.2	3.9	3.1	3.1	1.5	1.5
PDI-SMA2-PC02-0.5-1.25-180502	100.0	100.0	100.0	97.9	93.5	90.8	88.7	87.0	85.1	81.9	78.2	74.9	71.8	63.8	25.6	19.2	12.8	10.7	8.5	4.3	4.3
PDI-SMA2-PC02-1.25-2-180502	100.0	100.0	100.0	100.0	98.4	97.2	97.0	95.4	91.1	80.3	71.0	60.1	50.8	41.5	25.2	20.3	16.4	10.6	7.7	3.9	3.9
PDI-SMA3-PC01-1.8-3-180501	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.9	98.0	92.9	84.4	77.9	73.2	67.2	37.5	28.1	21.1	16.4	12.9	7.0	7.0
PDI-SMA3-PC01-3-bottom-180501	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.7	99.3	96.6	91.8	87.8	84.5	79.8	32.3	22.9	16.7	14.6	10.4	4.2	4.2
PDI-SMA3-PC02-0-1.2-180502	100.0	100.0	100.0	100.0	95.9	83.8	65.0	45.7	29.2	19.6	11.2	6.1	4.5	3.6	2.0	1.2	1.0	0.8	0.6	0.4	0.4
PDI-SMA3-PC03-1.7-bottom-180501	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9	98.0	95.9	93.9	92.3	87.8	46.4	34.5	21.6	17.3	12.9	6.5	6.5
PDI-SMA3-PC04-0-1-180430	100.0	100.0	100.0	100.0	94.7	83.8	72.7	59.2	44.0	33.6	24.8	19.4	17.4	15.5	6.2	4.1	2.9	2.4	1.8	1.2	1.2
PDI-SMA3-PC04-1-bottom-180430	100.0	100.0	100.0	100.0	100.0	93.6	82.9	63.9	46.4	35.4	26.0	20.7	18.6	16.6	5.6	3.8	2.8	1.9	1.4	0.5	0.5
PDI-SMA3-PC05-0-0.8-180430	100.0	100.0	100.0	100.0	96.9	96.6	96.6	95.5	93.8	90.2	83.3	77.6	73.8	67.8	36.7	27.2	16.8	14.7	10.5	6.3	6.3
PDI-SMA3-PC05-0.8-1.25-180430	100.0	100.0	100.0	100.0	100.0	100.0	100.0	97.9	96.2	93.2	86.7	81.2	77.7	73.2	41.3	32.6	23.9	16.3	13.0	7.6	5.4
PDI-SMA3-PC06-TOP-0-bottom-180501	100.0	100.0	100.0	73.9	59.8	56.0	55.6	53.7	49.3	46.3	43.1	40.6	38.9	36.9	15.4	12.3	6.1	5.1	4.1	2.0	2.0
PDI-SMA3-PC06-BOT-0-bottom-180501	100.0	100.0	100.0	93.3	90.5	66.9	58.2	42.9	32.0	23.8	19.5	17.2	16.0	14.8	4.9	3.2	2.0	1.6	0.8	0.0	0.0

Reviewed by: Eljah Goble

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Date Received: May 21, 2018
Date Tested: June 20, 2018

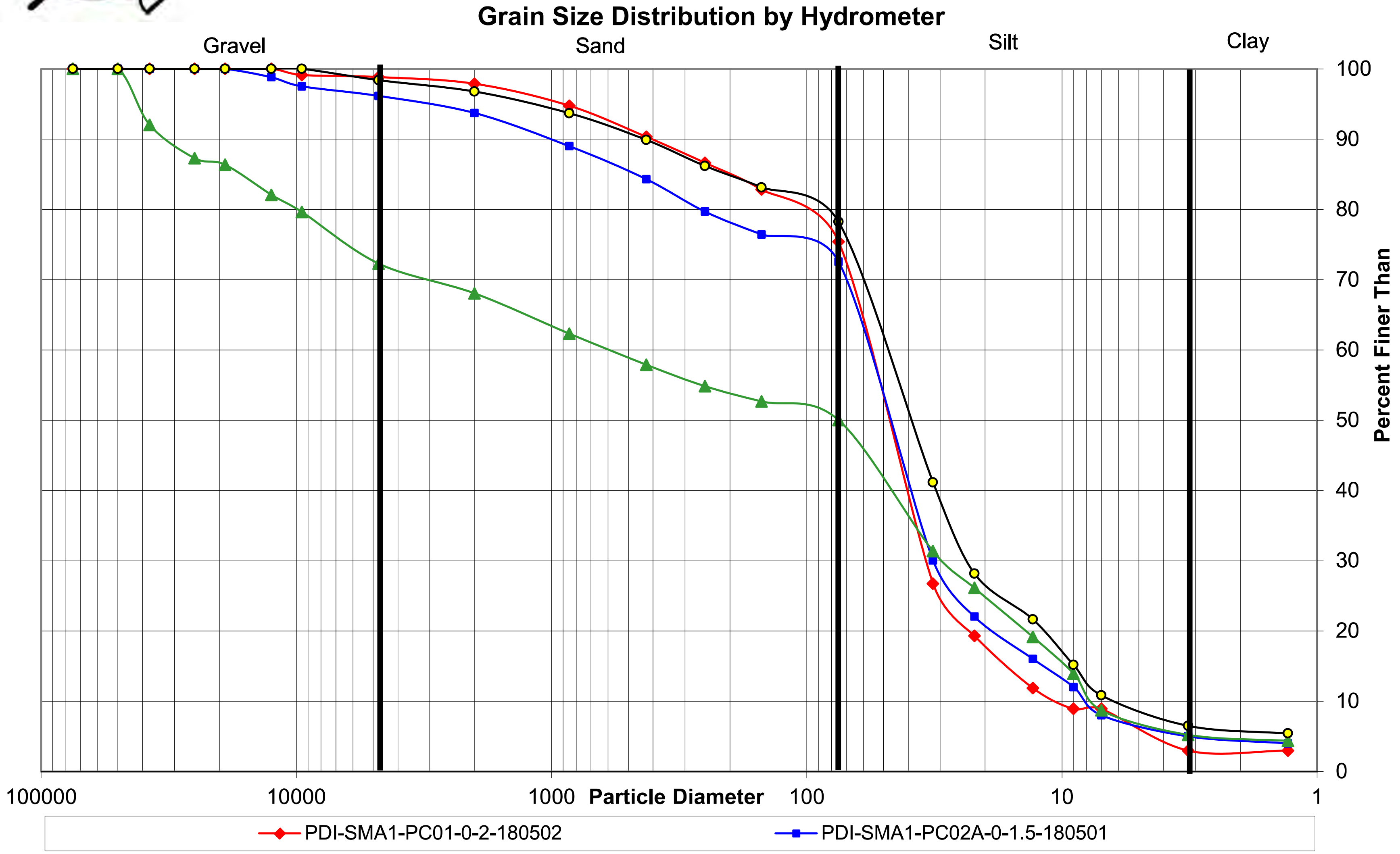
Client: Analytical Resources, Inc.

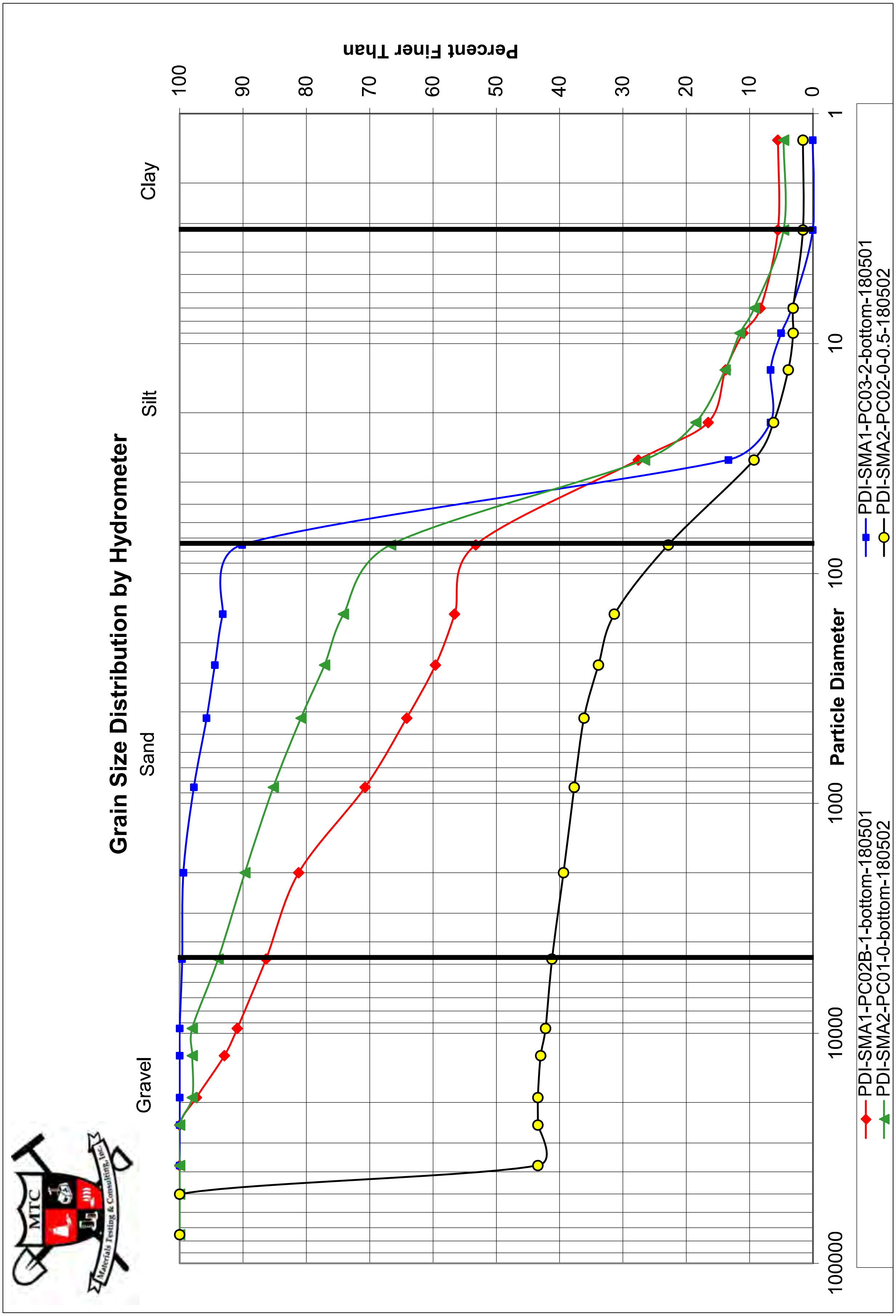
Sampled by: Others
Tested by: B. Goble

Percent Retained in Each Size Fraction

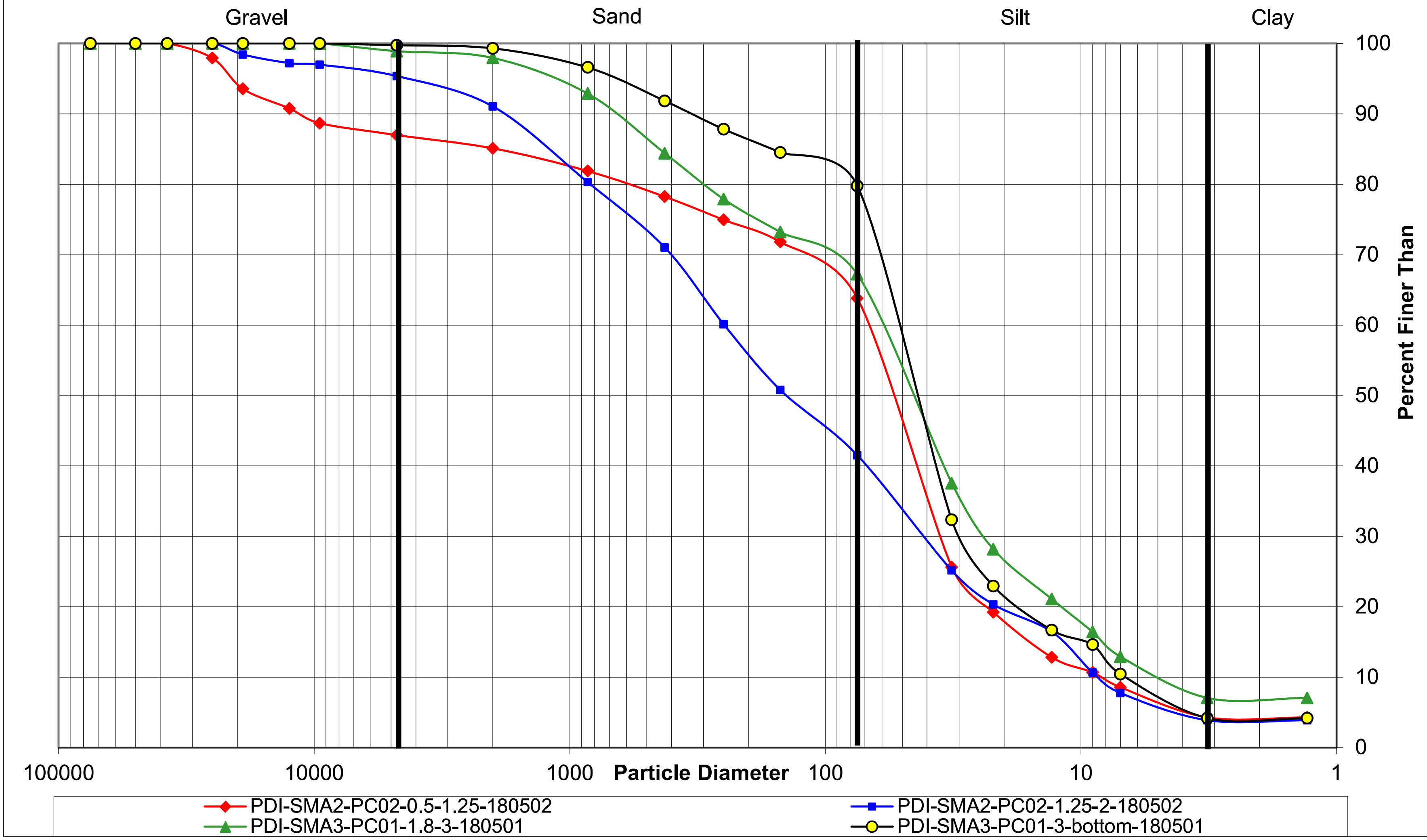
Description	% Coarse Gravel				% Gravel			% Coarse Sand	% Medium Sand		% Fine Sand			% Very Coarse Silt	% Coarse Silt	% Medium Silt	% Fine Silt	% Fine Silt	% Very Fine Silt	% Clay	
Particle Size (microns)	3-2"	2-1 1/2"	1 1/2"-1"	1-3/4"	3/4-1/2"	1/2-3/8"	3/8"-4750	4750-2000	2000-850	850-425	425-250	250-150	150-75	75-32	32-22	22-13	13-9	9-7	7-3.2	3.2-1.3	<1.3
PDI-SMA1-PC01-0-2-180502	0.0	0.0	0.0	0.0	0.0	0.9	0.3	0.9	3.2	4.4	3.7	3.8	7.4	48.7	7.4	7.4	3.0	0.0	5.9	0.0	3.0
PDI-SMA1-PC02A-0-1.5-180501	0.0	0.0	0.0	0.0	1.2	1.3	1.4	2.4	4.7	4.7	4.6	3.3	3.9	42.5	8.0	6.0	4.0	4.0	3.0	1.0	4.0
PDI-SMA1-PC02A-1.6-bottom-180501	0.0	8.0	4.7	0.9	4.3	2.4	7.3	4.2	5.7	4.4	3.1	2.2	2.6	18.7	5.2	7.0	5.2	5.2	3.5	0.9	4.4
PDI-SMA1-PC02B-0.5-1-180501	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	3.1	3.8	3.7	3.0	4.9	37.1	13.0	6.5	6.5	4.3	4.3	1.1	5.4
PDI-SMA1-PC02B-1-bottom-180501	0.0	0.0	0.0	2.6	4.4	2.0	4.5	5.1	10.5	6.6	4.5	3.0	3.3	25.7	11.0	2.8	2.8	2.8	2.8	0.0	5.5
PDI-SMA1-PC03-2-bottom-180501	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	1.7	2.0	1.3	1.3	3.1	76.8	6.7	0.0	1.7	1.7	3.3	0.0	0.0
PDI-SMA2-PC01-0-bottom-180502	0.0	0.0	0.0	2.0	0.0	0.0	4.1	4.2	4.5	4.4	3.7	3.0	7.4	40.1	8.1	4.6	2.3	2.3	4.6	0.0	4.6
PDI-SMA2-PC02-0-0.5-180502	0.0	56.6	0.0	0.0	0.4	0.8	1.0	1.8	1.7	1.5	2.3	2.5	8.5	13.5	3.1	2.3	0.8	0.0	1.5	0.0	1.5
PDI-SMA2-PC02-0.5-1.25-180502	0.0	0.0	2.1	4.4	2.8	2.1	1.7	1.9	3.2	3.6	3.3	3.1	8.0	38.2	6.4	6.4	2.1	2.1	4.3	0.0	4.3
PDI-SMA2-PC02-1.25-2-180502	0.0	0.0	0.0	1.6	1.2	0.2	1.6	4.3	10.8	9.3	10.9	9.3	9.3	16.3	4.8	3.9	5.8	2.9	3.9	0.0	3.9
PDI-SMA3-PC01-1.8-3-180501	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.9	5.1	8.5	6.5	4.7	6.0	29.7	9.4	7.0	4.7	3.5	5.9	0.0	7.0
PDI-SMA3-PC01-3-bottom-180501	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	2.7	4.8	4.0	3.3	4.7	47.4	9.4	6.3	2.1	4.2	6.3	0.0	4.2
PDI-SMA3-PC02-0-1.2-180502	0.0	0.0	0.0	4.1	12.1	18.8	19.4	16.4	9.6	8.4	5.1	1.7	0.8	1.7	0.8	0.2	0.2	0.2	0.2	0.0	0.4
PDI-SMA3-PC03-1.7-bottom-180501	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.8	2.2	2.0	1.6	4.5	41.5	11.9	12.9	4.3	4.3	6.5	0.0	6.5
PDI-SMA3-PC04-0-1-180430	0.0	0.0	0.0	5.3	10.9	11.1	13.5	15.2	10.3	8.9	5.4	2.0	1.9	9.3	2.1	1.2	0.6	0.6	0.6	0.0	1.2
PDI-SMA3-PC04-1-bottom-180430	0.0	0.0	0.0	0.0	6.4	10.8	18.9	17.6	11.0	9.4	5.3	2.1	2.0	10.9	1.9	0.9	0.9	0.5	0.9	0.0	0.5
PDI-SMA3-PC05-0-0.8-180430	0.0	0.0	0.0	3.1	0.3	0.0	1.1	1.8	3.6	6.9	5.8	3.8	6.0	31.2	9.4	10.5	2.1	4.2	4.2	0.0	6.3
PDI-SMA3-PC05-0.8-1.25-180430	0.0	0.0	0.0	0.0	0.0	0.0	2.1	1.7	3.0	6.5	5.5	3.6	4.5	31.9	8.7	8.7	7.6	3.3	5.4	2.2	5.4
PDI-SMA3-PC06-TOP-0-bottom-180501	0.0	0.0	26.1	14.1	3.9	0.3	1.9	4.4	3.0	3.2	2.5	1.7	2.0	21.5	3.1	6.1	1.0	1.0	2.0	0.0	2.0
PDI-SMA3-PC06-BOT-0-bottom-180501	0.0	0.0	6.7	2.8	23.7	8.7	15.3	10.9	8.2	4.3	2.3	1.2	1.3	9.9	1.6	1.2	0.4	0.8	0.8	0.0	0.0

Reviewed by: ______________________

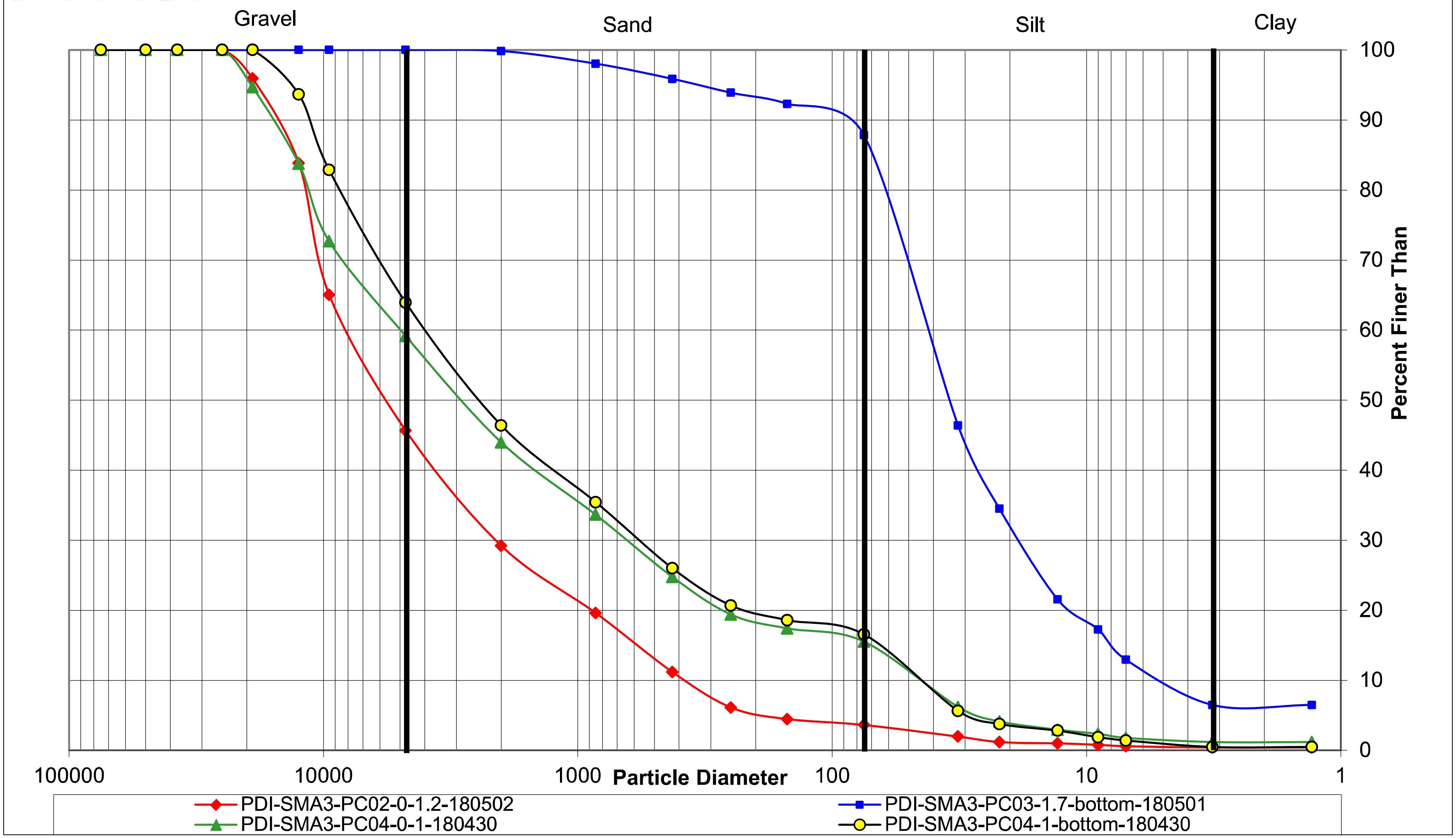

Grain Size Distribution by Hydrometer
Gravel
Sand
Silt
Clay
100
90
80
70
60
50
40
30
20
10
0
Percent Finer Than
100000
10000
1000
Particle Diameter
100
10
1
PDI-SMA1-PC01-0-2-180502
PDI-SMA1-PC02A-0-1.5-180501

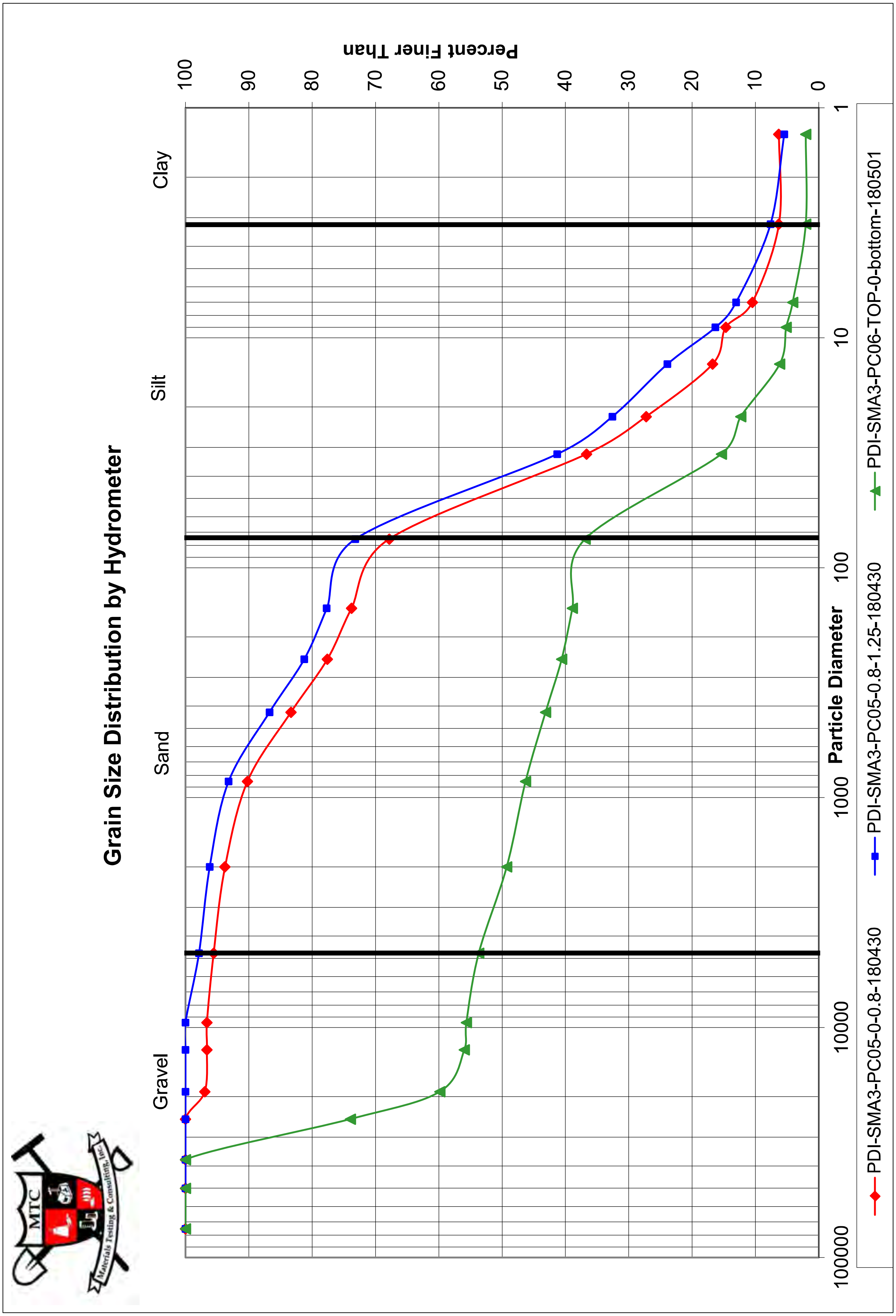

Grain Size Distribution by Hydrometer
MTC
Materials Testing & Consulting, Inc.
Gravel
Sand
Silt
Clay
Percent Finer Than
100
90
80
70
60
50
40
30
20
10
0
Particle Diameter
100000
10000
1000
100
10
1
PDI-SMA1-PC02B-1-bottom-180501
PDI-SMA2-PC01-0-bottom-180502
PDI-SMA1-PC03-2-bottom-180501
PDI-SMA2-PC02-0-0.5-180502

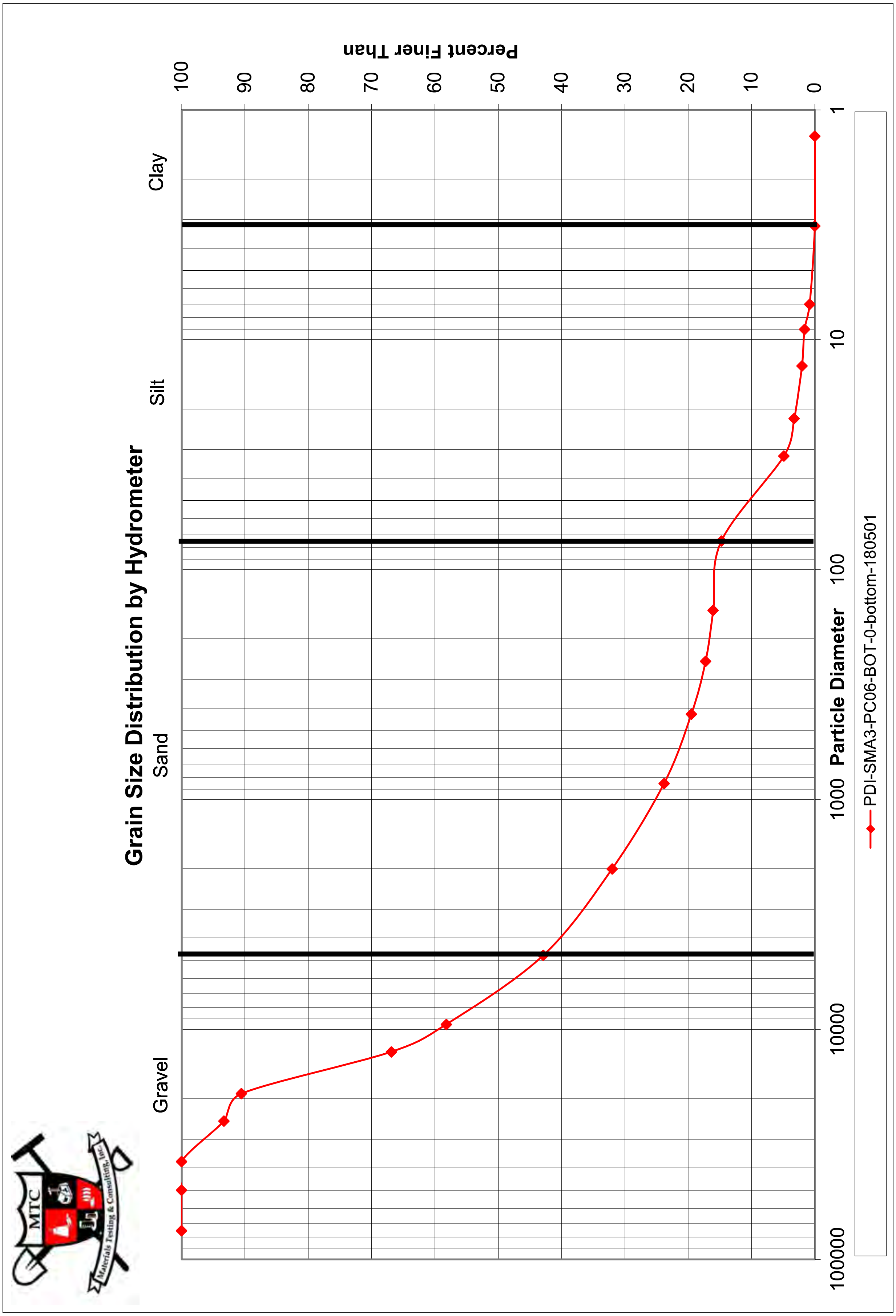
Grain Size Distribution by Hydrometer



Grain Size Distribution by Hydrometer




Grain Size Distribution by Hydrometer
Gravel
Sand
Silt
Clay
Percent Finer Than
100
90
80
70
60
50
40
30
20
10
0
Particle Diameter
100000
10000
1000
100
10
1
PDI-SMA3-PC05-0-0.8-180430
PDI-SMA3-PC05-0.8-1.25-180430
PDI-SMA3-PC06-TOP-0-bottom-180501
Materials Testing & Consulting, Inc.
MTC


MTC
Materials Testing & Consulting, Inc.
Grain Size Distribution by Hydrometer
Gravel
Sand
Silt
Clay
Percent Finer Than
100
90
80
70
60
50
40
30
20
10
0
100000
10000
1000
100
10
1
Particle Diameter
PDI-SMA3-PC06-BOT-0-bottom-180501

Materials Testing & Consulting, Inc.
Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Date Received: May 21, 2018
Date Tested: June 20, 2018

Client: Analytical Resources, Inc.
Sampled by: Others
Tested by: B. Goble

Specific Gravity - ASTM D854

Sample #	Source	Specific Gravity
S18-0876	PDI-SMA1-PC01-0-2-180502	2.39
S18-0880	PDI-SMA1-PC02B-0.5-1-180501	2.32
S18-0883	PDI-SMA1-PC03-2-bottom-180501	2.53
S18-0884	PDI-SMA2-PC01-0-bottom-180502	2.59
S18-0889	PDI-SMA3-PC01-1.8-3-180501	2.14
S18-0891	PDI-SMA3-PC02-0-1.2-180502	2.70
S18-0893	PDI-SMA3-PC03-1.7-bottom-180501	2.45
S18-0894	PDI-SMA3-PC04-0-1-180430	2.64
S18-0895	PDI-SMA3-PC04-1-bottom-180430	2.66
S18-0896	PDI-SMA3-PC05-0-0.8-180430	2.25
S18-0897	PDI-SMA3-PC05-0.8-1.25-180430	2.21
S18-0900	PDI-SMA3-PC06-bot-0-bottom-180501	2.46

Reviewed by:

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspections • Materials Testing • Environmental Consulting

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA1-PC01-0-2-180502
Sample #: S18-0876

Date Received: 21-May-18
Sampled By: Others
Date Tested: 12-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

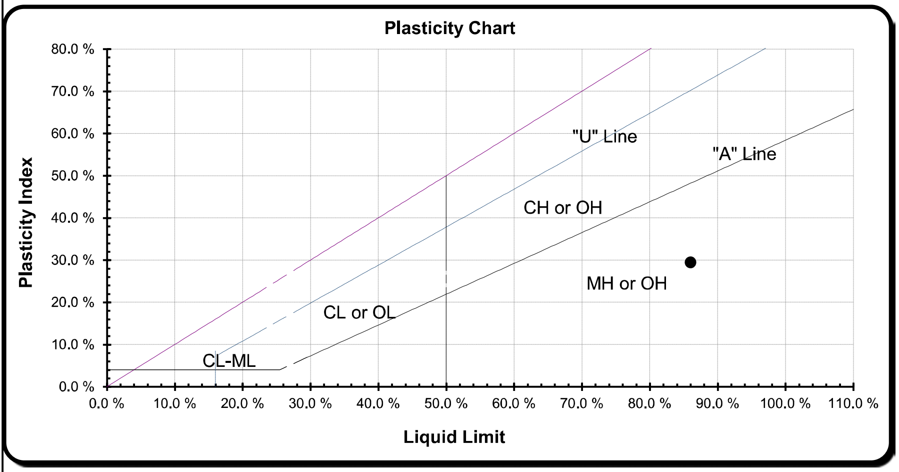
Liquid Limit Determination

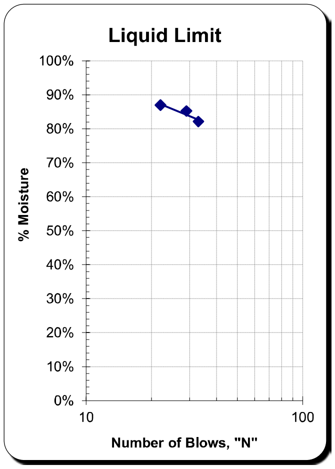
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	8.24	6.17	7.84			
Weight of Dry Soils + Pan:	5.21	4.03	4.90			
Weight of Pan:	1.52	1.52	1.52			
Weight of Dry Soils:	3.69	2.51	3.38			
Weight of Moisture:	3.03	2.14	2.94			
% Moisture:	82.1 %	85.3 %	87.0 %			
Number of Blows:	33	29	22			

Liquid Limit @ 25 Blows:	86.0 %
Plastic Limit:	56.6 %
Plasticity Index, I_P:	29.5 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	7.58	6.75				
Weight of Dry Soils + Pan:	5.39	4.86				
Weight of Pan:	1.52	1.52				
Weight of Dry Soils:	3.87	3.34				
Weight of Moisture:	2.19	1.89				
% Moisture:	56.6 %	56.6 %				





Comments: ____________________

Reviewed by: ____________________

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ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA1-PC02A-0-1.5-180501
Sample #: S18-0878

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided

Sample Color
Brown

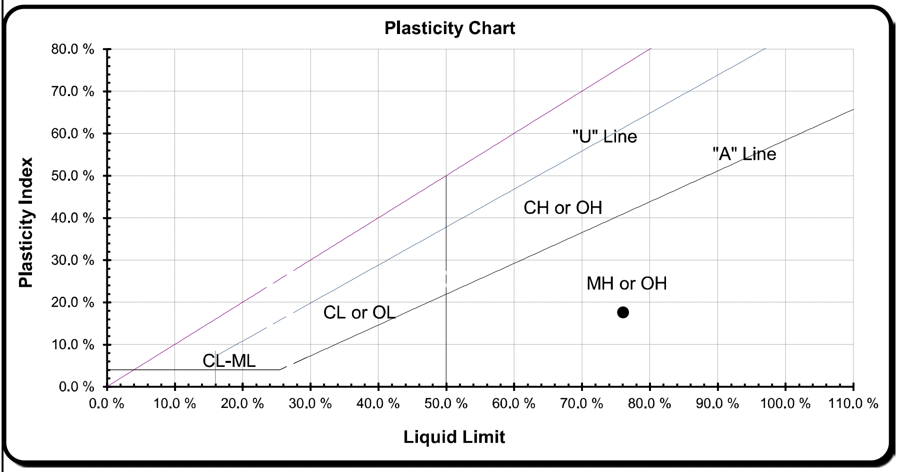
Liquid Limit Determination

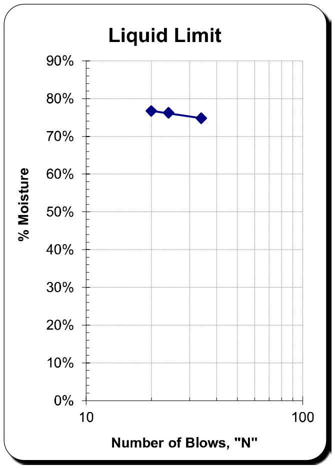
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	11.09	9.18	9.12			
Weight of Dry Soils + Pan:	6.99	5.87	5.82			
Weight of Pan:	1.51	1.53	1.52			
Weight of Dry Soils:	5.48	4.34	4.30			
Weight of Moisture:	4.10	3.31	3.30			
% Moisture:	74.8 %	76.3 %	76.7 %			
Number of Blows:	34	24	20			

Liquid Limit @ 25 Blows: 76.1 %
Plastic Limit: 58.5 %
Plasticity Index, I_P: 17.6 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	7.21	6.66				
Weight of Dry Soils + Pan:	5.11	4.77				
Weight of Pan:	1.53	1.53				
Weight of Dry Soils:	3.58	3.24				
Weight of Moisture:	2.10	1.89				
% Moisture:	58.7 %	58.3 %				





Comments:

Reviewed by: EGabe Goble

Materials Testing & Consulting, Inc.
Geotechnical Engineering • Special Inspections • Materials Testing • Environmental Consulting

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA1-PC02B-0.5-1-180501
Sample #: S18-0880

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

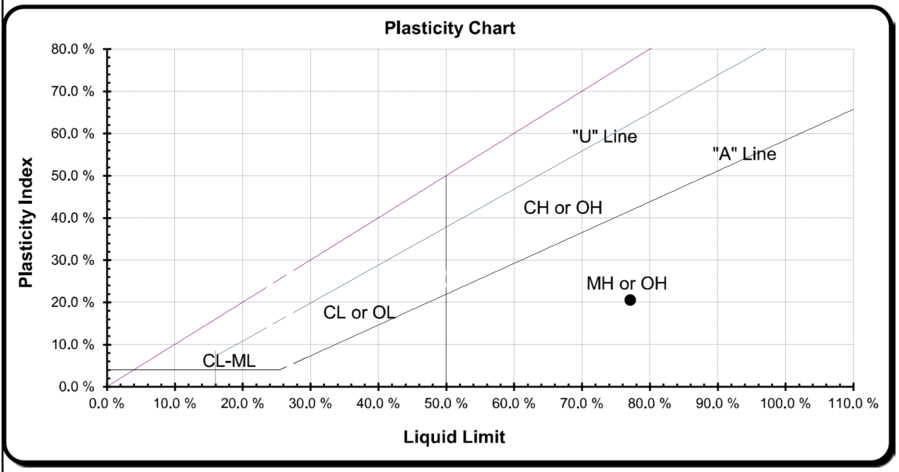
Liquid Limit Determination

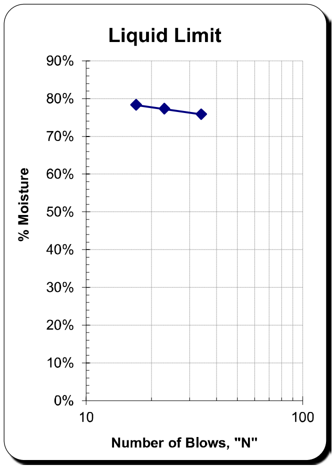
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	10.19	9.49	9.51			
Weight of Dry Soils + Pan:	6.45	6.01	6.00			
Weight of Pan:	1.52	1.51	1.52			
Weight of Dry Soils:	4.93	4.50	4.48			
Weight of Moisture:	3.74	3.48	3.51			
% Moisture:	75.9 %	77.3 %	78.4 %			
Number of Blows:	34	23	17			

Liquid Limit @ 25 Blows:	77.1 %
Plastic Limit:	56.6 %
Plasticity Index, I_P:	20.5 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	6.22	5.32				
Weight of Dry Soils + Pan:	4.52	3.95				
Weight of Pan:	1.53	1.52				
Weight of Dry Soils:	2.99	2.43				
Weight of Moisture:	1.70	1.37				
% Moisture:	56.9 %	56.4 %				





Comments: ______

Reviewed by: ______

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA1-PC03-2-BOTTOM-180501
Sample #: S18-0883

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

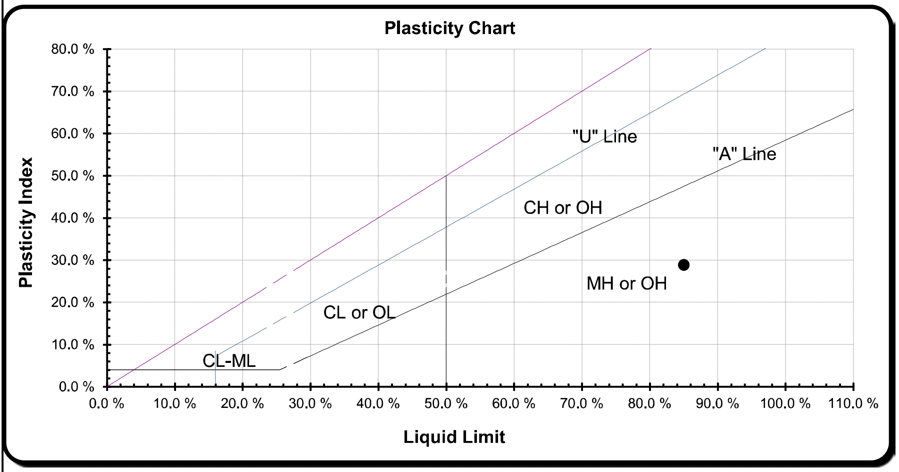
Liquid Limit Determination

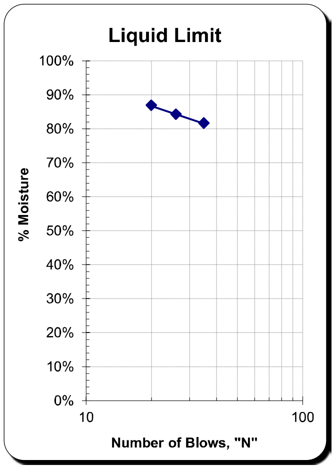
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	8.68	9.40	8.55			
Weight of Dry Soils + Pan:	5.46	5.79	5.28			
Weight of Pan:	1.52	1.51	1.52			
Weight of Dry Soils:	3.94	4.28	3.76			
Weight of Moisture:	3.22	3.61	3.27			
% Moisture:	81.7 %	84.4 %	87.0 %			
Number of Blows:	35	26	20			

Liquid Limit @ 25 Blows: 85.0 %
Plastic Limit: 56.2 %
Plasticity Index, I_P: 28.8 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	7.04	8.04				
Weight of Dry Soils + Pan:	5.04	5.71				
Weight of Pan:	1.52	1.52				
Weight of Dry Soils:	3.52	4.19				
Weight of Moisture:	2.00	2.33				
% Moisture:	56.8 %	55.6 %				





Comments: ____________________

Reviewed by: Egbert Goble

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ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA2-PC01-0-BOTTOM-180502
Sample #: S18-0884

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

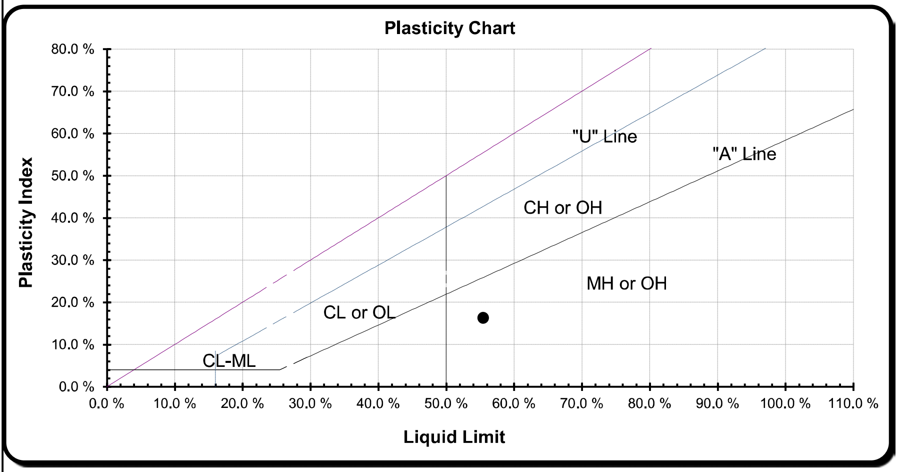
Liquid Limit Determination

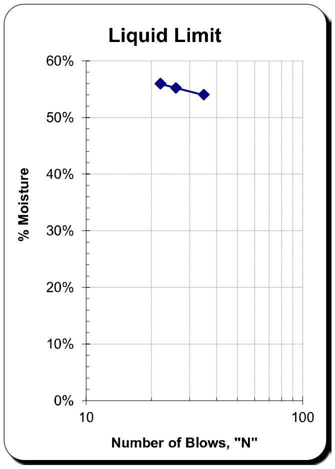
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	11.30	11.49	10.89			
Weight of Dry Soils + Pan:	7.87	7.95	7.53			
Weight of Pan:	1.52	1.54	1.53			
Weight of Dry Soils:	6.35	6.41	6.00			
Weight of Moisture:	3.43	3.54	3.36			
% Moisture:	54.0 %	55.2 %	56.0 %			
Number of Blows:	35	26	22			

Liquid Limit @ 25 Blows: 55.5 %
Plastic Limit: 39.2 %
Plasticity Index, I_P: 16.3 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	6.13	7.39				
Weight of Dry Soils + Pan:	4.84	5.73				
Weight of Pan:	1.53	1.52				
Weight of Dry Soils:	3.31	4.21				
Weight of Moisture:	1.29	1.66				
% Moisture:	39.0 %	39.4 %				





Comments: ______________________________

Reviewed by: ______________________________

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA2-PC02-0.5-1.25-180502
Sample #: S18-0886

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

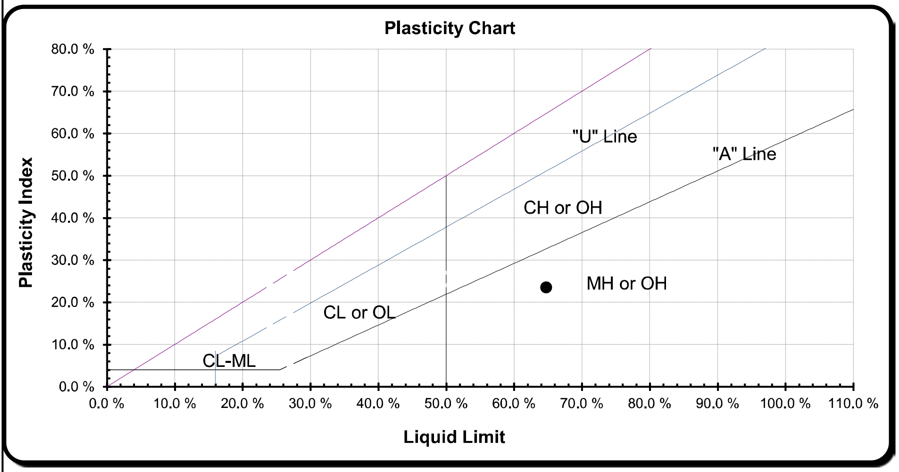
Liquid Limit Determination

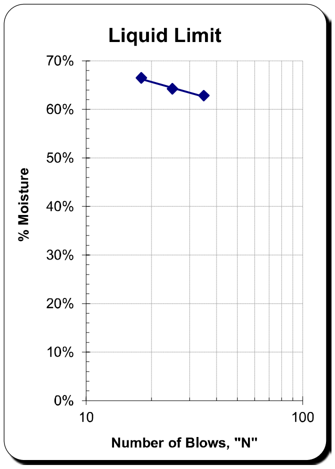
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	10.15	11.60	9.29			
Weight of Dry Soils + Pan:	6.82	7.66	6.19			
Weight of Pan:	1.52	1.53	1.53			
Weight of Dry Soils:	5.30	6.13	4.66			
Weight of Moisture:	3.33	3.94	3.10			
% Moisture:	62.8 %	64.3 %	66.5 %			
Number of Blows:	35	25	18			

Liquid Limit @ 25 Blows: 64.8 %
Plastic Limit: 41.2 %
Plasticity Index, I_P: 23.5 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	5.74	5.58				
Weight of Dry Soils + Pan:	4.51	4.39				
Weight of Pan:	1.52	1.51				
Weight of Dry Soils:	2.99	2.88				
Weight of Moisture:	1.23	1.19				
% Moisture:	41.1 %	41.3 %				





Comments:

Reviewed by: EGaber Goble

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-PC01-1.8-3-180501
Sample #: S18-0889

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

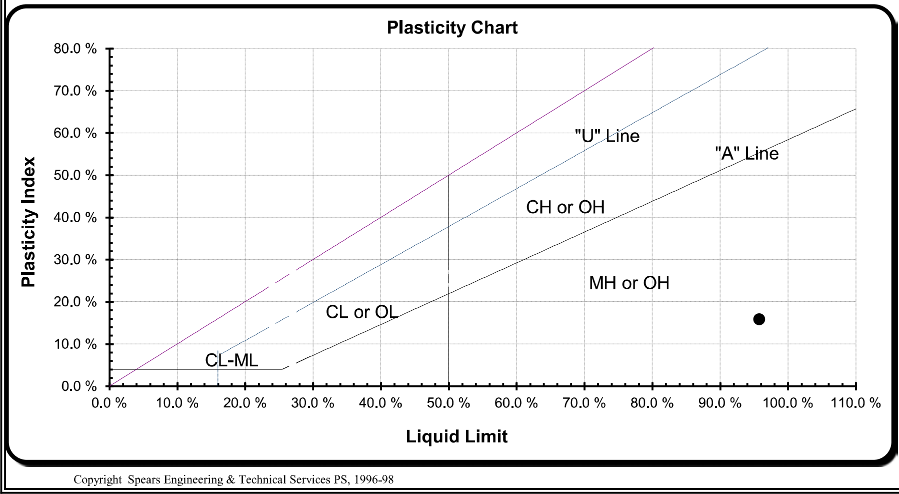
Liquid Limit Determination

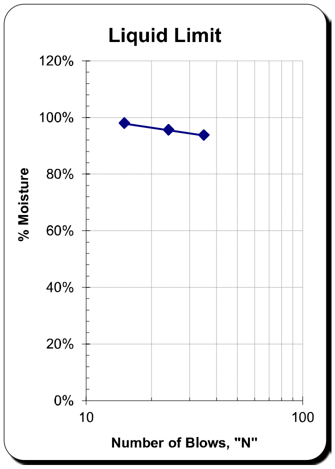
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	11.48	8.72	9.75			
Weight of Dry Soils + Pan:	6.66	5.20	5.67			
Weight of Pan:	1.52	1.52	1.51			
Weight of Dry Soils:	5.14	3.68	4.16			
Weight of Moisture:	4.82	3.52	4.08			
% Moisture:	93.8 %	95.7 %	98.1 %			
Number of Blows:	35	24	15			

Liquid Limit @ 25 Blows: 95.8 %
Plastic Limit: 79.9 %
Plasticity Index, I_P: 15.8 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	6.13	7.58				
Weight of Dry Soils + Pan:	4.08	4.89				
Weight of Pan:	1.51	1.53				
Weight of Dry Soils:	2.57	3.36				
Weight of Moisture:	2.05	2.69				
% Moisture:	79.8 %	80.1 %				





Comments:

Reviewed by: EGabe Goble

Materials Testing & Consulting, Inc.

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ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-PC01-3-BOTTOM-180501
Sample #: S18-0890

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

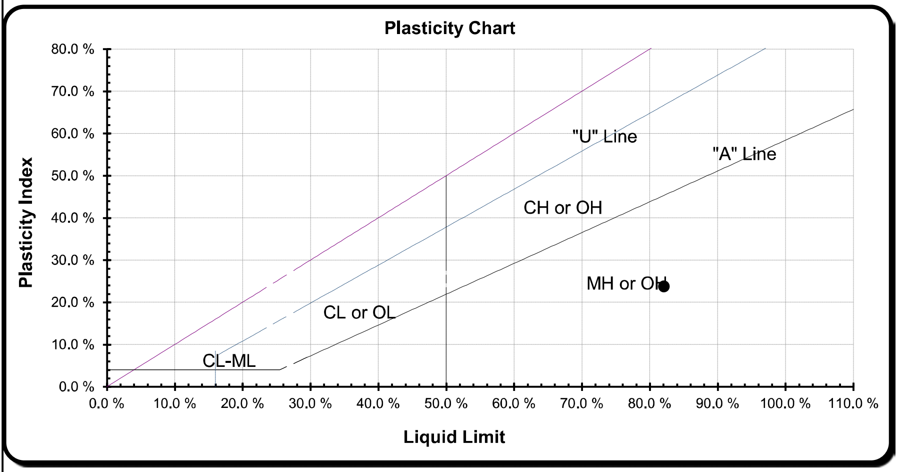
Liquid Limit Determination

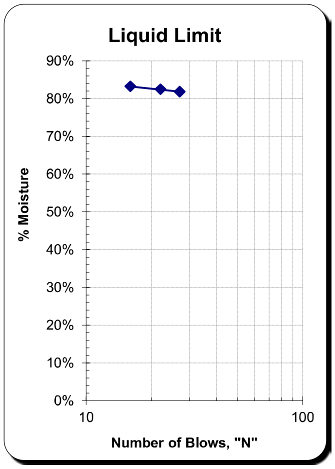
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	9.66	8.72	8.87			
Weight of Dry Soils + Pan:	6.01	5.47	5.54			
Weight of Pan:	1.55	1.53	1.54			
Weight of Dry Soils:	4.46	3.94	4.00			
Weight of Moisture:	3.65	3.25	3.33			
% Moisture:	81.8 %	82.5 %	83.3 %			
Number of Blows:	27	22	16			

Liquid Limit @ 25 Blows: 82.1 %
Plastic Limit: 58.3 %
Plasticity Index, I_P: 23.8 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	5.72	6.77				
Weight of Dry Soils + Pan:	4.18	4.84				
Weight of Pan:	1.54	1.53				
Weight of Dry Soils:	2.64	3.31				
Weight of Moisture:	1.54	1.93				
% Moisture:	58.3 %	58.3 %				





Comments:

Reviewed by:

Materials Testing & Consulting, Inc.
Geotechnical Engineering • Special Inspections • Materials Testing • Environmental Consulting

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-PC03-1.7-BOTTOM-180501
Sample #: S18-0893

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

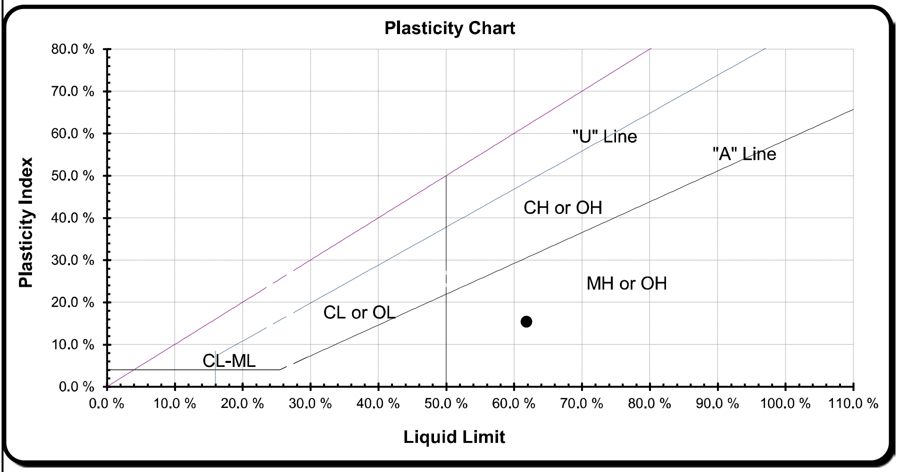
Liquid Limit Determination

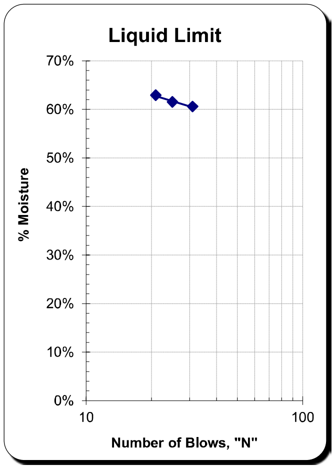
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	11.00	12.52	11.30			
Weight of Dry Soils + Pan:	7.43	8.33	7.53			
Weight of Pan:	1.54	1.52	1.54			
Weight of Dry Soils:	5.89	6.81	5.99			
Weight of Moisture:	3.57	4.19	3.77			
% Moisture:	60.6 %	61.5 %	62.9 %			
Number of Blows:	31	25	21			

Liquid Limit @ 25 Blows: 61.8 %
Plastic Limit: 46.4 %
Plasticity Index, I_P: 15.4 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	8.90	10.16				
Weight of Dry Soils + Pan:	6.56	7.42				
Weight of Pan:	1.53	1.51				
Weight of Dry Soils:	5.03	5.91				
Weight of Moisture:	2.34	2.74				
% Moisture:	46.5 %	46.4 %				





Comments: ______________________________

Reviewed by: ______________________________

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspections • Materials Testing • Environmental Consulting

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-PC04-1-BOTTOM-180430
Sample #: S18-0895

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

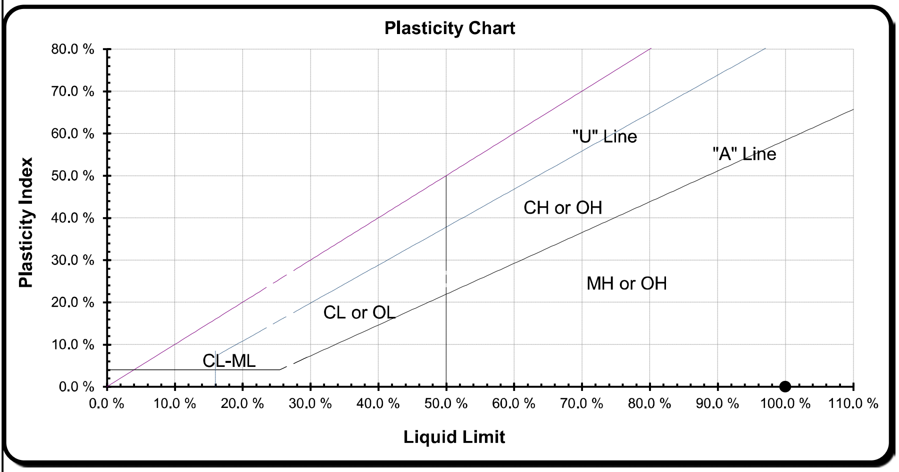
Liquid Limit Determination

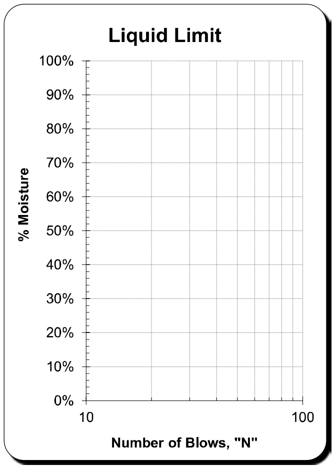
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:						
Weight of Dry Soils + Pan:						
Weight of Pan:						
Weight of Dry Soils:						
Weight of Moisture:						
% Moisture:						
Number of Blows:						

Liquid Limit @ 25 Blows: N/A
Plastic Limit: N/A
Plasticity Index, I_P: N/A

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:						
Weight of Dry Soils + Pan:						
Weight of Pan:						
Weight of Dry Soils:						
Weight of Moisture:						
% Moisture:						





Comments: This sample would not roll to 1/8" or reach 25 blows. This sample is classified as Non-Plastic.

Reviewed by:

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspections • Materials Testing • Environmental Consulting

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-PC05-0-0.8-180430
Sample #: S18-0896

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

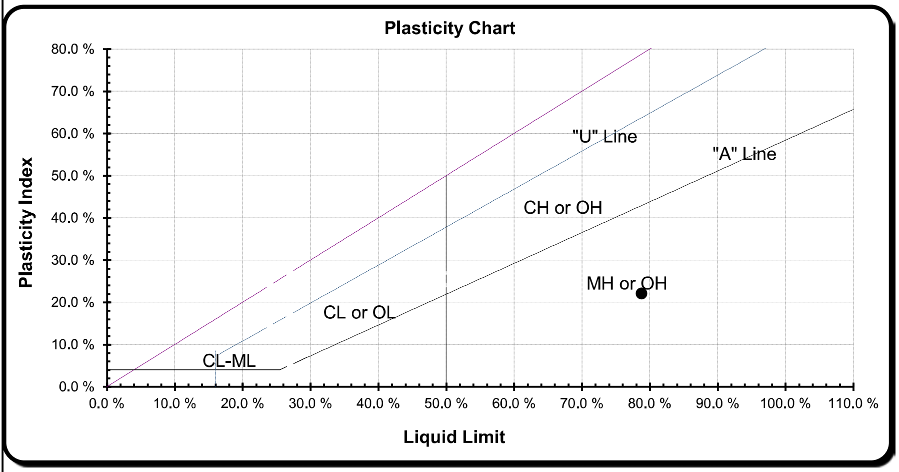
Liquid Limit Determination

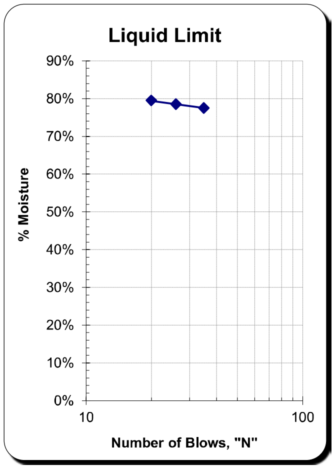
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	11.02	10.76	9.57			
Weight of Dry Soils + Pan:	6.87	6.69	6.00			
Weight of Pan:	1.52	1.51	1.51			
Weight of Dry Soils:	5.35	5.18	4.49			
Weight of Moisture:	4.15	4.07	3.57			
% Moisture:	77.6 %	78.6 %	79.5 %			
Number of Blows:	35	26	20			

Liquid Limit @ 25 Blows:	78.8 %
Plastic Limit:	56.7 %
Plasticity Index, I_P:	22.1 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	6.98	7.22				
Weight of Dry Soils + Pan:	5.01	5.15				
Weight of Pan:	1.52	1.52				
Weight of Dry Soils:	3.49	3.63				
Weight of Moisture:	1.97	2.07				
% Moisture:	56.5 %	57.0 %				





Comments: ______________________________

Reviewed by: ______________________________

Materials Testing & Consulting, Inc.
Geotechnical Engineering • Special Inspections • Materials Testing • Environmental Consulting

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-PC05-0.8-1.25-180430
Sample #: S18-0897

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

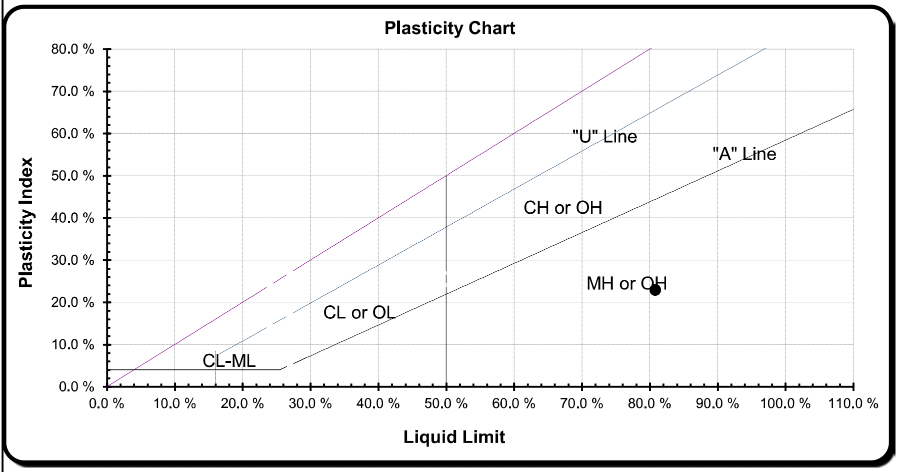
Liquid Limit Determination

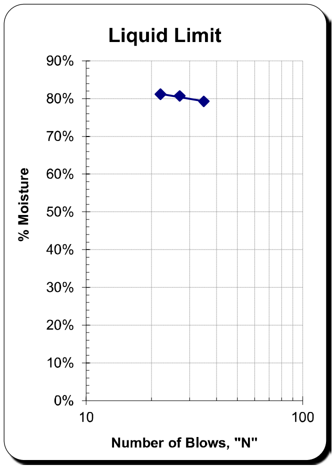
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	9.39	8.45	10.08			
Weight of Dry Soils + Pan:	5.91	5.35	6.25			
Weight of Pan:	1.52	1.51	1.53			
Weight of Dry Soils:	4.39	3.84	4.72			
Weight of Moisture:	3.48	3.10	3.83			
% Moisture:	79.3 %	80.7 %	81.1 %			
Number of Blows:	35	27	22			

Liquid Limit @ 25 Blows: 80.8 %
Plastic Limit: 57.9 %
Plasticity Index, I_P: 22.9 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	6.62	6.76				
Weight of Dry Soils + Pan:	4.76	4.84				
Weight of Pan:	1.54	1.53				
Weight of Dry Soils:	3.22	3.31				
Weight of Moisture:	1.86	1.92				
% Moisture:	57.8 %	58.0 %				


Plasticity Chart


Liquid Limit

Comments: ____________________

Reviewed by: ____________________

Materials Testing & Consulting, Inc.
Geotechnical Engineering • Special Inspections • Materials Testing • Environmental Consulting

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-PC06-TOP-0-BOTTOM-180501
Sample #: S18-0899

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

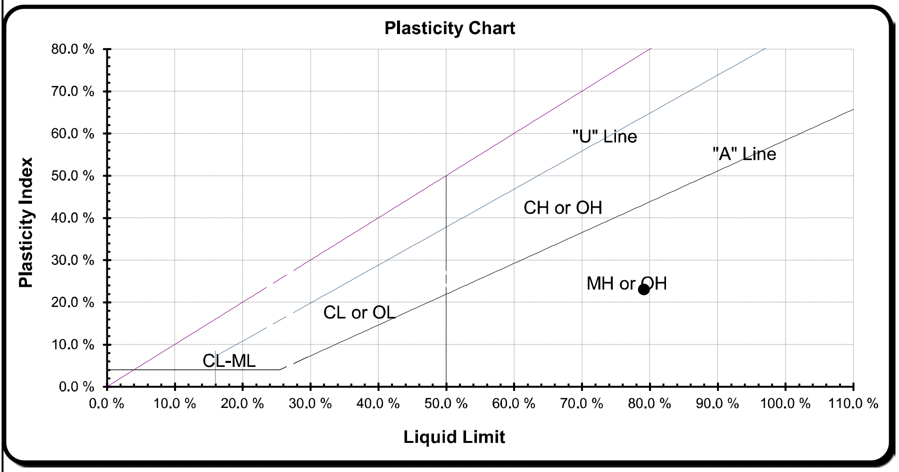
Liquid Limit Determination

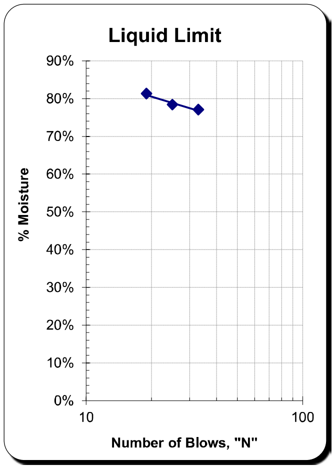
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	8.03	8.47	10.19			
Weight of Dry Soils + Pan:	5.20	5.42	6.30			
Weight of Pan:	1.53	1.53	1.52			
Weight of Dry Soils:	3.67	3.89	4.78			
Weight of Moisture:	2.83	3.05	3.89			
% Moisture:	77.1 %	78.4 %	81.4 %			
Number of Blows:	33	25	19			

Liquid Limit @ 25 Blows:	79.2 %
Plastic Limit:	56.1 %
Plasticity Index, I_P:	23.0 %

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:	5.27	6.32				
Weight of Dry Soils + Pan:	3.92	4.60				
Weight of Pan:	1.52	1.53				
Weight of Dry Soils:	2.40	3.07				
Weight of Moisture:	1.35	1.72				
% Moisture:	56.3 %	56.0 %				





Comments:

Reviewed by: EGabe Goble

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspections • Materials Testing • Environmental Consulting

ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-PC06-BOT-0-BOTTOM-180501
Sample #: S18-0900

Date Received: 21-May-18
Sampled By: Others
Date Tested: 20-Jun-18
Tested By: B. Goble

Unified Soils Classification System, ASTM D-2487
No Data Provided
Sample Color
Brown

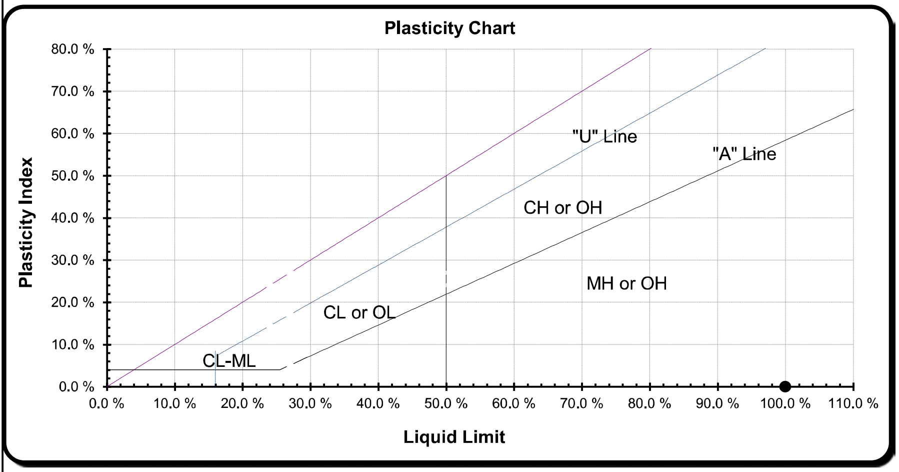
Liquid Limit Determination

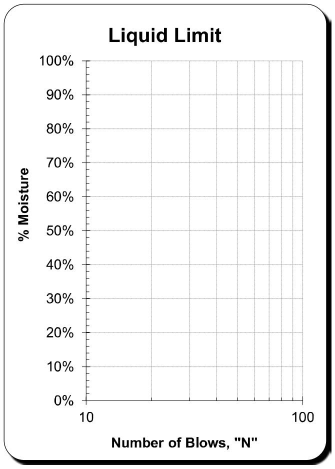
	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:						
Weight of Dry Soils + Pan:						
Weight of Pan:						
Weight of Dry Soils:						
Weight of Moisture:						
% Moisture:						
Number of Blows:						

Liquid Limit @ 25 Blows:	N/A
Plastic Limit:	N/A
Plasticity Index, I_P:	N/A

Plastic Limit Determination

	#1	#2	#3	#4	#5	#6
Weight of Wet Soils + Pan:						
Weight of Dry Soils + Pan:						
Weight of Pan:						
Weight of Dry Soils:						
Weight of Moisture:						
% Moisture:						





Comments: This sample would not roll to 1/8" or reach 25 blows. This sample is classified as Non-Plastic.

Reviewed by:

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project: Simpson Shelton Harbor (18E0251)
Project #: 18S010-21
Date Received: May 21, 2018
Date Tested: June 12, 2018

Client: Analytical Resources, Inc.
Sampled by: Others
Tested by: B. Goble

Moisture Content - ASTM D2216

Sample #	Source	Tare	Wet + Tare	Dry + Tare	Wgt. Of Moisture	Wgt. Of Soil	% Moisture
S18-0876	PDI-SMA1_PC01-0-2-180502	1.5	98.6	44.3	54.3	42.8	127.0%
S18-0877	PDI-SMA1-PC01-2-bottom-180502	1.5	105.0	51.1	53.9	49.6	108.7%
S18-0878	PDI-SMA1-PC02A-0-1.5-180501	1.5	55.3	26.7	28.5	25.2	113.1%
S18-0879	PDI-SMA1-PC02A-1.6-bottom-180501	107.7	249.7	171.9	77.9	64.2	121.3%
S18-0880	PDI-SMA1-PC02B-0.5-1-180501	1.5	68.2	34.7	33.5	33.2	100.8%
S18-0881	PDI-SMA1-PC02B-1-bottom-180501	103.8	253.3	173.5	79.9	69.7	114.7%
S18-0882	PDI-SMA1-PC03-0-2-180501	1.5	78.1	37.7	40.4	36.2	111.5%
S18-0883	PDI-SMA1-PC03-2-bottom-180501	1.5	70.1	30.9	39.2	29.4	133.4%
S18-0884	PDI-SMA2-PC01-0-bottom-180502	1.5	83.9	42.9	41.0	41.4	99.2%
S18-0885	PDI-SMA2-PC02-0-0.5-180502	1.5	104.5	48.9	55.6	47.3	117.5%
S18-0886	PDI-SMA2-PC02-0.5-1.25-180502	1.5	85.7	41.3	44.4	39.8	111.3%
S18-0887	PDI-SMA2-PC02-1.25-2-180502	101.2	268.5	190.2	78.3	89.0	88.0%
S18-0888	PDI-SMA3-PC01-0-1.8-180501	1.5	68.1	24.2	43.9	22.6	193.9%
S18-0889	PDI-SMA3-PC01-1.8-3-180501	1.5	55.8	20.1	35.7	18.6	192.3%
S18-0890	PDI-SMA3-PC01-3-bottom-180501	1.5	66.1	27.9	38.2	26.4	144.6%
S18-0891	PDI-SMA3-PC02-0-1.2-180502	1.5	73.0	62.5	10.5	61.0	17.2%
S18-0892	PDI-SMA3-PC03-0-1.7-180501	1.5	86.2	35.6	50.6	34.1	148.6%
S18-0893	PDI-SMA3-PC03-1.7-bottom-180501	1.5	86.0	39.9	46.1	38.4	120.2%
S18-0894	PDI-SMA3-PC04-0-1-180430	1.5	85.0	66.3	18.8	64.7	29.0%
S18-0895	PDI-SMA3-PC04-1-bottom-180430	1.5	89.5	64.3	25.2	62.7	40.2%
S18-0896	PDI-SMA3-PC05-0-0.8-180430	1.5	63.5	25.5	38.0	24.0	158.4%
S18-0897	PDI-SMA3-PC05-0.8-1.25-180430	1.5	57.3	22.9	34.4	21.3	161.4%
S18-0898	PDI-SMA3-PC05-1.25-bottom-180430	1.5	55.0	24.9	30.1	23.4	128.7%
S18-0899	PDI-SMA3-PC06-TOP-0-bottom-180501	1.5	77.6	39.6	38.0	38.1	99.6%
S18-0900	PDI-SMA3-PC06-BOT-0-bottom-180501	1.5	100.0	74.8	25.2	73.3	34.4%

Organic Content - ASTM D2974

Sample #	Source	Tare	Soil + Tare, Pre-Ignition	Soil + Tare, Post Ignition	% Organics
S18-0879	PDI-SMA1-PC02A-1.6-bottom-180501	107.7	171.9	147.2	38.4%
S18-0881	PDI-SMA1-PC02B-1-bottom-180501	103.8	173.5	143.6	42.8%
S18-0887	PDI-SMA2-PC02-1.25-2-180502	101.2	190.2	161.7	32.0%

Reviewed by:

HWA GEOSCIENCES INC.
Geotechnical Engineering • Hydrogeology • Geoenvironmental • Inspection and Testing

July 17, 2018
HWA Project No. 2012-002-23 Task 48

Materials Testing & Consulting, Inc.
2118 Black Lake Blvd. SW
Olympia, WA 98512

Attention: Ms. Beth Goble

Subject: **MATERIALS LABORATORY REPORT**
One Dimensional Consolidation Testing
Simpson Shelton Harbor
Client Project No. 18S010-21

Dear Ms. Goble,

As requested, HWA GeoSciences Inc. (HWA) performed laboratory testing for the subject project. Herein we present the results of our laboratory analyses, which are summarized on the attached Figures. The laboratory testing program was performed in general accordance with your instructions and appropriate ASTM Standards as outlined below.

SAMPLE INFORMATION: Five samples of soil were delivered to our laboratory on June 12, 2018 by MTC personnel. The client delivered trimmed sections of what are understood to be relatively undisturbed samples that had been previously extruded from 2.8-inch Shelby tubes. The samples were contained in resealable plastic containers at the time of delivery.

ONE DIMENSIONAL CONSOLIDATION PROPERTIES OF SOIL: The consolidation properties of the soil samples were measured in general accordance with ASTM D2435. Each sample was carefully trimmed into a 2.5-inch diameter metal ring in preparation for consolidation tests. Saturation was maintained by inundation of the samples throughout the test. The samples were subjected to increasing increments of total stress, the duration of which was selected to exceed the time required for completion of primary consolidation as defined in the Standard, Method B. Unloading of the samples was carried out incrementally. The test results are presented on the attached One Dimensional Consolidation of Soils report, Figures 1A through 5B.

21312 30th Drive SE
Suite 110
Bothell, WA 98021-7010
Tel: 425.774.0106
Fax: 425.774.2714
www.hwageo.com

CLOSURE: Experience has shown that laboratory test values for soil and other natural materials vary with each representative sample. As such, HWA has no knowledge as to the extent and quantity of material the tested sample may represent. HWA also makes no warranty as to how representative either the sample tested or the test results obtained are to actual field conditions. It is a well established fact that sampling methods present varying degrees of disturbance or variance that affect sample representativeness.

No copy should be made of this report except in its entirety.

We appreciate the opportunity to provide laboratory testing services on this project. Should you have any questions or comments, or if we may be of further service, please call.

Sincerely,

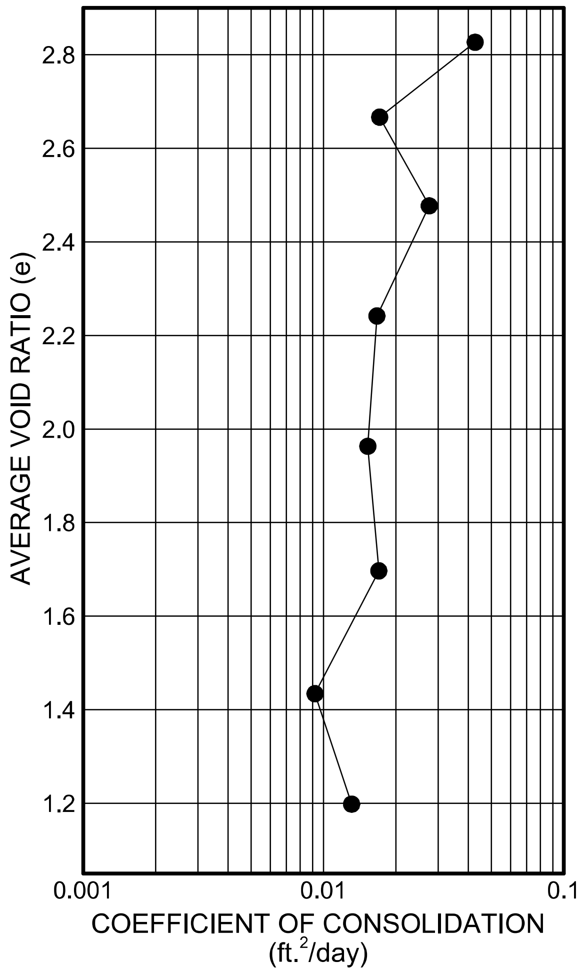
HWA GEOSCIENCES INC.

Daniel Walton
Materials Laboratory Supervisor

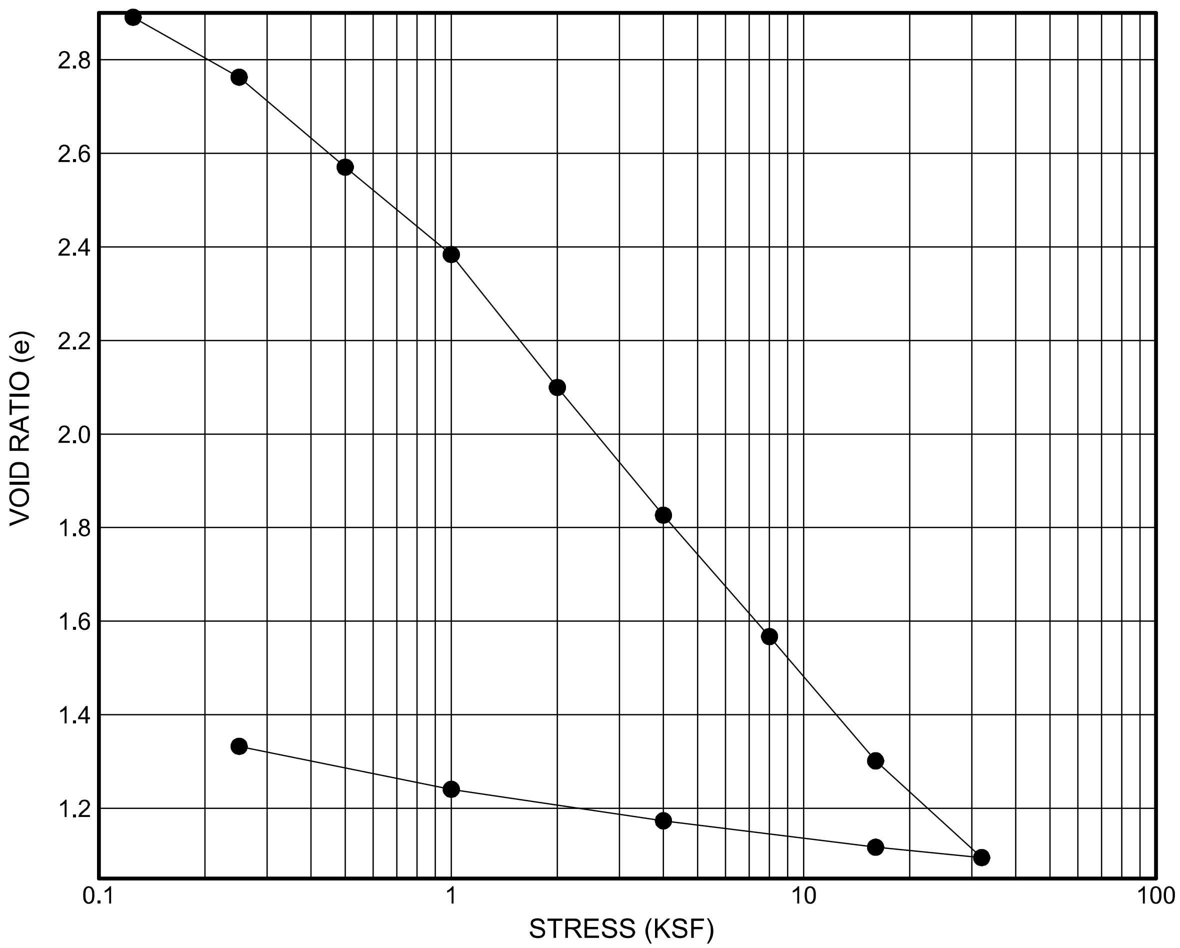
Steven E. Greene, L.G., L.E.G
Principal Engineering Geologist
Vice President

Attachments:

Figure 1A-5B One Dimensional Consolidation of Soils



VOID RATIO VS. STRESS



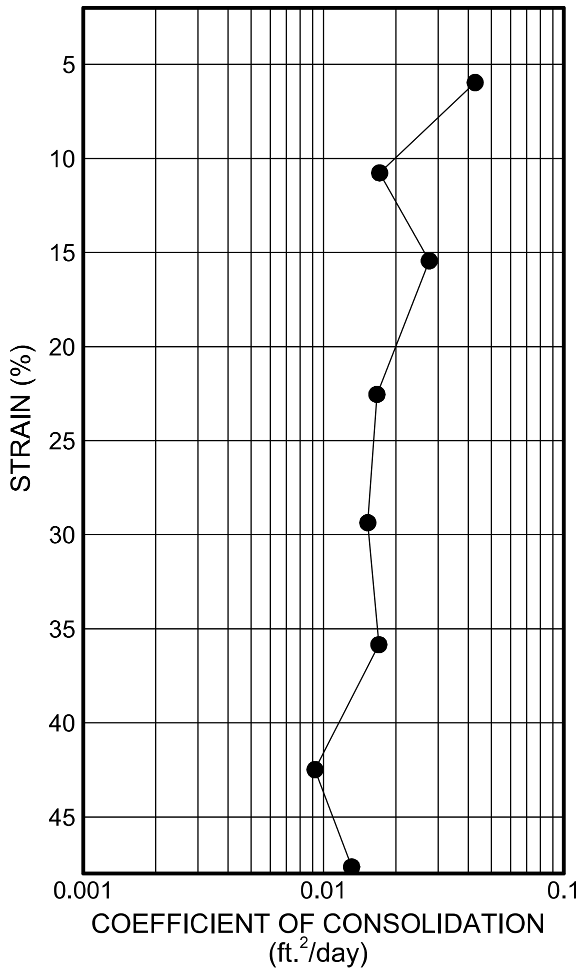
SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA1-PC01	2.0 - 2.0	(OH) Very dark brown, organic SILT	122.5	58.0	99.7	100.1	34.5	61.6	3.001	1.332

HWA GEOSCIENCES INC.

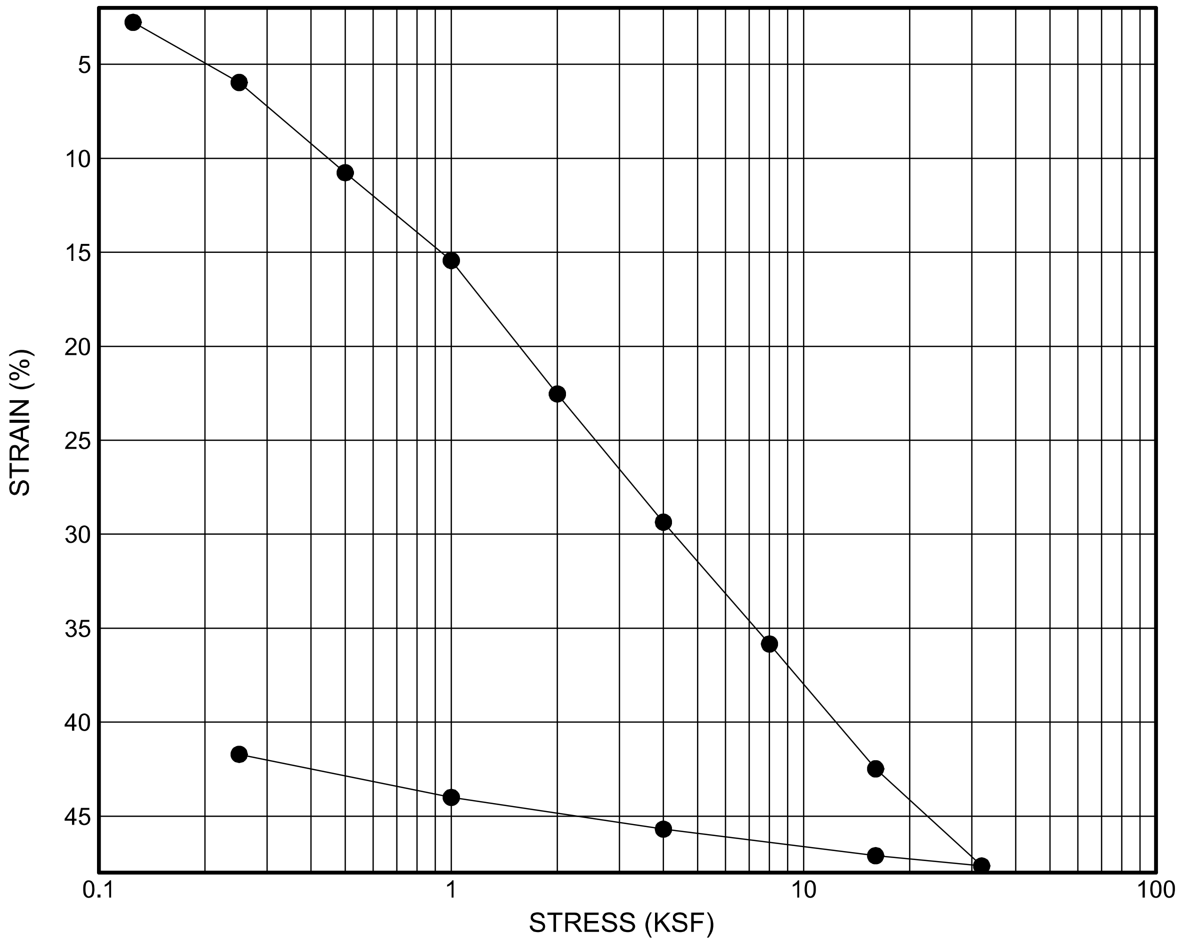
MLT for MTC, Inc.
Simpson Shelton Harbor

ONE DIMENSIONAL CONSOLIDATION OF SOILS ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 1A



STRAIN VS. STRESS



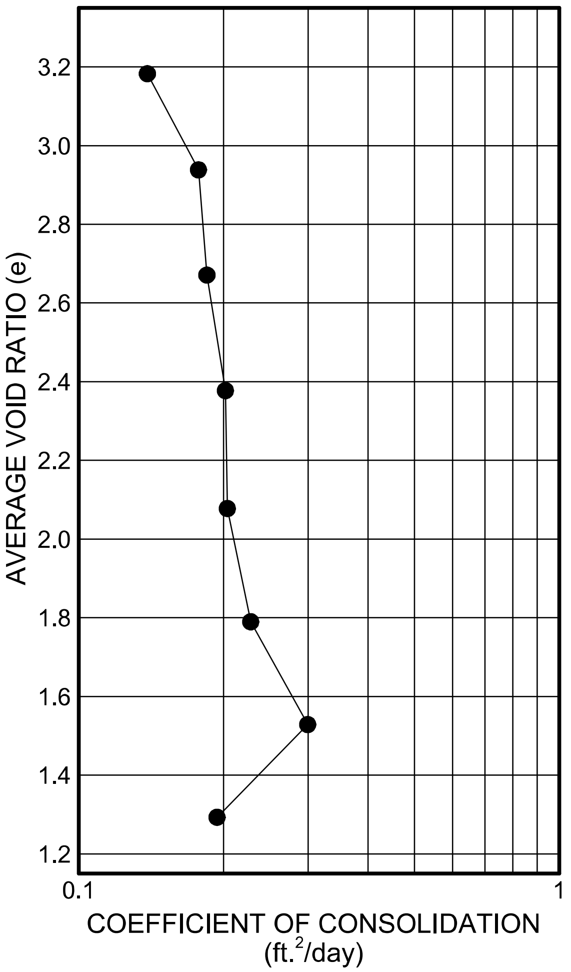
SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA1-PC01	2.0 - 2.0	(OH) Very dark brown, organic SILT	122.5	58.0	99.7	100.1	34.5	61.6	3.001	1.332

HWA GEOSCIENCES INC.

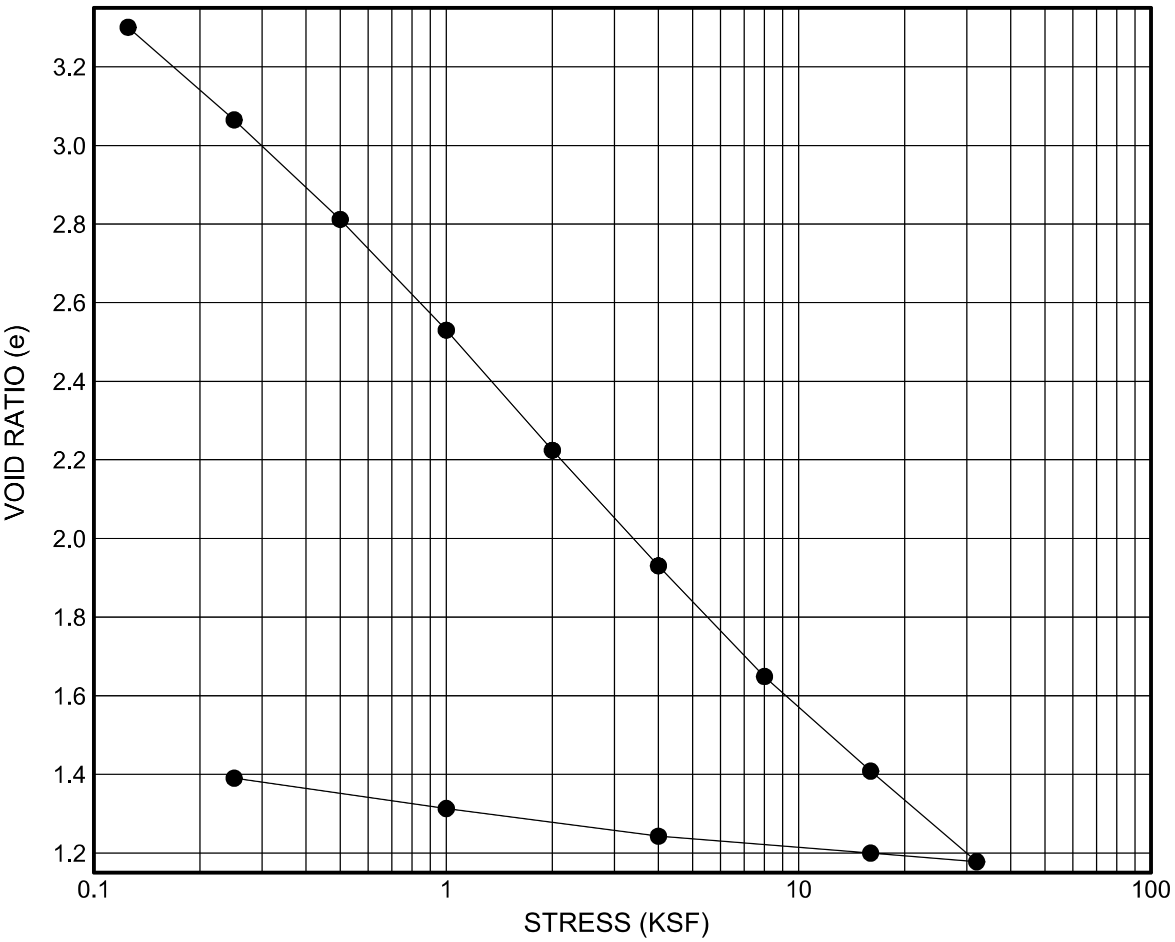
MLT for MTC, Inc.
Simpson Shelton Harbor

ONE DIMENSIONAL CONSOLIDATION OF SOILS
ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 1B



VOID RATIO VS. STRESS



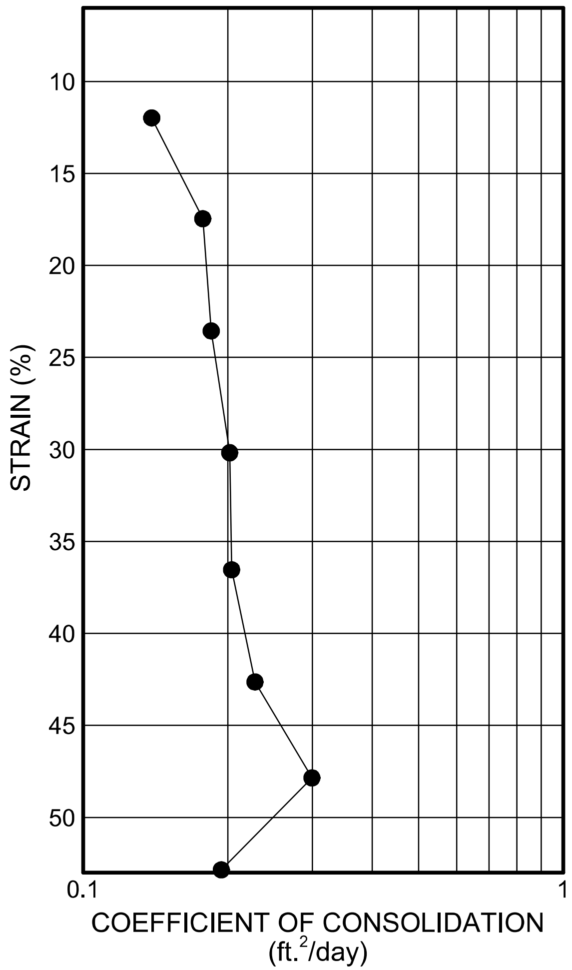
SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA1-PC03	0.0 - 2.0	(OH) Very dark grayish brown, organic SILT	125.8	54.5	100.8	99.9	34.5	66.6	3.618	1.390

HWA GEOSCIENCES INC.

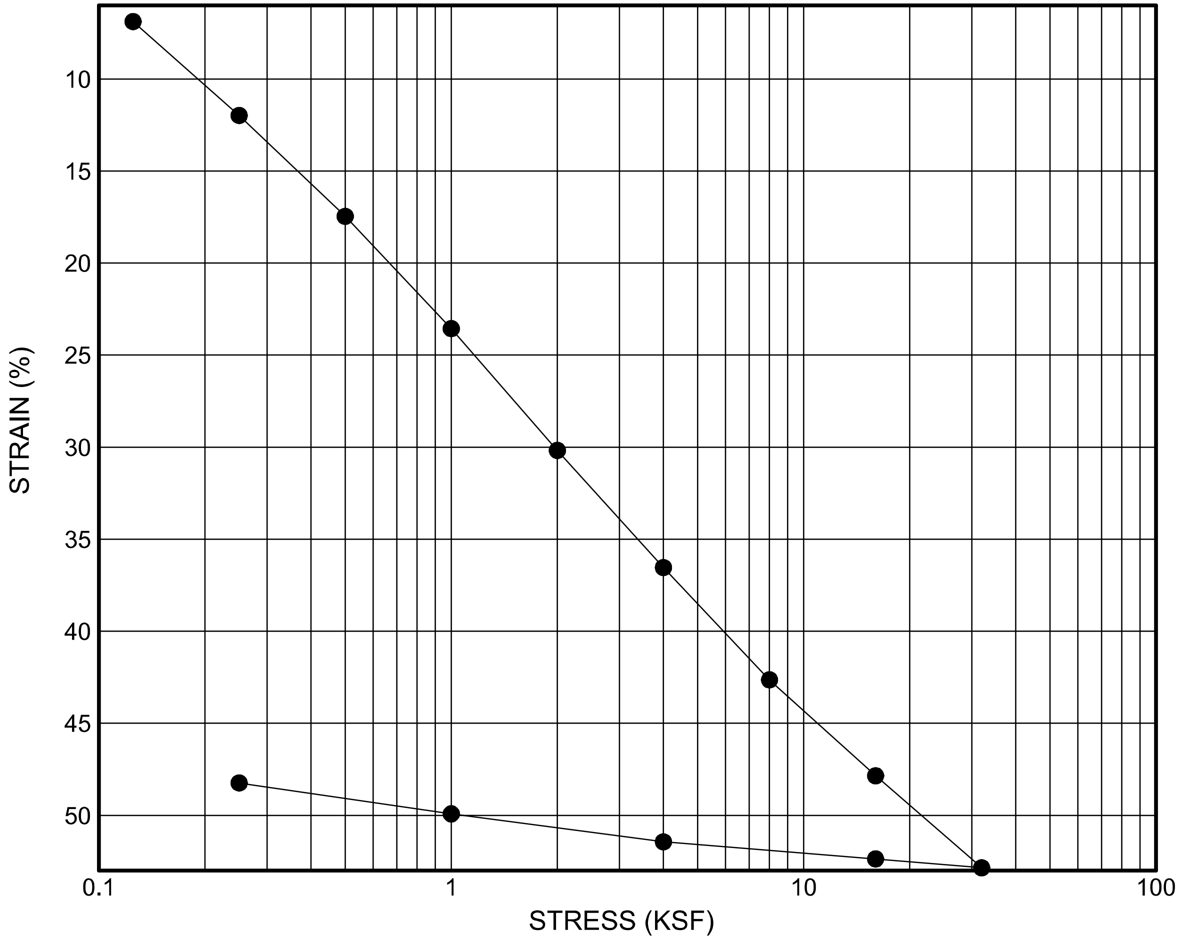
MLT for MTC, Inc.
Simpson Shelton Harbor

ONE DIMENSIONAL CONSOLIDATION OF SOILS ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 2A



STRAIN VS. STRESS



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA1-PC03	0.0 - 2.0	(OH) Very dark grayish brown, organic SILT	125.8	54.5	100.8	99.9	34.5	66.6	3.618	1.390

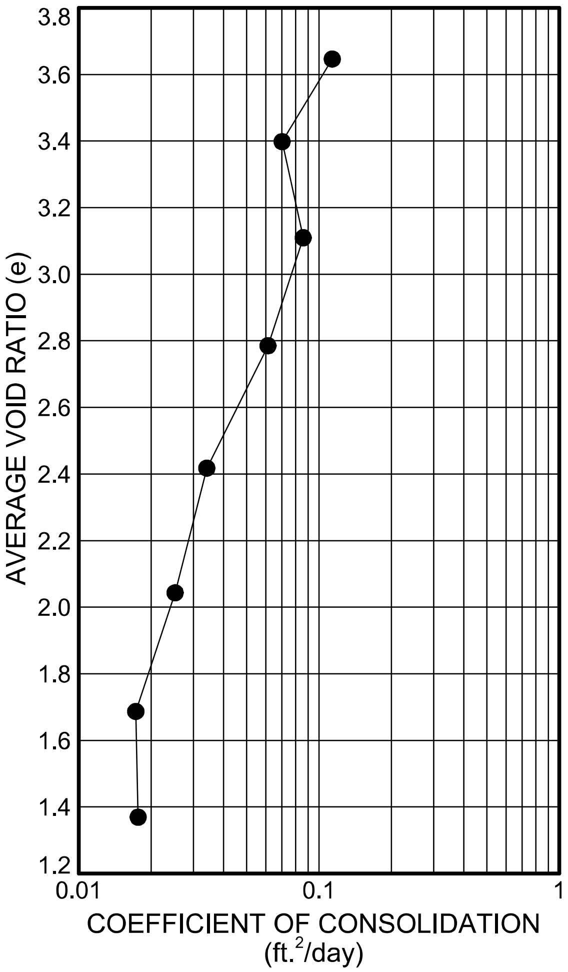
HWA GEOSCIENCES INC.

MLT for MTC, Inc.
Simpson Shelton Harbor

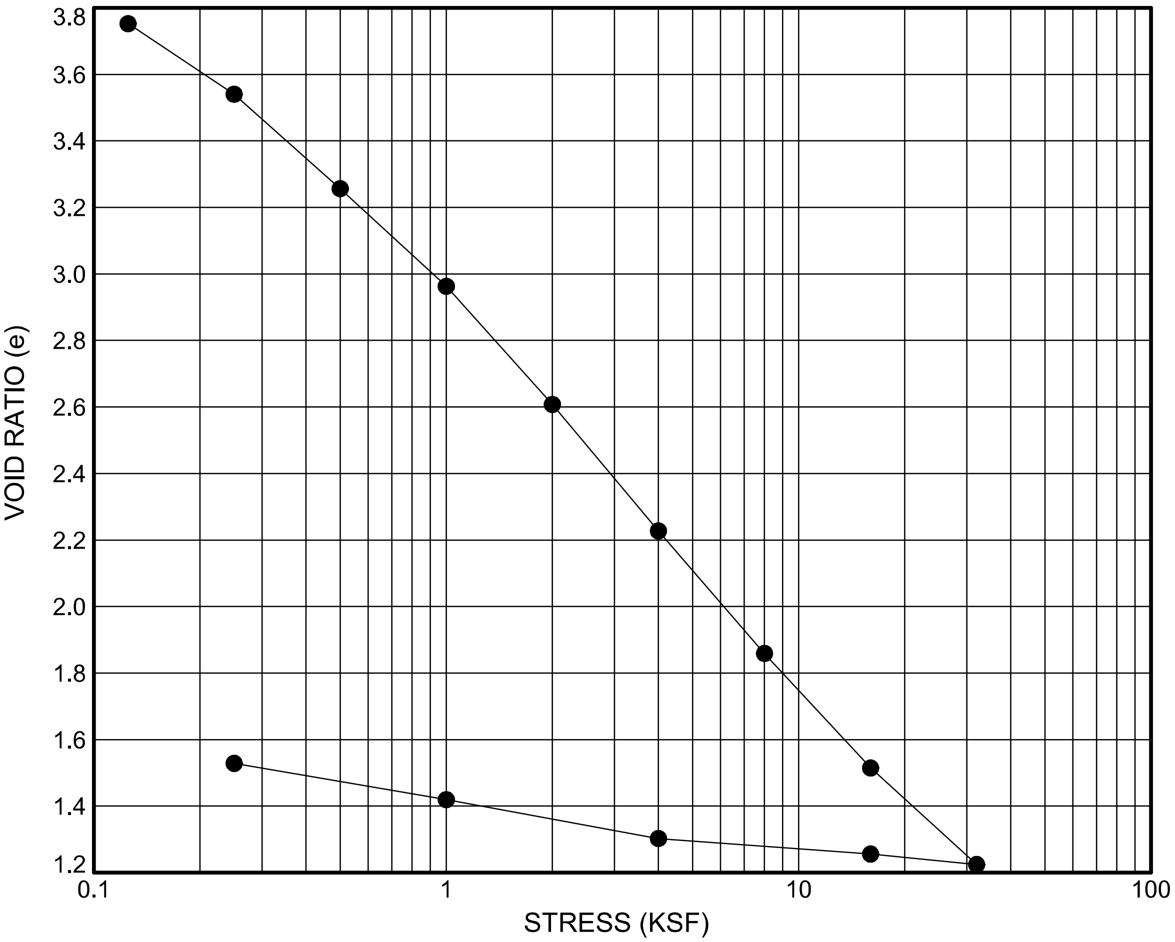
ONE DIMENSIONAL CONSOLIDATION OF SOILS
ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 2B

HWA_CONSOL_PG2_MTC-SIMPSON SHELTON 2012-002 T48.GPJ 7/17/18



VOID RATIO VS. STRESS



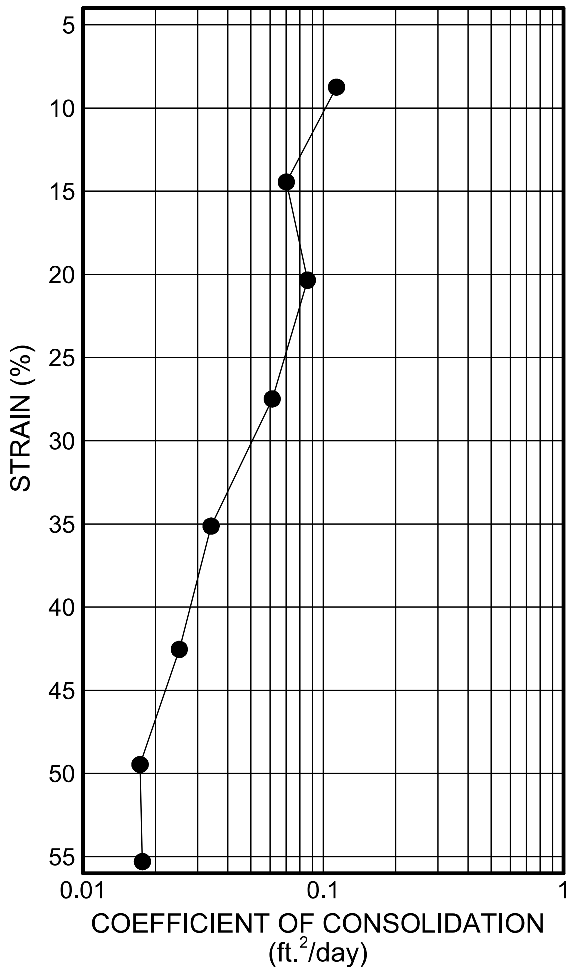
SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA3-PC01	0.0 - 1.8	(OH) Very dark brown, organic SILT	174.8	71.0	100.4	99.9	27.0	53.1	3.975	1.528

HWA GEOSCIENCES INC.

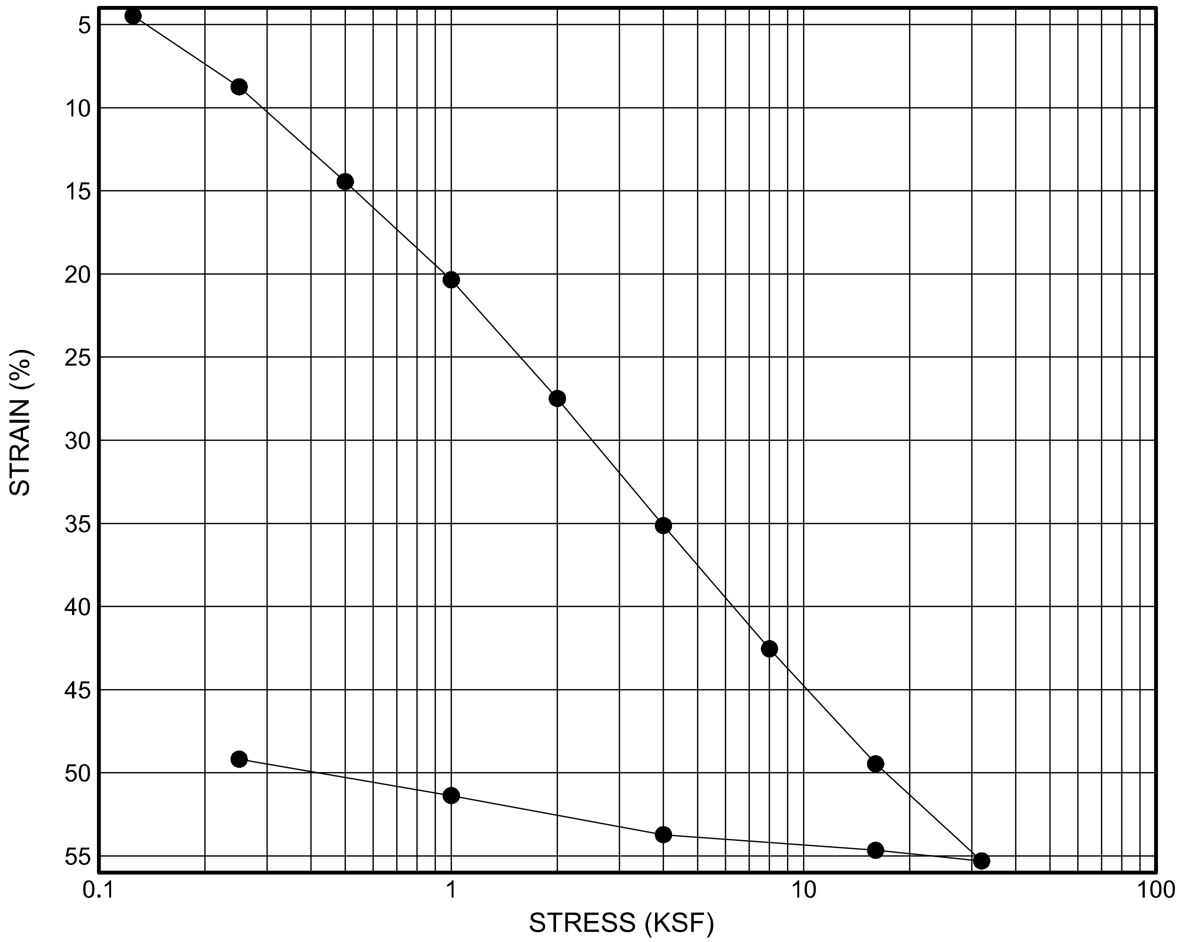
MLT for MTC, Inc.
Simpson Shelton Harbor

ONE DIMENSIONAL CONSOLIDATION OF SOILS
ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 3A



STRAIN VS. STRESS



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA3-PC01	0.0 - 1.8	(OH) Very dark brown, organic SILT	174.8	71.0	100.4	99.9	27.0	53.1	3.975	1.528

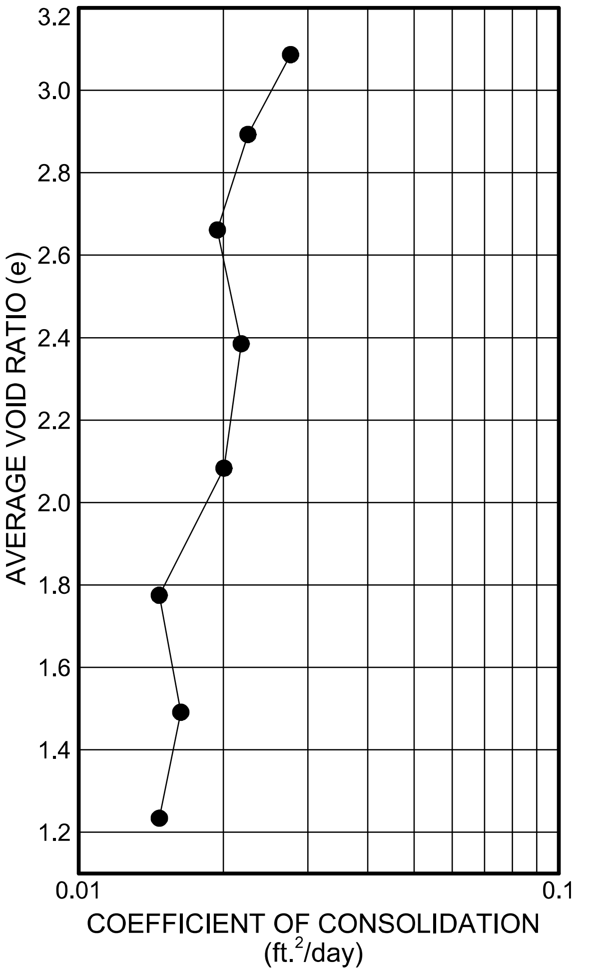
HWA GEOSCIENCES INC.

MLT for MTC, Inc.
Simpson Shelton Harbor

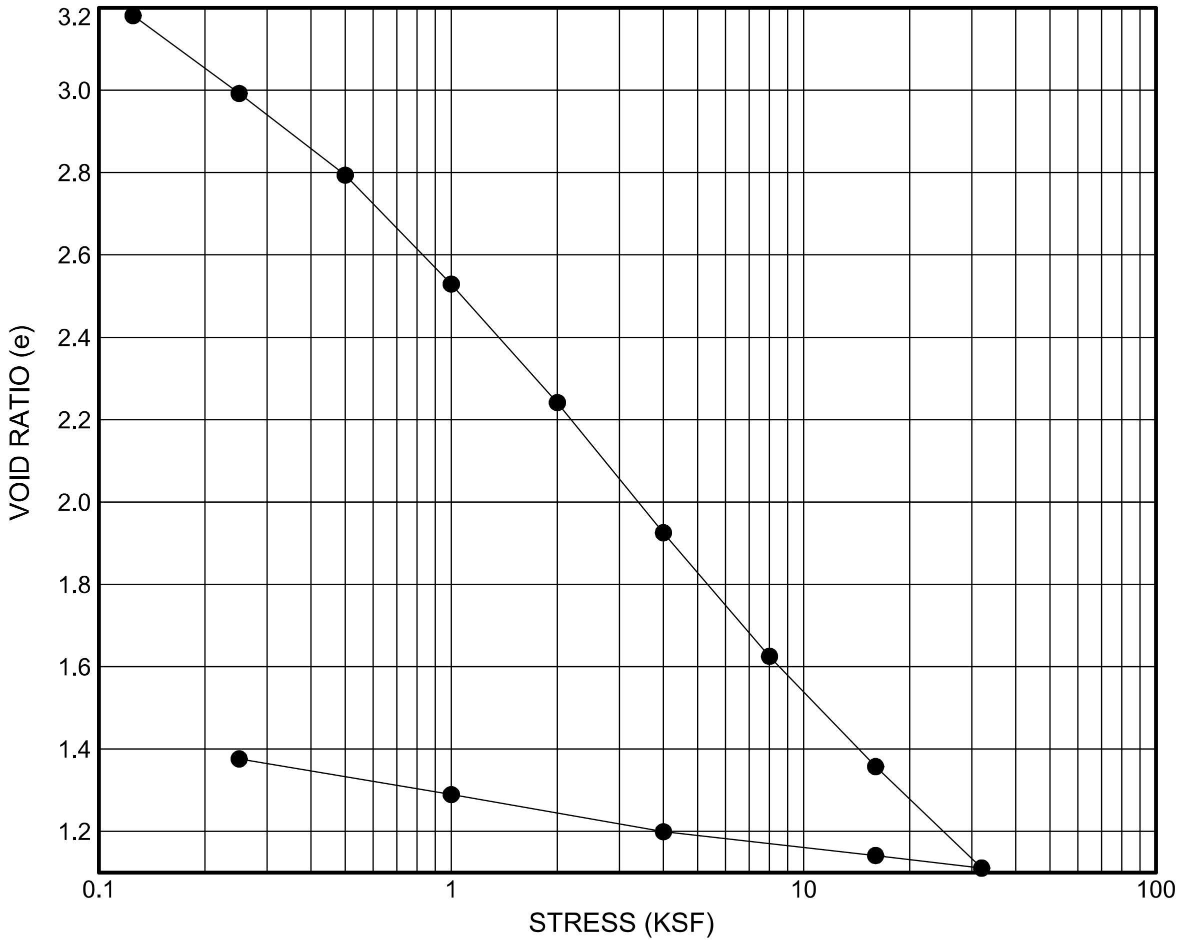
ONE DIMENSIONAL CONSOLIDATION OF SOILS ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 3B

HWA_CONSOL_PG2_MTC-SIMPSON SHELTON 2012-002 T48.GPJ 7/18/18



VOID RATIO VS. STRESS



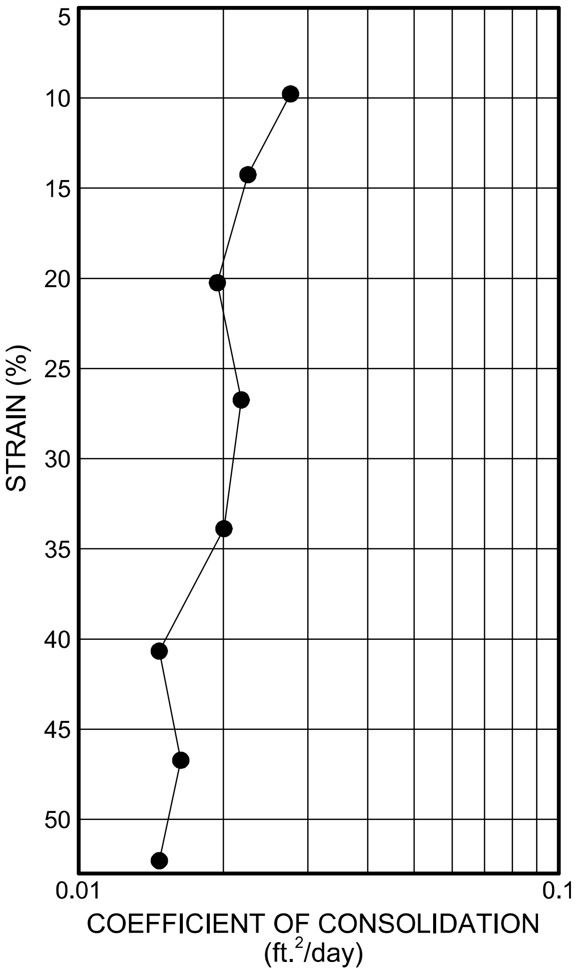
SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA3-PC03	0.0 - 1.7	(OH) Very dark brown, organic SILT	141.5	58.5	100.8	99.8	27.0	61.7	3.424	1.376

HWA GEOSCIENCES INC.

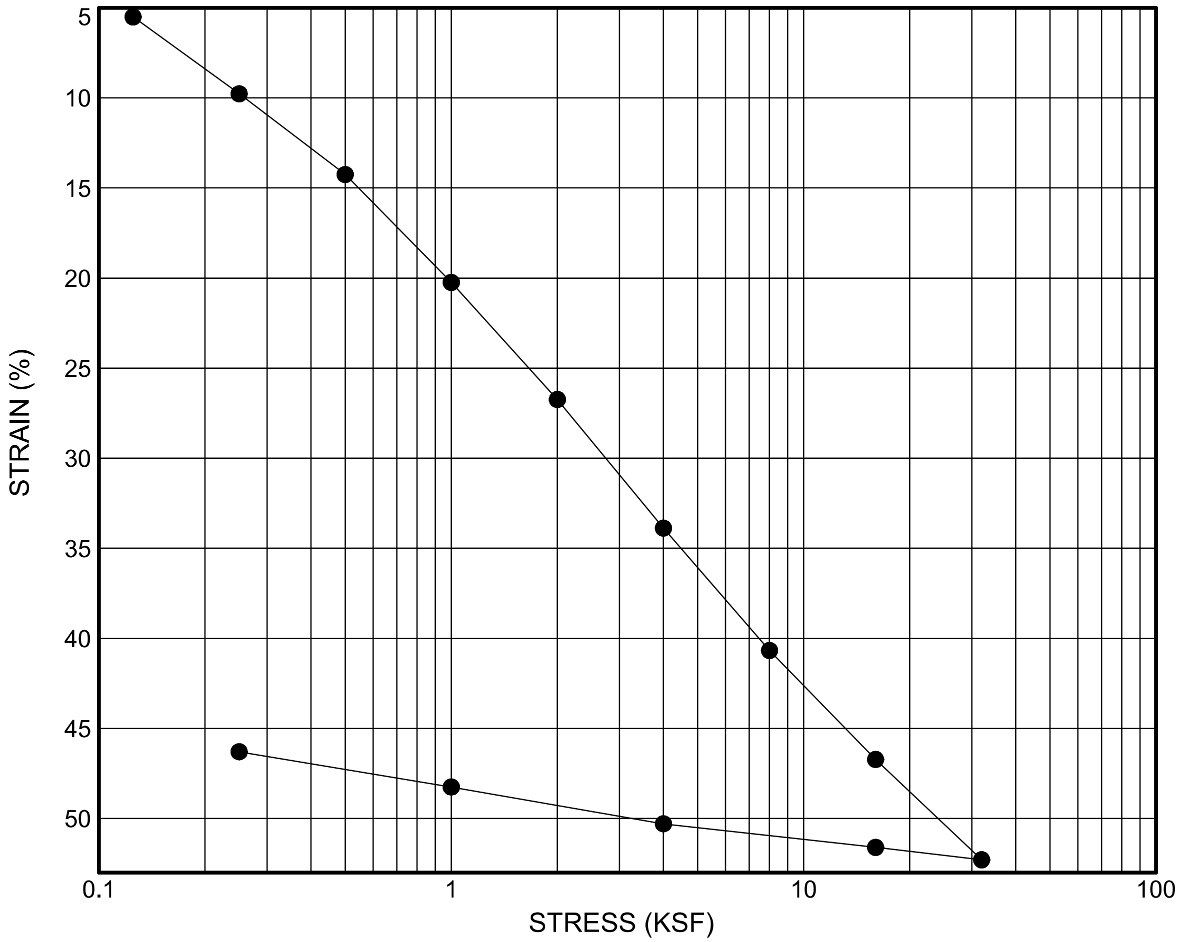
MLT for MTC, Inc.
Simpson Shelton Harbor

ONE DIMENSIONAL CONSOLIDATION OF SOILS ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 4A



STRAIN VS. STRESS



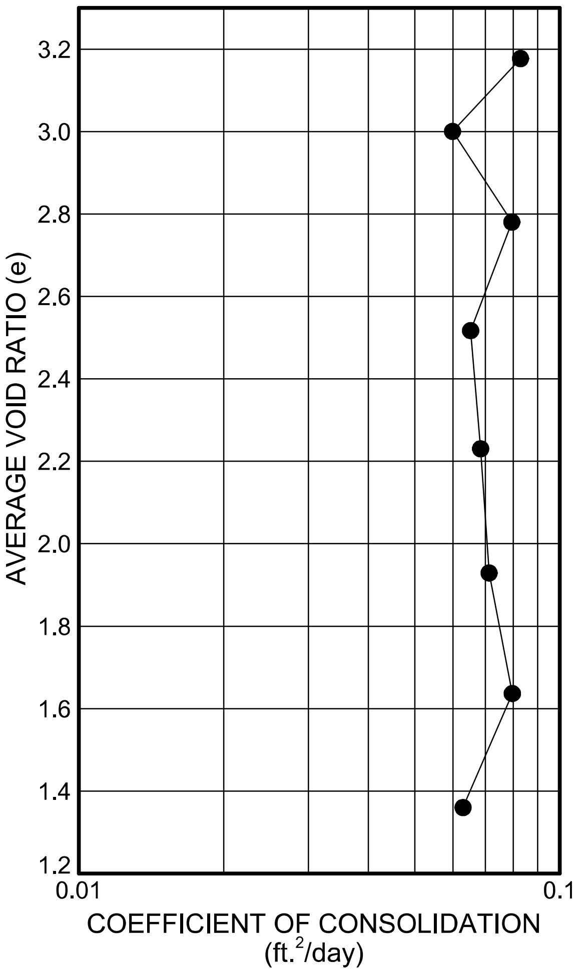
SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA3-PC03	0.0 - 1.7	(OH) Very dark brown, organic SILT	141.5	58.5	100.8	99.8	27.0	61.7	3.424	1.376

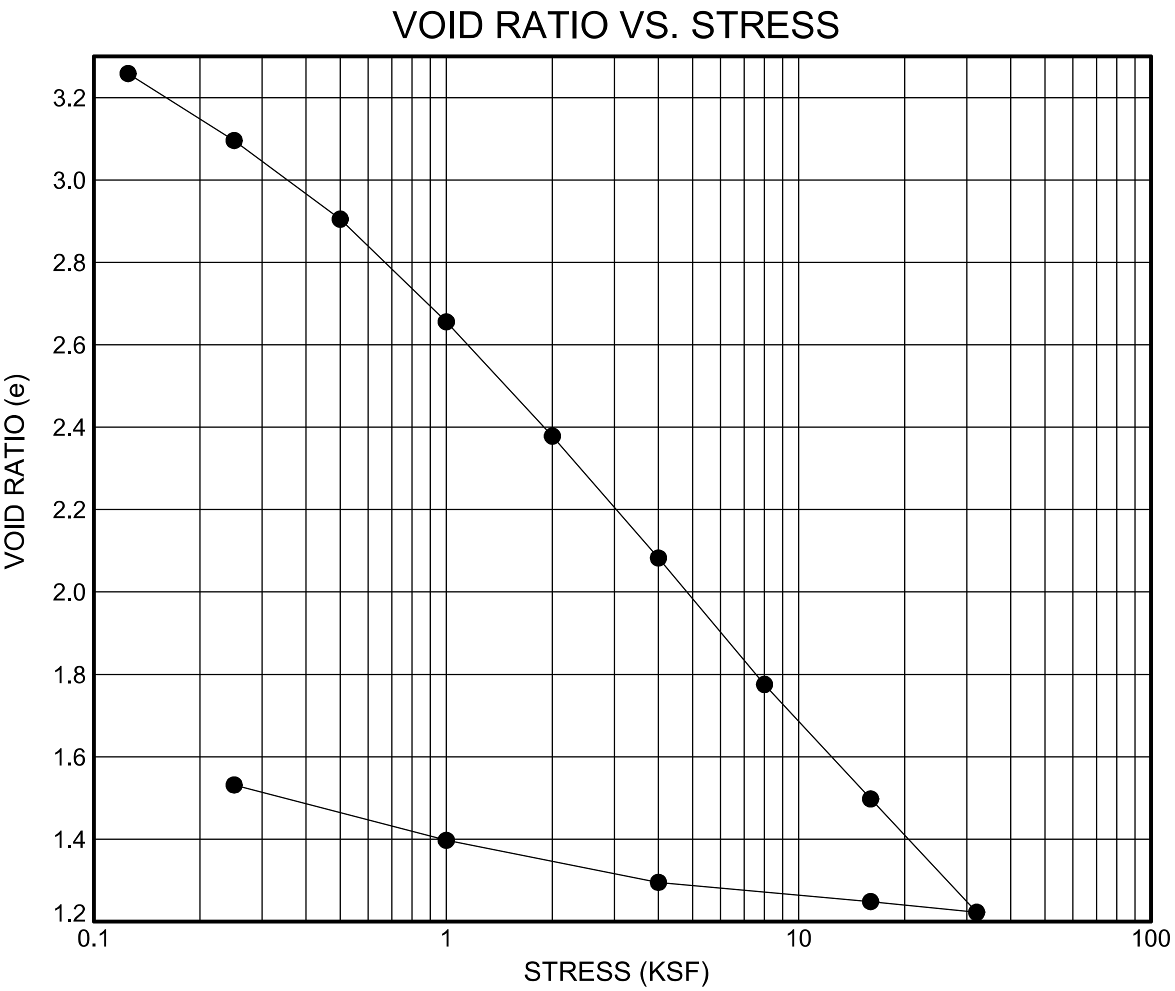
HWA GEOSCIENCES INC.

MLT for MTC, Inc.
Simpson Shelton Harbor

ONE DIMENSIONAL CONSOLIDATION OF SOILS ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 4B





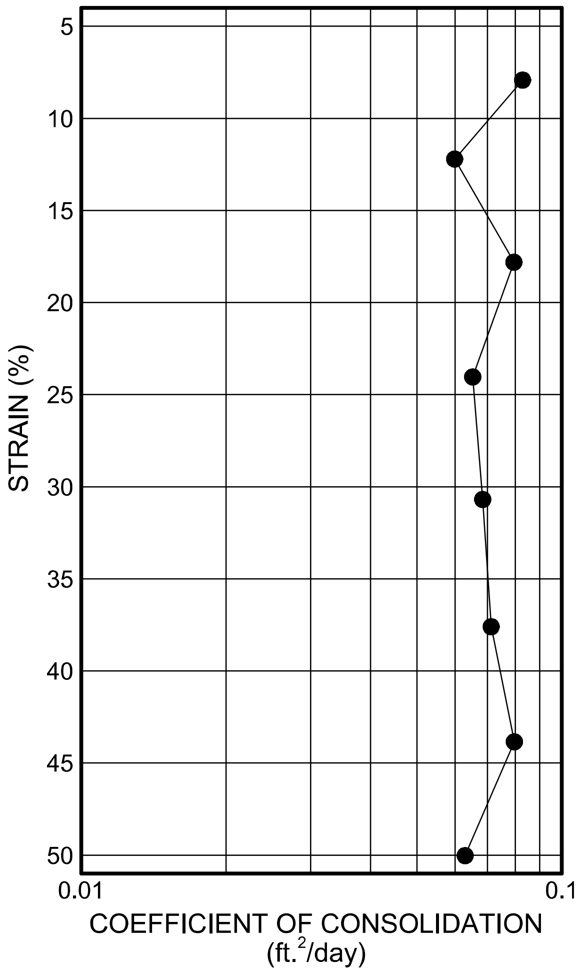
SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA3-PC05	1.3 - 1.3	(OH) Very dark brown, organic SILT	134.5	64.8	100.8	99.5	27.0	58.0	3.448	1.531

HWA GEOSCIENCES INC.

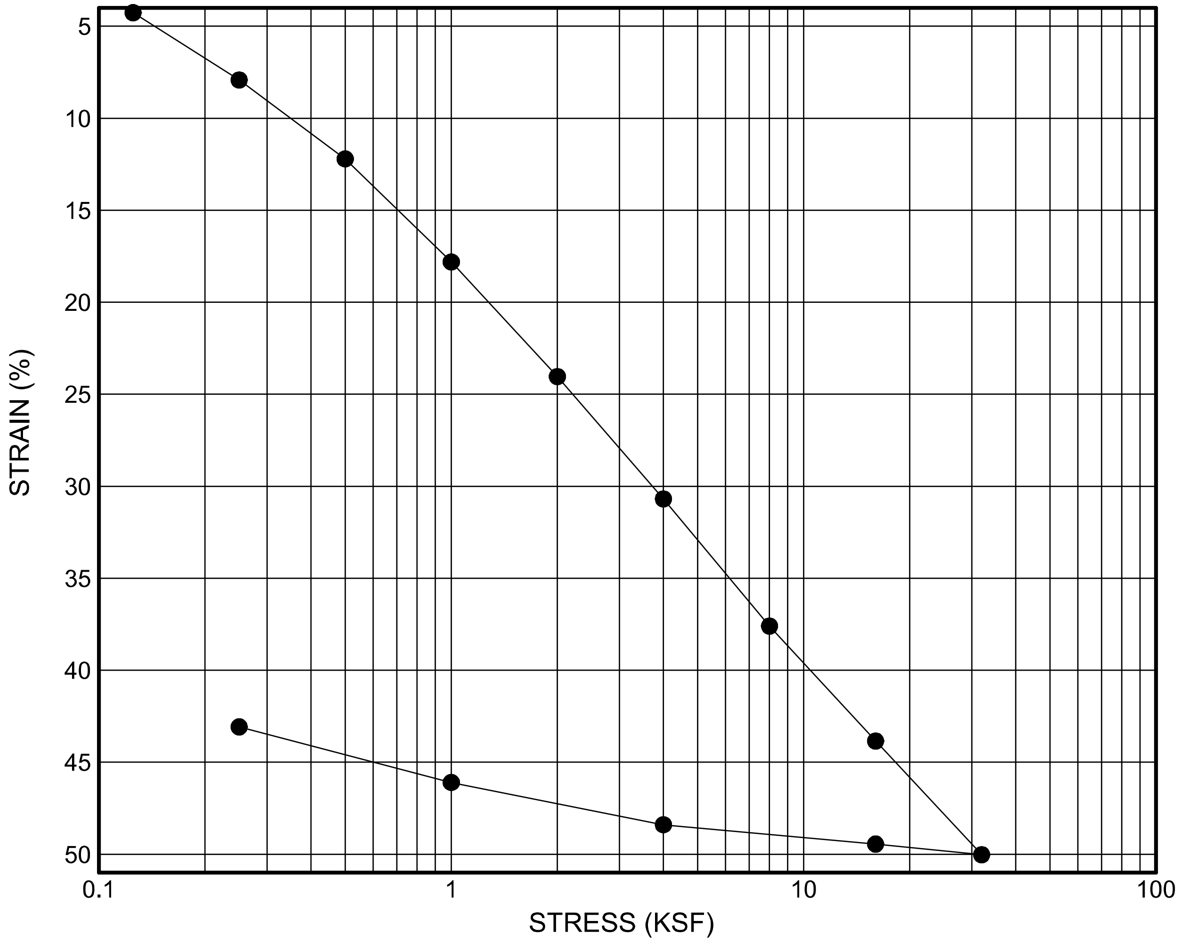
MLT for MTC, Inc.
Simpson Shelton Harbor

ONE DIMENSIONAL CONSOLIDATION OF SOILS ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 5A



STRAIN VS. STRESS



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487	% MC		% Saturation		Dry Density (pcf)		Void Ratio (e)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final
●	PDI-SMA3-PC05	1.3 - 1.3	(OH) Very dark brown, organic SILT	134.5	64.8	100.8	99.5	27.0	58.0	3.448	1.531

HWA GEOSCIENCES INC.

MLT for MTC, Inc.
Simpson Shelton Harbor

ONE DIMENSIONAL CONSOLIDATION OF SOILS ASTM D2435

PROJECT NO.: 2012-002 T48 FIGURE: 5B

HWA_CONSOL_PG2_MTC-SIMPSON SHELTON 2012-002 T48.GPJ 7/17/18

Anchor QEA, LLC	Project:	Simpson Shelton Harbor	
720 Olive Way, Suite 1900	Project Number:	110008-01.03	**Reported:**
Seattle WA, 98101	Project Manager:	Cheronne Oreiro	19-Jul-2018 16:46

Method:

Sample Preparation:
Preparation Method:
Preparation Batch:
Prepared:
Final Volume:

Anchor QEA, LLC	Project: Simpson Shelton Harbor	
720 Olive Way, Suite 1900	Project Number: 110008-01.03	**Reported:**
Seattle WA, 98101	Project Manager: Cheronne Oreiro	19-Jul-2018 16:46

Certified Analyses included in this Report

Analyte	Certifications

Code	Description	Number	Expires
ADEC	Alaska Dept of Environmental Conservation	17-015	02/07/2019
CALAP	California Department of Public Health CAELAP	2748	06/30/2018
DoD-ELAP	DoD-Environmental Laboratory Accreditation Program	66169	02/07/2019
NELAP	ORELAP - Oregon Laboratory Accreditation Program	WA100006-011	05/12/2019
WADOE	WA Dept of Ecology	C558	06/30/2019
WA-DW	Ecology - Drinking Water	C558	06/30/2019

Anchor QEA, LLC	Project: Simpson Shelton Harbor	
720 Olive Way, Suite 1900	Project Number: 110008-01.03	**Reported:**
Seattle WA, 98101	Project Manager: Cheronne Oreiro	19-Jul-2018 16:46

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
[2C]	Indicates this result was quantified on the second column on a dual column analysis.

Analytical Resources, Incorporated
Analytical Chemists and Consultants

12 July 2018

Cheronne Oreiro
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101

RE: Simpson Shelton Harbor

Please find enclosed sample receipt documentation and analytical results for samples from the project referenced above.

Sample analyses were performed according to ARI's Quality Assurance Plan and any provided project specific Quality Assurance Plan. Each analytical section of this report has been approved and reviewed by an analytical peer, the appropriate Laboratory Supervisor or qualified substitute, and a technical reviewer.

Should you have any questions or problems, please feel free to contact us at your convenience.

Associated Work Order(s)	Associated SDG ID(s)
18E0079	N/A

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed in the enclose Narrative. ARI, an accredited laboratory, certifies that the report results for which ARI is accredited meets all the requirements of the accrediting body. A list of certified analyses, accreditations, and expiration dates is included in this report.

Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his/her designee, as verified by the following signature.

Analytical Resources, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

ACCREDITED IN ACCORDANCE WITH nelac
Cert# 100006

PJLA Testing
Accreditation # 66169

Chain of Custod cord and Laboratory Analysis Request 18E0079

COC#

ANCHOR QEA

Date: 4/25/2018
Laboratory : ARI
Project Name: Shelton Harbor Remediation
Project Number: 110008-01.03
Project Contact: Cheronne Oreiro
Phone Number: (206) 287-9130
Shipment Method: Courier

					Sediment and Field QC		
Line	Field Sample ID	Collection Date/Time	Matrix	No. of Containers	Moisture Content	Grain Size	Comments
1	PDI-SMA3-SPT01-S1-180425	4/25/18 1140	~~SO~~SE	1	X		
2	PDI-SMA3-SPT01-S2-180425	1150	SE	1	X	X	
3	PDI-SMA3-SPT01-S3-180425	1200	SE	1	X		
4	PDI-SMA3-SPT01-S4-180425	1210	SE	1	X	X	
5	PDI-SMA3-SPT01-S5-180425	1220	SE	1	X	X	
6	PDI-SMA3-SPT01-S6-180425	1230	SE	1	X	X	
7	PDI-SMA3-SPT01-S7-180425	1240	SE	1	X	X	
8	PDI-SMA3-SPT01-S8-180425	1250	SE	1	X		
9			SE				
10			SE				
11			SE				
12			SE				
13			SE				
14			SE				

1 See project SQAPP for analyte lists and test methods
2 Email sample confirmation report to labdata@anchorqea.com

Additional notes/comments:

Relinquished By: / Eli Patmont
Company: Anchor QEA LLC.
Signature/Printed Name
Date/Time: 5/3/2018 1345

Received By: Stephanie Fisher/Stephanie Fisher
Company: ARI
Signature/Printed Name
Date/Time: 5/3/18 1345

Relinquished By:
Company:
Signature/Printed Name
Date/Time

Received By:
Company:
Signature/Printed Name
Date/Time

Distribution: A copy will be made for the laboratory and client. The Project file will retain th

Chain of Custod cord and Laboratory Analysis Request 18E0079 **COC#**

ANCHOR QEA

Date: 4/25/17
Laboratory : ARI
Project Name: Shelton Harbor Remediation
Project Number: 110008-01.03
Project Contact: Cheronne Oreiro
Phone Number: (206) 287-9130
Shipment Method: Courier

					Sediment and Field QC		
Line	Field Sample ID	Collection Date/Time	Matrix	No. of Containers	Moisture Content	Grain Size	Comments
1	PDI-SMA3-SPT02-S1-180425	4/25/18 0945	SO SE	1	X		
2	PDI-SMA3-SPT02-S2-180425	0955	SE	1	X	X	
3	PDI-SMA3-SPT02-S3-180425	1005	SE	1	X		
4	PDI-SMA3-SPT02-S4-180425	1015	SE	1	X	X	
5	PDI-SMA3-SPT02-S5-180425	1025	SE	1	X		
6	PDI-SMA3-SPT02-S6-180425	1035	SE	1	X	X	
7	PDI-SMA3-SPT02-S7-180425	1045	SE	1	X		
8	PDI-SMA3-SPT02-S8-180625	1055	SE	1	X	X	
9			SE				
10			SE				
11			SE				
12			SE				
13			SE				
14			SE				

1 See project SQAPP for analyte lists and test methods

2 Email sample confirmation report to labdata@anchorqea.com

Additional notes/comments:

Relinquished By: / Eli Patmont
Company: Anchor QEA LLC.
Signature/Printed Name
Date/Time: 5/3/2018 1345

Received By: Stephanie Fishel
Company: ARI
Signature/Printed Name
Date/Time: 5/3/18 1345

Relinquished By:
Company:
Signature/Printed Name
Date/Time

Received By:
Company:
Signature/Printed Name
Date/Time

Distribution: A copy will be made for the laboratory and client. The Project file will retain th

Analytical Report

Anchor QEA, LLC	Project: Simpson Shelton Harbor	
720 Olive Way, Suite 1900	Project Number: 110008-01.03	**Reported:**
Seattle WA, 98101	Project Manager: Cheronne Oreiro	12-Jul-2018 12:36

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
PDI-SMA3-SPT01-S1-180425	18E0079-01	Solid	25-Apr-2018 11:40	03-May-2018 13:45
PDI-SMA3-SPT01-S2-180425	18E0079-02	Solid	25-Apr-2018 11:50	03-May-2018 13:45
PDI-SMA3-SPT01-S3-180425	18E0079-03	Solid	25-Apr-2018 12:00	03-May-2018 13:45
PDI-SMA3-SPT01-S4-180425	18E0079-04	Solid	25-Apr-2018 12:10	03-May-2018 13:45
PDI-SMA3-SPT01-S5-180425	18E0079-05	Solid	25-Apr-2018 12:20	03-May-2018 13:45
PDI-SMA3-SPT01-S6-180425	18E0079-06	Solid	25-Apr-2018 12:30	03-May-2018 13:45
PDI-SMA3-SPT01-S7-180425	18E0079-07	Solid	25-Apr-2018 12:40	03-May-2018 13:45
PDI-SMA3-SPT01-S8-180425	18E0079-08	Solid	25-Apr-2018 12:50	03-May-2018 13:45
PDI-SMA3-SPT02-S1-180425	18E0079-09	Solid	25-Apr-2018 09:45	03-May-2018 13:45
PDI-SMA3-SPT02-S2-180425	18E0079-10	Solid	25-Apr-2018 09:55	03-May-2018 13:45
PDI-SMA3-SPT02-S3-180425	18E0079-11	Solid	25-Apr-2018 10:05	03-May-2018 13:45
PDI-SMA3-SPT02-S4-180425	18E0079-12	Solid	25-Apr-2018 10:15	03-May-2018 13:45
PDI-SMA3-SPT02-S5-180425	18E0079-13	Solid	25-Apr-2018 10:25	03-May-2018 13:45
PDI-SMA3-SPT02-S6-180425	18E0079-14	Solid	25-Apr-2018 10:35	03-May-2018 13:45
PDI-SMA3-SPT02-S7-180425	18E0079-15	Solid	25-Apr-2018 10:45	03-May-2018 13:45
PDI-SMA3-SPT02-S8-180425	18E0079-16	Solid	25-Apr-2018 10:55	03-May-2018 13:45

Anchor QEA, LLC	Project: Simpson Shelton Harbor	
720 Olive Way, Suite 1900	Project Number: 110008-01.03	**Reported:**
Seattle WA, 98101	Project Manager: Cheronne Oreiro	12-Jul-2018 12:36

Case Narrative

Sample receipt

Samples as listed on the preceding page were received May 3, 2018 under ARI work order 18E0079. For details regarding sample receipt, please refer to the Cooler Receipt Form.

Grainsize and Moisture Content

The samples were submitted to Materials Testing & Consulting, Inc. (MTC) for grainsize analysis. The MTC report is included here in its entirety.

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Cooler Receipt Form

ARI Client: Anchor Qea

Project Name: Shelton Harbor Remediation

COC No(s): ______ NA

Delivered by: Fed-Ex UPS Courier [✓ Hand Delivered] Other: ______

Assigned ARI Job No: 18E0079

Tracking No: ______ [✓ NA]

Preliminary Examination Phase:

Were intact, properly signed and dated custody seals attached to the outside of to cooler? YES [✓ NO]

Were custody papers included with the cooler? .... [✓ YES] NO

Were custody papers properly filled out (ink, signed, etc.) .... [✓ YES] NO

Temperature of Cooler(s) (°C) (recommended 2.0-6.0 °C for chemistry) 17.8 ___ ___ ___ ___
Time: 1345

If cooler temperature is out of compliance fill out form 00070F

Temp Gun ID#: D002565

Cooler Accepted by: Sef Date: 5/3/18 Time: 1345

Complete custody forms and attach all shipping documents

Log-In Phase:

Was a temperature blank included in the cooler? .... YES [✓ NO]

What kind of packing material was used? ... Bubble Wrap Wet Ice Gel Packs Baggies Foam Block Paper Other: —

Was sufficient ice used (if appropriate)? .... NA YES [✓ NO]

Were all bottles sealed in individual plastic bags? .... [✓ YES] NO

Did all bottles arrive in good condition (unbroken)? .... [✓ YES] NO

Were all bottle labels complete and legible? .... [✓ YES] NO

Did the number of containers listed on COC match with the number of containers received? .... [✓ YES] NO

Did all bottle labels and tags agree with custody papers? .... YES [✓ NO]

Were all bottles used correct for the requested analyses? .... [✓ YES] NO

Do any of the analyses (bottles) require preservation? (attach preservation sheet, excluding VOCs)... [✓ NA] YES NO

Were all VOC vials free of air bubbles? .... [✓ NA] YES NO

Was sufficient amount of sample sent in each bottle? .... [✓ YES] NO

Date VOC Trip Blank was made at ARI.......... [✓ NA] ______

Was Sample Split by ARI : [✓ NA] YES Date/Time: ______ Equipment: ______ Split by: ______

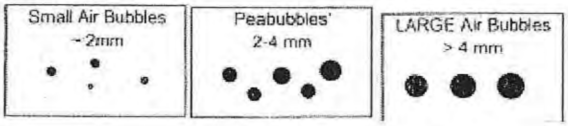
Samples Logged by: Sef Date: 5/4/18 Time: 1139

***** Notify Project Manager of discrepancies or concerns *****

Sample ID on Bottle	~~Sample ID on COC~~	~~Sample ID on Bottle~~	Sample ID on COC
(PDI-SMA3-SPT02-S1-180425)		(PDI-SMA3-SPT02-S2-180425)	

Additional Notes, Discrepancies, & Resolutions:

By: Date:



Small → "sm" (< 2 mm)
Peabubbles → "pb" (2 to < 4 mm)
Large → "lg" (4 to < 6 mm)
Headspace → "hs" (> 6 mm)

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Cooler Temperature Compliance Form

ARI Work Order: 18E0079

Cooler#: ______ **Temperature(°C):** 17.6

Sample ID	Bottle Count	Bottle Type
Samples received		
above 6°		

Cooler#: ______ **Temperature(°C):** ______

Sample ID	Bottle Count	Bottle Type

Cooler#: ______ **Temperature(°C):** ______

Sample ID	Bottle Count	Bottle Type

Cooler#: ______ **Temperature(°C):** ______

Sample ID	Bottle Count	Bottle Type

Completed by: Sef Date: 5/3/18 Time: 1345

Materials Testing & Consulting, Inc.
Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project: Simpson Shelton Harbor
Project #: 18S010-21
Client : Analytical Resources, Inc.
Source: Multiple
MTC Sample#: Multiple

Date Received: May 15, 2018
Sampled By: Others
Date Tested: May 30, 2018
Tested By: AE/CFM

CASE NARRATIVE

1. Sixteen samples were submitted for analysis.
2. Nine samples were analyzed for grain size distribution according to ASTM D422. The samples were prepared according to ASTM D421. An assumed specific gravity of 2.65 was used in the hydrometer calculations. A standard milkshake mixer type device was used to disperse the fine fraction sample for one minute.
3. Sixteen samples were analyzed for moisture content determination according to ASTM D2216.
4. The data is provided in summary tables and plots.
5. There were no noted anomalies in this project.

Reviewed by:

Corporate ~ 777 Chrysler Drive • Burlington, WA 98233 • Phone (360) 755-1990 • Fax (360) 755-1980
Regional Offices: Olympia ~ 360.534.9777 Bellingham ~ 360.647.6111 Silverdale ~ 360.698.6787 Tukwila ~ 206.241.1974
Visit our website: www.mtc-inc.net

Materials Testing & Consulting, Inc.
Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Date Received: May 15, 2018
Date Tested: May 31, 2018

Client: Analytical Resources, Inc.
Sampled by: Others
Tested by: AE/CFM

Moisture Content - ASTM D2216

Sample #	Location	Tare	Wet + Tare	Dry + Tare	Wgt. Of Moisture	Wgt. Of Soil	% Moisture
S18-0774	PDI-SMA3-SPT01-S1-180425	10.6	296.2	271.0	25.2	260.4	9.7%
S18-0775	PDI-SMA3-SPT01-S2-180425	10.0	171.4	146.7	24.7	136.7	18.1%
S18-0776	PDI-SMA3-SPT01-S3-180425	9.9	95.2	65.3	29.9	55.4	54.0%
S18-0777	PDI-SMA3-SPT01-S4-180425	10.8	229.8	202.6	27.2	191.8	14.2%
S18-0778	PDI-SMA3-SPT01-S5-180425	11.3	191.0	161.5	29.5	150.2	19.6%
S18-0779	PDI-SMA3-SPT01-S6-180425	10.9	224.5	193.6	30.9	182.7	16.9%
S18-0780	PDI-SMA3-SPT01-S7-180425	10.0	304.4	242.3	62.1	232.3	26.7%
S18-0781	PDI-SMA3-SPT01-S8-180425	9.9	485.4	404.1	81.3	394.2	20.6%
S18-0782	PDI-SMA3-SPT02-S1-180425	10.4	166.3	108.2	58.1	97.8	59.4%
S18-0783	PDI-SMA3-SPT02-S2-180425	10.6	227.4	198.7	28.7	188.1	15.3%
S18-0784	PDI-SMA3-SPT02-S3-180425	10.2	161.9	130.7	31.2	120.5	25.9%
S18-0785	PDI-SMA3-SPT02-S4-180425	10.1	273.0	216.7	56.3	206.6	27.3%
S18-0786	PDI-SMA3-SPT02-S5-180425	10.2	160.1	136.9	23.2	126.7	18.3%
S18-0787	PDI-SMA3-SPT02-S6-180425	10.2	181.3	159.8	21.5	149.6	14.4%
S18-0788	PDI-SMA3-SPT02-S7-180425	10.3	451.3	373.8	77.5	363.5	21.3%
S18-0789	PDI-SMA3-SPT02-S8-180425	10.3	193.7	165.9	27.8	155.6	17.9%

Reviewed by:

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Sieve Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-SPT01-S2-180425
Sample#: S18-0775

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D-2487 Unified Soils Classification System
GP-GM, Poorly graded Gravel with Silt and Sand
Sample Color:
Brown

ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

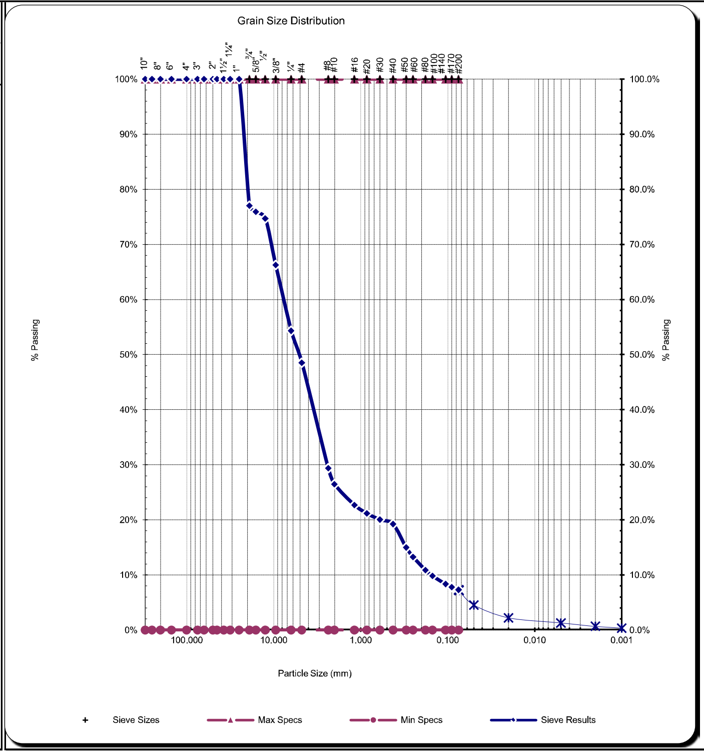
$D_{(5)}$ = 0.051 mm
$D_{(10)}$ = 0.154 mm
$D_{(15)}$ = 0.301 mm
$D_{(30)}$ = 2.437 mm
$D_{(50)}$ = 5.146 mm
$D_{(60)}$ = 7.819 mm
$D_{(90)}$ = 22.387 mm
Dust Ratio = 11/29

% Gravel = 51.5%
% Sand = 41.2%
% Silt & Clay = 7.3%
Liquid Limit = n/a
Plasticity Index = n/a
Sand Equivalent = n/a
Fracture %, 1 Face = n/a
Fracture %, 2+ Faces = n/a

Coeff. of Curvature, C_C = 4.92
Coeff. of Uniformity, C_U = 50.70
Fineness Modulus = 5.11
Plastic Limit = n/a
Moisture %, as sampled = 18.1%
Req'd Sand Equivalent =
Req'd Fracture %, 1 Face =
Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
US	Metric				
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	77%	77%	100.0%	0.0%
5/8"	16.00		76%	100.0%	0.0%
1/2"	12.50	75%	75%	100.0%	0.0%
3/8"	9.50	66%	66%	100.0%	0.0%
1/4"	6.30		54%	100.0%	0.0%
#4	4.75	49%	49%	100.0%	0.0%
#8	2.36		29%	100.0%	0.0%
#10	2.00	27%	27%	100.0%	0.0%
#16	1.18		23%	100.0%	0.0%
#20	0.850		21%	100.0%	0.0%
#30	0.600		20%	100.0%	0.0%
#40	0.425	19%	19%	100.0%	0.0%
#50	0.300		15%	100.0%	0.0%
#60	0.250		13%	100.0%	0.0%
#80	0.180		11%	100.0%	0.0%
#100	0.150		10%	100.0%	0.0%
#140	0.106		8%	100.0%	0.0%
#170	0.090		8%	100.0%	0.0%
#200	0.075	7.3%	7.3%	100.0%	0.0%



Comments: ______________________________

Reviewed by: ______________________________

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Hydrometer Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client : Analytical Resources, Inc.
Source: PDI-SMA3-SPT01-S2-180425
Sample#: S18-0775

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D 2487 Soils Classification
GP-GM, Poorly graded Gravel with Silt and Sand
Sample Color
Brown

ASTM D-422, HYDROMETER ANALYSIS

Assumed Sp Gr : 2.65
Sample Weight: 50.17 grams
Hydroscopic Moist.: 0.87%
Adj. Sample Wgt : 49.74 grams

Hydrometer Reading Minutes	Corrected Reading	Percent Passing	Soils Particle Diameter
2	6	3.2%	0.0378 mm
5	5	2.7%	0.0240 mm
15	3	1.6%	0.0140 mm
30	3	1.6%	0.0099 mm
60	3	1.6%	0.0070 mm
250	2	1.1%	0.0035 mm
1440	1	0.5%	0.0014 mm

% Gravel: 51.5%
% Sand: 41.2%
% Silt: 6.0%
% Clay: 1.3%

Liquid Limit: n/a
Plastic Limit: n/a
Plasticity Index: n/a

ASTM C-136

Sieve Analysis
Grain Size Distribution

Sieve Size	Percent Passing	Soils Particle Diameter
3.0"	100%	75.000 mm
2.0"	100%	50.000 mm
1.5"	100%	37.500 mm
1.25"	100%	31.500 mm
1.0"	100%	25.000 mm
3/4"	77%	19.000 mm
5/8"	76%	16.000 mm
1/2"	75%	12.500 mm
3/8"	66%	9.500 mm
1/4"	54%	6.300 mm
#4	49%	4.750 mm
#10	27%	2.000 mm
#20	21%	0.850 mm
#40	19%	0.425 mm
#100	10%	0.150 mm
#200	7.3%	0.075 mm
Silts	7.2%	0.074 mm
	4.5%	0.050 mm
	2.2%	0.020 mm
Clays	1.3%	0.005 mm
	0.7%	0.002 mm
Colloids	0.4%	0.001 mm

USDA Soil Textural Classification

	Particle Size
% Sand:	2.0 - 0.05 mm
% Silt:	0.05 - 0.002 mm
% Clay:	< 0.002 mm

USDA Soil Textural Classification

N/A

Comments: ______________________________

Reviewed by: ______________________________

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Sieve Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-SPT01-S5-180425
Sample#: S18-0778

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D-2487 Unified Soils Classification System
SW, Well-graded Sand with Gravel
Sample Color:
Brown

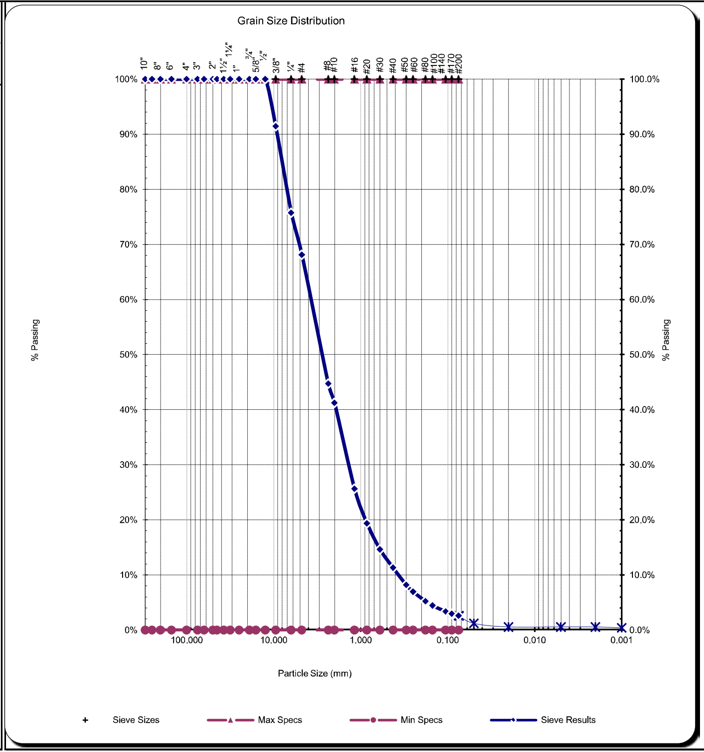
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.171 mm	% Gravel = 31.9%	Coeff. of Curvature, C_C = 1.36
$D_{(10)}$ = 0.372 mm	% Sand = 65.5%	Coeff. of Uniformity, C_U = 10.53
$D_{(15)}$ = 0.619 mm	% Silt & Clay = 2.6%	Fineness Modulus = 4.43
$D_{(30)}$ = 1.408 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 2.894 mm	Plasticity Index = n/a	Moisture %, as sampled = 19.6%
$D_{(60)}$ = 3.917 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 9.198 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 3/13	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00		100%	100.0%	0.0%
1/2"	12.50	100%	100%	100.0%	0.0%
3/8"	9.50	91%	91%	100.0%	0.0%
1/4"	6.30		76%	100.0%	0.0%
#4	4.75	68%	68%	100.0%	0.0%
#8	2.36		45%	100.0%	0.0%
#10	2.00	41%	41%	100.0%	0.0%
#16	1.18		26%	100.0%	0.0%
#20	0.850		19%	100.0%	0.0%
#30	0.600		15%	100.0%	0.0%
#40	0.425	11%	11%	100.0%	0.0%
#50	0.300		8%	100.0%	0.0%
#60	0.250		7%	100.0%	0.0%
#80	0.180		5%	100.0%	0.0%
#100	0.150		4%	100.0%	0.0%
#140	0.106		3%	100.0%	0.0%
#170	0.090		3%	100.0%	0.0%
#200	0.075	2.6%	2.6%	100.0%	0.0%



Comments: ______________________________

Reviewed by: ______________________________

Hydrometer Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client : Analytical Resources, Inc.
Source: PDI-SMA3-SPT01-S5-180425
Sample#: S18-0778

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D 2487 Soils Classification
SW, Well-graded Sand with Gravel

Sample Color
Brown

ASTM D-422, HYDROMETER ANALYSIS

Assumed Sp Gr : 2.65
Sample Weight: 72.31 grams
Hydroscopic Moist.: 0.35%
Adj. Sample Wgt : 72.06 grams

Hydrometer Reading Minutes	Corrected Reading	Percent Passing	Soils Particle Diameter
2	1	0.6%	0.0387 mm
5	1	0.6%	0.0245 mm
15	1	0.6%	0.0141 mm
30	1	0.6%	0.0100 mm
60	1	0.6%	0.0071 mm
250	1	0.6%	0.0035 mm
1440	1	0.6%	0.0014 mm

% Gravel: 31.9%
% Sand: 65.5%
% Silt: 2.0%
% Clay: 0.6%

Liquid Limit: n/a
Plastic Limit: n/a
Plasticity Index: n/a

ASTM C-136

Sieve Analysis
Grain Size Distribution

Sieve Size	Percent Passing	Soils Particle Diameter
3.0"	100%	75.000 mm
2.0"	100%	50.000 mm
1.5"	100%	37.500 mm
1.25"	100%	31.500 mm
1.0"	100%	25.000 mm
3/4"	100%	19.000 mm
5/8"	100%	16.000 mm
1/2"	100%	12.500 mm
3/8"	91%	9.500 mm
1/4"	76%	6.300 mm
#4	68%	4.750 mm
#10	41%	2.000 mm
#20	19%	0.850 mm
#40	11%	0.425 mm
#100	4%	0.150 mm
#200	2.6%	0.075 mm
Silts	2.6%	0.074 mm
	1.2%	0.050 mm
	0.6%	0.020 mm
Clays	0.6%	0.005 mm
	0.6%	0.002 mm
Colloids	0.4%	0.001 mm

USDA Soil Textural Classification

	Particle Size
% Sand:	2.0 - 0.05 mm
% Silt:	0.05 - 0.002 mm
% Clay:	< 0.002 mm

USDA Soil Textural Classification

N/A

Comments: ______________________

Reviewed by: ______________________

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Sieve Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-SPT01-S6-180425
Sample#: S18-0779

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D-2487 Unified Soils Classification System
SW, Well-graded Sand with Gravel
Sample Color:
Brown

ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

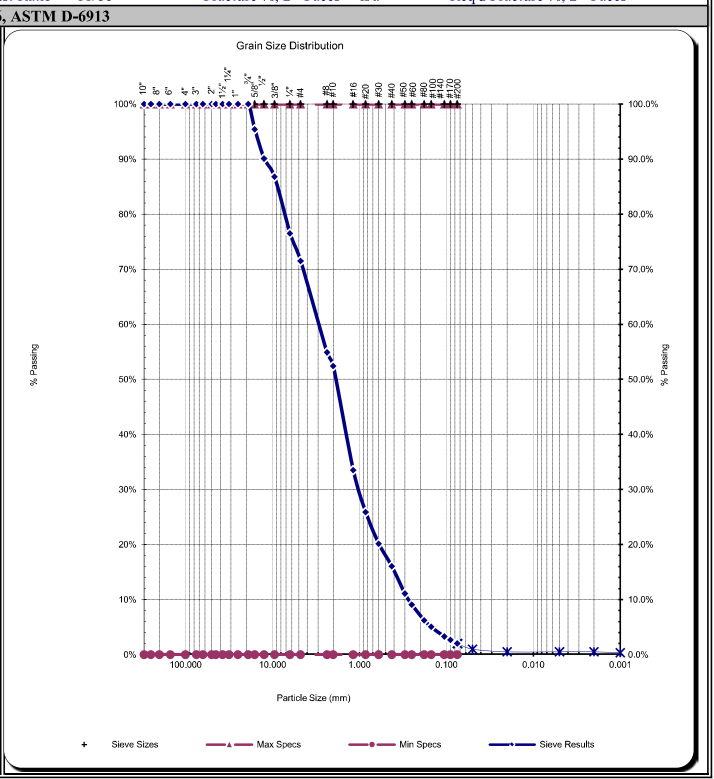
$D_{(5)}$ = 0.148 mm
$D_{(10)}$ = 0.273 mm
$D_{(15)}$ = 0.398 mm
$D_{(30)}$ = 1.028 mm
$D_{(50)}$ = 1.896 mm
$D_{(60)}$ = 3.094 mm
$D_{(90)}$ = 12.421 mm
Dust Ratio = 11/86

% Gravel = 28.5%
% Sand = 69.4%
% Silt & Clay = 2.1%
Liquid Limit = n/a
Plasticity Index = n/a
Sand Equivalent = n/a
Fracture %, 1 Face = n/a
Fracture %, 2+ Faces = n/a

Coeff. of Curvature, C_C = 1.25
Coeff. of Uniformity, C_U = 11.33
Fineness Modulus = 4.17
Plastic Limit = n/a
Moisture %, as sampled = 16.9%
Req'd Sand Equivalent =
Req'd Fracture %, 1 Face =
Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
US	Metric				
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00		95%	100.0%	0.0%
1/2"	12.50	90%	90%	100.0%	0.0%
3/8"	9.50	87%	87%	100.0%	0.0%
1/4"	6.30		77%	100.0%	0.0%
#4	4.75	72%	72%	100.0%	0.0%
#8	2.36		55%	100.0%	0.0%
#10	2.00	52%	52%	100.0%	0.0%
#16	1.18		33%	100.0%	0.0%
#20	0.850		26%	100.0%	0.0%
#30	0.600		20%	100.0%	0.0%
#40	0.425	16%	16%	100.0%	0.0%
#50	0.300		11%	100.0%	0.0%
#60	0.250		9%	100.0%	0.0%
#80	0.180		6%	100.0%	0.0%
#100	0.150		5%	100.0%	0.0%
#140	0.106		3%	100.0%	0.0%
#170	0.090		3%	100.0%	0.0%
#200	0.075	2.1%	2.1%	100.0%	0.0%



Comments:

Reviewed by: EJabe Noble

Materials Testing & Consulting, Inc.
Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Hydrometer Report

Project: Simpson Shelton Harbor (18E0079) **Date Received:** 15-May-18
Project #: 18S010-21 **Sampled By:** Others
Client : Analytical Resources, Inc. **Date Tested:** 31-May-18
Source: PDI-SMA3-SPT01-S6-180425 **Tested By:** AE/CFM
Sample#: S18-0779

ASTM D 2487 Soils Classification
SW, Well-graded Sand with Gravel
Sample Color
Brown

ASTM D-422, HYDROMETER ANALYSIS

Assumed Sp Gr : 2.65
Sample Weight: 100.59 grams
Hydroscopic Moist.: 0.78%
Adj. Sample Wgt : 99.81 grams

Hydrometer Reading Minutes	Corrected Reading	Percent Passing	Soils Particle Diameter
2	1	0.5%	0.0387 mm
5	1	0.5%	0.0245 mm
15	1	0.5%	0.0141 mm
30	1	0.5%	0.0100 mm
60	1	0.5%	0.0071 mm
250	1	0.5%	0.0035 mm
1440	1	0.5%	0.0014 mm

% Gravel: 28.5%
% Sand: 69.4%
% Silt: 1.5%
% Clay: 0.5%

Liquid Limit: n/a
Plastic Limit: n/a
Plasticity Index: n/a

ASTM C-136

Sieve Analysis
Grain Size Distribution

Sieve Size	Percent Passing	Soils Particle Diameter
3.0"	100%	75.000 mm
2.0"	100%	50.000 mm
1.5"	100%	37.500 mm
1.25"	100%	31.500 mm
1.0"	100%	25.000 mm
3/4"	100%	19.000 mm
5/8"	95%	16.000 mm
1/2"	90%	12.500 mm
3/8"	87%	9.500 mm
1/4"	77%	6.300 mm
#4	72%	4.750 mm
#10	52%	2.000 mm
#20	26%	0.850 mm
#40	16%	0.425 mm
#100	5%	0.150 mm
#200	2.1%	0.075 mm
Silts	2.0%	0.074 mm
	1.0%	0.050 mm
	0.5%	0.020 mm
Clays	0.5%	0.005 mm
	0.5%	0.002 mm
Colloids	0.4%	0.001 mm

USDA Soil Textural Classification

	Particle Size
% Sand:	2.0 - 0.05 mm
% Silt:	0.05 - 0.002 mm
% Clay:	< 0.002 mm

USDA Soil Textural Classification
N/A

Comments:

Reviewed by:

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Sieve Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-SPT02-S2-180425
Sample#: S18-0783

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D-2487 Unified Soils Classification System
SM, Silty Sand with Gravel
Sample Color:
Gray

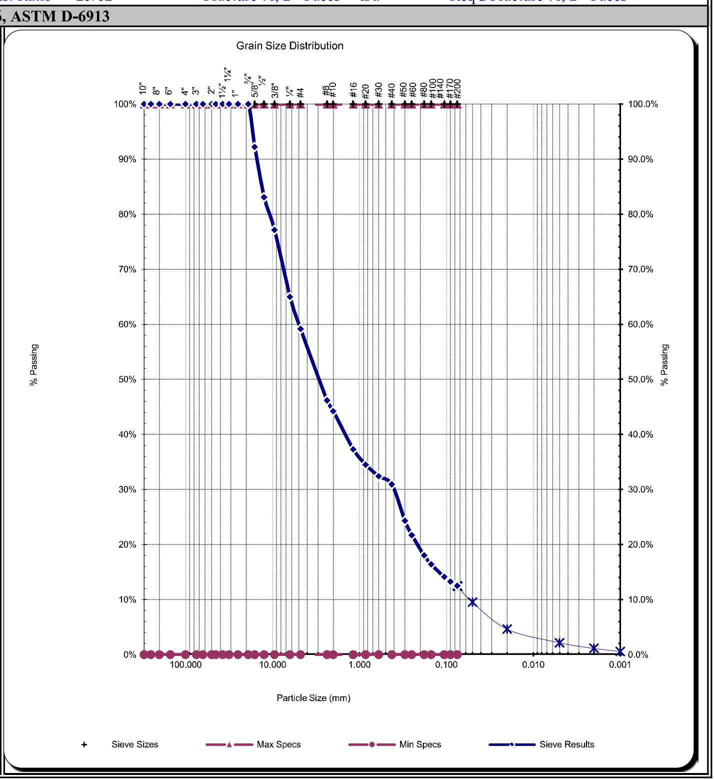
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.030 mm	% Gravel = 40.9%	Coeff. of Curvature, C_C = 0.55
$D_{(10)}$ = 0.060 mm	% Sand = 46.7%	Coeff. of Uniformity, C_U = 82.80
$D_{(15)}$ = 0.123 mm	% Silt & Clay = 12.5%	Fineness Modulus = 4.07
$D_{(30)}$ = 0.407 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 3.064 mm	Plasticity Index = n/a	Moisture %, as sampled = 15.3%
$D_{(60)}$ = 4.978 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 15.153 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 25/62	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00		92%	100.0%	0.0%
1/2"	12.50	83%	83%	100.0%	0.0%
3/8"	9.50	77%	77%	100.0%	0.0%
1/4"	6.30		65%	100.0%	0.0%
#4	4.75	59%	59%	100.0%	0.0%
#8	2.36		46%	100.0%	0.0%
#10	2.00	44%	44%	100.0%	0.0%
#16	1.18		37%	100.0%	0.0%
#20	0.850		35%	100.0%	0.0%
#30	0.600		32%	100.0%	0.0%
#40	0.425	31%	31%	100.0%	0.0%
#50	0.300		24%	100.0%	0.0%
#60	0.250		22%	100.0%	0.0%
#80	0.180		18%	100.0%	0.0%
#100	0.150		16%	100.0%	0.0%
#140	0.106		14%	100.0%	0.0%
#170	0.090		13%	100.0%	0.0%
#200	0.075	12.5%	12.5%	100.0%	0.0%



Comments:

Reviewed by: EJabi Noble

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Hydrometer Report

Project:	Simpson Shelton Harbor (18E0079)	**Date Received:**	15-May-18	**ASTM D 2487 Soils Classification**
Project #:	18S010-21	**Sampled By:**	Others	SM, Silty Sand with Gravel
Client :	Analytical Resources, Inc.	**Date Tested:**	31-May-18	**Sample Color**
Source:	PDI-SMA3-SPT02-S2-180425	**Tested By:**	AE/CFM	Gray
Sample#:	S18-0783			

ASTM D-422, HYDROMETER ANALYSIS

Assumed Sp Gr : 2.65

Sample Weight: 50.29 grams

Hydroscopic Moist.: 0.95%

Adj. Sample Wgt : 49.82 grams

Hydrometer Reading Minutes	Corrected Reading	Percent Passing	Soils Particle Diameter
2	9	8.0%	0.0371 mm
5	6	5.3%	0.0239 mm
15	4	3.6%	0.0139 mm
30	3	2.7%	0.0099 mm
60	3	2.7%	0.0070 mm
250	2	1.8%	0.0035 mm
1440	1	0.9%	0.0014 mm

% Gravel:	40.9%	**Liquid Limit:**	n/a
% Sand:	46.7%	**Plastic Limit:**	n/a
% Silt:	10.3%	**Plasticity Index:**	n/a
% Clay:	2.2%		

ASTM C-136

Sieve Analysis

Grain Size Distribution

Sieve Size	Percent Passing	Soils Particle Diameter
3.0"	100%	75.000 mm
2.0"	100%	50.000 mm
1.5"	100%	37.500 mm
1.25"	100%	31.500 mm
1.0"	100%	25.000 mm
3/4"	100%	19.000 mm
5/8"	92%	16.000 mm
1/2"	83%	12.500 mm
3/8"	77%	9.500 mm
1/4"	65%	6.300 mm
#4	59%	4.750 mm
#10	44%	2.000 mm
#20	35%	0.850 mm
#40	31%	0.425 mm
#100	16%	0.150 mm
#200	12.5%	0.075 mm
Silts	12.4%	0.074 mm
	9.5%	0.050 mm
	4.6%	0.020 mm
Clays	2.2%	0.005 mm
	1.1%	0.002 mm
Colloids	0.6%	0.001 mm

USDA Soil Textural Classification

	Particle Size
% Sand:	2.0 - 0.05 mm
% Silt:	0.05 - 0.002 mm
% Clay:	< 0.002 mm

USDA Soil Textural Classification

N/A

Comments:

Reviewed by:

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Sieve Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-SPT02-S4-180425
Sample#: S18-0785

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D-2487 Unified Soils Classification System
GW, Well-graded Gravel with Sand
Sample Color:
Brown

ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

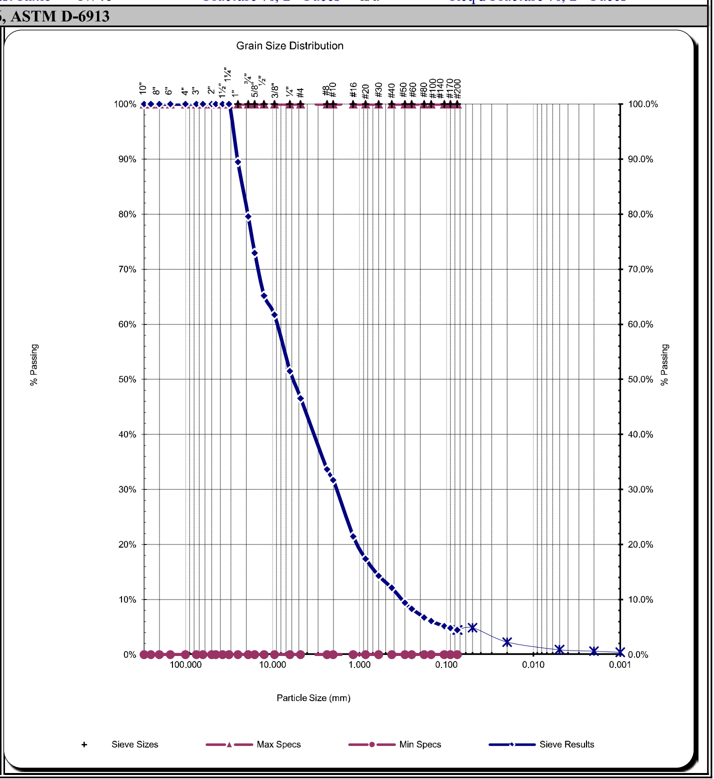
$D_{(5)}$ = 0.099 mm
$D_{(10)}$ = 0.327 mm
$D_{(15)}$ = 0.656 mm
$D_{(30)}$ = 1.863 mm
$D_{(50)}$ = 5.832 mm
$D_{(60)}$ = 8.965 mm
$D_{(90)}$ = 25.323 mm
Dust Ratio = 17/46

% Gravel = 53.5%
% Sand = 42.1%
% Silt & Clay = 4.5%
Liquid Limit = n/a
Plasticity Index = n/a
Sand Equivalent = n/a
Fracture %, 1 Face = n/a
Fracture %, 2+ Faces = n/a

Coeff. of Curvature, C_C = 1.18
Coeff. of Uniformity, C_U = 27.37
Fineness Modulus = 5.27
Plastic Limit = n/a
Moisture %, as sampled = 27.3%
Req'd Sand Equivalent =
Req'd Fracture %, 1 Face =
Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
US	Metric				
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	89%	89%	100.0%	0.0%
3/4"	19.00	80%	80%	100.0%	0.0%
5/8"	16.00		73%	100.0%	0.0%
1/2"	12.50	65%	65%	100.0%	0.0%
3/8"	9.50	62%	62%	100.0%	0.0%
1/4"	6.30		51%	100.0%	0.0%
#4	4.75	47%	47%	100.0%	0.0%
#8	2.36		34%	100.0%	0.0%
#10	2.00	32%	32%	100.0%	0.0%
#16	1.18		22%	100.0%	0.0%
#20	0.850		17%	100.0%	0.0%
#30	0.600		14%	100.0%	0.0%
#40	0.425	12%	12%	100.0%	0.0%
#50	0.300		9%	100.0%	0.0%
#60	0.250		8%	100.0%	0.0%
#80	0.180		7%	100.0%	0.0%
#100	0.150		6%	100.0%	0.0%
#140	0.106		5%	100.0%	0.0%
#170	0.090		5%	100.0%	0.0%
#200	0.075	4.5%	4.5%	100.0%	0.0%



Comments:

Reviewed by:

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Hydrometer Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client : Analytical Resources, Inc.
Source: PDI-SMA3-SPT02-S4-180425
Sample#: S18-0785

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D 2487 Soils Classification
GW, Well-graded Gravel with Sand
Sample Color
Brown

ASTM D-422, HYDROMETER ANALYSIS

Assumed Sp Gr : 2.65
Sample Weight: 50.08 grams
Hydroscopic Moist.: 0.95%
Adj. Sample Wgt : 49.61 grams

Hydrometer Reading Minutes	Corrected Reading	Percent Passing	Soils Particle Diameter
2	8	5.1%	0.0374 mm
5	4	2.6%	0.0241 mm
15	3	1.9%	0.0140 mm
30	2	1.3%	0.0100 mm
60	2	1.3%	0.0070 mm
250	1	0.6%	0.0035 mm
1440	1	0.6%	0.0014 mm

% Gravel: 53.5%
% Sand: 42.1%
% Silt: 3.6%
% Clay: 0.9%

Liquid Limit: n/a
Plastic Limit: n/a
Plasticity Index: n/a

ASTM C-136

Sieve Analysis

Grain Size Distribution

	Sieve Size	Percent Passing	Soils Particle Diameter
	3.0"	100%	75.000 mm
	2.0"	100%	50.000 mm
	1.5"	100%	37.500 mm
	1.25"	100%	31.500 mm
	1.0"	100%	25.000 mm
	3/4"	80%	19.000 mm
	5/8"	73%	16.000 mm
	1/2"	65%	12.500 mm
	3/8"	62%	9.500 mm
	1/4"	51%	6.300 mm
	#4	47%	4.750 mm
	#10	32%	2.000 mm
	#20	17%	0.850 mm
	#40	12%	0.425 mm
	#100	6%	0.150 mm
	#200	4.5%	0.075 mm
Silts		4.5%	0.074 mm
		4.9%	0.050 mm
		2.3%	0.020 mm
Clays		0.9%	0.005 mm
		0.6%	0.002 mm
Colloids		0.4%	0.001 mm

USDA Soil Textural Classification

	Particle Size
% Sand:	2.0 - 0.05 mm
% Silt:	0.05 - 0.002 mm
% Clay:	< 0.002 mm

USDA Soil Textural Classification

N/A

Comments: ____________________

Reviewed by: ____________________

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Sieve Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-SPT02-S6-180425
Sample#: S18-0787

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D-2487 Unified Soils Classification System
SW, Well-graded Sand with Gravel
Sample Color:
Brown

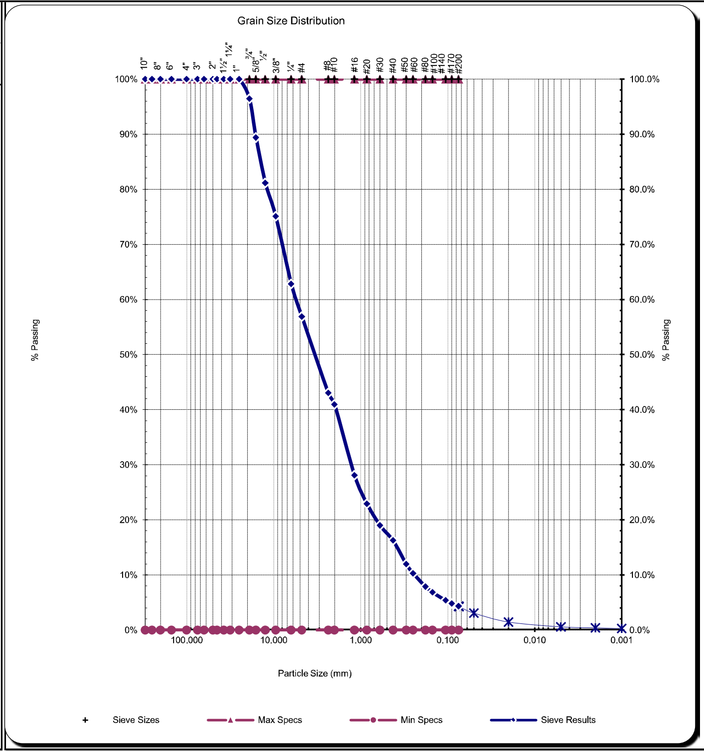
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.095 mm	% Gravel = 43.1%	Coeff. of Curvature, C_C = 1.26
$D_{(10)}$ = 0.241 mm	% Sand = 52.6%	Coeff. of Uniformity, C_U = 23.00
$D_{(15)}$ = 0.388 mm	% Silt & Clay = 4.3%	Fineness Modulus = 4.62
$D_{(30)}$ = 1.300 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 3.556 mm	Plasticity Index = n/a	Moisture %, as sampled = 14.4%
$D_{(60)}$ = 5.552 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 16.247 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 4/15	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	96%	96%	100.0%	0.0%
5/8"	16.00		89%	100.0%	0.0%
1/2"	12.50	81%	81%	100.0%	0.0%
3/8"	9.50	75%	75%	100.0%	0.0%
1/4"	6.30		63%	100.0%	0.0%
#4	4.75	57%	57%	100.0%	0.0%
#8	2.36		43%	100.0%	0.0%
#10	2.00	41%	41%	100.0%	0.0%
#16	1.18		28%	100.0%	0.0%
#20	0.850		23%	100.0%	0.0%
#30	0.600		19%	100.0%	0.0%
#40	0.425	16%	16%	100.0%	0.0%
#50	0.300		12%	100.0%	0.0%
#60	0.250		10%	100.0%	0.0%
#80	0.180		8%	100.0%	0.0%
#100	0.150		7%	100.0%	0.0%
#140	0.106		5%	100.0%	0.0%
#170	0.090		5%	100.0%	0.0%
#200	0.075	4.3%	4.3%	100.0%	0.0%



Comments: ____________________

Reviewed by: ____________________

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Hydrometer Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client : Analytical Resources, Inc.
Source: PDI-SMA3-SPT02-S6-180425
Sample#: S18-0787

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D 2487 Soils Classification
SW, Well-graded Sand with Gravel

Sample Color
Brown

ASTM D-422, HYDROMETER ANALYSIS

Assumed Sp Gr : 2.65
Sample Weight: 100.28 grams
Hydroscopic Moist.: 0.68%
Adj. Sample Wgt : 99.60 grams

Hydrometer Reading Minutes	Corrected Reading	Percent Passing	Soils Particle Diameter
2	6	2.5%	0.0378 mm
5	4	1.6%	0.0241 mm
15	3	1.2%	0.0140 mm
30	2	0.8%	0.0100 mm
60	2	0.8%	0.0070 mm
250	1	0.4%	0.0035 mm
1440	1	0.4%	0.0014 mm

% Gravel: 43.1%
% Sand: 52.6%
% Silt: 3.7%
% Clay: 0.6%

Liquid Limit: n/a
Plastic Limit: n/a
Plasticity Index: n/a

ASTM C-136

Sieve Analysis
Grain Size Distribution

Sieve Size	Percent Passing	Soils Particle Diameter
3.0"	100%	75.000 mm
2.0"	100%	50.000 mm
1.5"	100%	37.500 mm
1.25"	100%	31.500 mm
1.0"	100%	25.000 mm
3/4"	96%	19.000 mm
5/8"	89%	16.000 mm
1/2"	81%	12.500 mm
3/8"	75%	9.500 mm
1/4"	63%	6.300 mm
#4	57%	4.750 mm
#10	41%	2.000 mm
#20	23%	0.850 mm
#40	16%	0.425 mm
#100	7%	0.150 mm
#200	4.3%	0.075 mm
Silts	4.3%	0.074 mm
	3.1%	0.050 mm
	1.5%	0.020 mm
Clays	0.6%	0.005 mm
	0.4%	0.002 mm
Colloids	0.3%	0.001 mm

USDA Soil Textural Classification

	Particle Size
% Sand:	2.0 - 0.05 mm
% Silt:	0.05 - 0.002 mm
% Clay:	< 0.002 mm

USDA Soil Textural Classification

N/A

Comments:

Reviewed by:

Materials Testing & Consulting, Inc.

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Sieve Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client: Analytical Resources, Inc.
Source: PDI-SMA3-SPT02-S8-180425
Sample#: S18-0789

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D-2487 Unified Soils Classification System
SW, Well-graded Sand with Gravel
Sample Color:
Brown

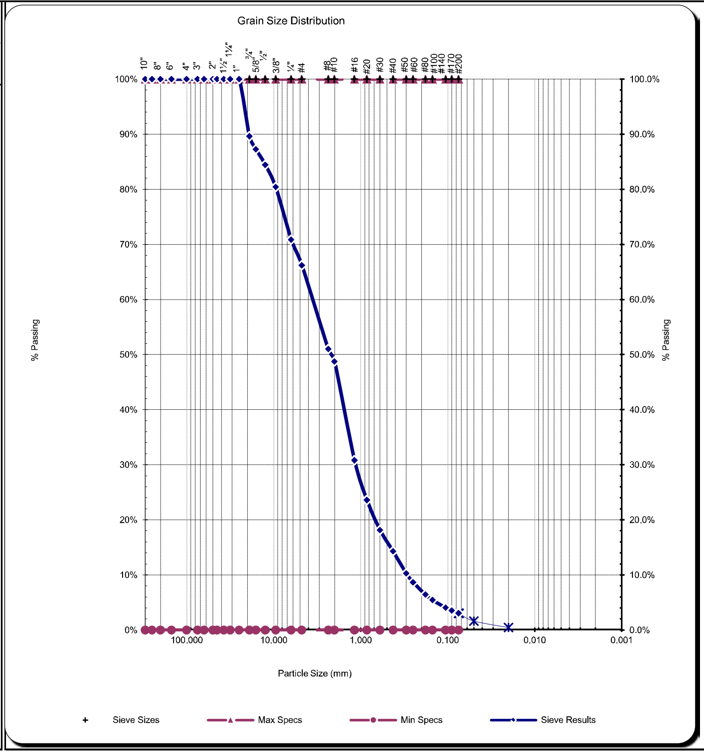
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.135 mm	% Gravel = 33.8%	Coeff. of Curvature, C_C =	1.19
$D_{(10)}$ = 0.291 mm	% Sand = 63.1%	Coeff. of Uniformity, C_U =	12.96
$D_{(15)}$ = 0.457 mm	% Silt & Clay = 3.1%	Fineness Modulus =	4.48
$D_{(30)}$ = 1.142 mm	Liquid Limit = n/a	Plastic Limit =	n/a
$D_{(50)}$ = 2.193 mm	Plasticity Index = n/a	Moisture %, as sampled =	17.9%
$D_{(60)}$ = 3.770 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =	
$D_{(90)}$ = 19.199 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =	
Dust Ratio = 3/14	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =	

ASTM C-136, ASTM D-6913

Sieve Size		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
US	Metric				
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	90%	90%	100.0%	0.0%
5/8"	16.00		87%	100.0%	0.0%
1/2"	12.50	84%	84%	100.0%	0.0%
3/8"	9.50	80%	80%	100.0%	0.0%
1/4"	6.30		71%	100.0%	0.0%
#4	4.75	66%	66%	100.0%	0.0%
#8	2.36		51%	100.0%	0.0%
#10	2.00	49%	49%	100.0%	0.0%
#16	1.18		31%	100.0%	0.0%
#20	0.850		24%	100.0%	0.0%
#30	0.600		18%	100.0%	0.0%
#40	0.425	14%	14%	100.0%	0.0%
#50	0.300		10%	100.0%	0.0%
#60	0.250		9%	100.0%	0.0%
#80	0.180		6%	100.0%	0.0%
#100	0.150		5%	100.0%	0.0%
#140	0.106		4%	100.0%	0.0%
#170	0.090		4%	100.0%	0.0%
#200	0.075	3.1%	3.1%	100.0%	0.0%



Comments:

Reviewed by:

Materials Testing & Consulting, Inc.

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting

Hydrometer Report

Project: Simpson Shelton Harbor (18E0079)
Project #: 18S010-21
Client : Analytical Resources, Inc.
Source: PDI-SMA3-SPT02-S8-180425
Sample#: S18-0789

Date Received: 15-May-18
Sampled By: Others
Date Tested: 31-May-18
Tested By: AE/CFM

ASTM D 2487 Soils Classification
SW, Well-graded Sand with Gravel
Sample Color
Brown

ASTM D-422, HYDROMETER ANALYSIS

Assumed Sp Gr : 2.65
Sample Weight: 100.44 grams
Hydroscopic Moist.: 0.60%
Adj. Sample Wgt : 99.84 grams

Hydrometer Reading Minutes	Corrected Reading	Percent Passing	Soils Particle Diameter
2	2	1.0%	0.0386 mm
5	1	0.5%	0.0245 mm
15	1	0.5%	0.0141 mm
30	1	0.5%	0.0100 mm
60	1	0.5%	0.0071 mm
250	0.5	0.2%	#N/A mm
1440	0.5	0.2%	#N/A mm

% Gravel: 33.8%
% Sand: 63.1%
% Silt: #N/A
% Clay: #N/A

Liquid Limit: n/a
Plastic Limit: n/a
Plasticity Index: n/a

ASTM C-136

Sieve Analysis
Grain Size Distribution

	Sieve Size	Percent Passing	Soils Particle Diameter
	3.0"	100%	75.000 mm
	2.0"	100%	50.000 mm
	1.5"	100%	37.500 mm
	1.25"	100%	31.500 mm
	1.0"	100%	25.000 mm
	3/4"	90%	19.000 mm
	5/8"	87%	16.000 mm
	1/2"	84%	12.500 mm
	3/8"	80%	9.500 mm
	1/4"	71%	6.300 mm
	#4	66%	4.750 mm
	#10	49%	2.000 mm
	#20	24%	0.850 mm
	#40	14%	0.425 mm
	#100	5%	0.150 mm
	#200	3.1%	0.075 mm
Silts		3.0%	0.074 mm
		1.6%	0.050 mm
		0.5%	0.020 mm
Clays		#N/A	0.005 mm
		#N/A	0.002 mm
Colloids		#N/A	0.001 mm

USDA Soil Textural Classification

	Particle Size
% Sand:	2.0 - 0.05 mm
% Silt:	0.05 - 0.002 mm
% Clay:	< 0.002 mm

USDA Soil Textural Classification
N/A

Comments: ______________________

Reviewed by: ______________________

Analytical Resources, Incorporated
Analytical Chemists and Consultants

SUBCONTRACT ORDER
To: Materials Testing & Consulting, Inc. (Olympia)
ARI Work Order:18E0079

MTC# 18S010-21

SENDING LABORATORY:

Analytical Resources, Inc.
4611 S. 134th Place, Suite 100
Tukwila, WA 98168
Phone: (206) 695-6200
Fax: (206) 695-6201
Project Manager: Amanda Volgardsen
E-Mail: amandav@arilabs.com

RECEIVING LABORATORY:

Materials Testing & Consulting, Inc. (Olympia)
2118 Black Lake Blvd. SW
Olympia, WA 98512
Phone :(360) 534-9777
Fax:

PLEASE SEND DATA TO subdata@arilabs.com

Analysis	Due	Expires	Sub Laboratory ID	Comments
Sample ID: 18E0079-01 **Sampled: 04/25/18 11:40 Matrix: Solid**			S18-0774	
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 11:40		
Containers Supplied:				
Sample ID: 18E0079-02 **Sampled: 04/25/18 11:50 Matrix: Solid**			S18-0775	
Grainsize ASTM D422/421 (Subc)	05/17/18	04/25/19 11:50		
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 11:50		
Containers Supplied:				
Sample ID: 18E0079-03 **Sampled: 04/25/18 12:00 Matrix: Solid**			S18-0776	
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 12:00		
Containers Supplied:				
Sample ID: 18E0079-04 **Sampled: 04/25/18 12:10 Matrix: Solid**			S18-0777	
Grainsize ASTM D422/421 (Subc)	05/17/18	04/25/19 12:10		
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 12:10		
Containers Supplied:				

Full Package · Raw data
EDD

	5/15/18		5-15-18
Released By	Date	Received By	Date
Released By	Date	Received By	Date

Printed: 5/4/2018 11:48:38AM

Analytical Resources, Incorporated
Analytical Chemists and Consultants

SUBCONTRACT ORDER
To: Materials Testing & Consulting, Inc. (Olympia)
ARI Work Order:18E0079

Analysis	Due	Expires	Sub Laboratory ID	Comments
Sample ID: 18E0079-05 **Sampled: 04/25/18 12:20 Matrix: Solid**			S18-0778	
Grainsize ASTM D422/421 (Subc)	05/17/18	04/25/19 12:20		
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 12:20		
Containers Supplied:				
Sample ID: 18E0079-06 **Sampled: 04/25/18 12:30 Matrix: Solid**			S18-0779	
Grainsize ASTM D422/421 (Subc)	05/17/18	04/25/19 12:30		
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 12:30		
Containers Supplied:				
Sample ID: 18E0079-07 **Sampled: 04/25/18 12:40 Matrix: Solid**			S18-0780	
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 12:40		
Grainsize ASTM D422/421 (Subc)	05/17/18	04/25/19 12:40		
Containers Supplied:				
Sample ID: 18E0079-08 **Sampled: 04/25/18 12:50 Matrix: Solid**			S18-0781	
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 12:50		
Containers Supplied:				
Sample ID: 18E0079-09 **Sampled: 04/25/18 09:45 Matrix: Solid**			S18-0782	
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 09:45		
Containers Supplied:				

Released By	Date	Received By	Date
	5/15/18		5-15-18

Printed: 5/4/2018 11:48:38AM

SUBCONTRACT ORDER
To: Materials Testing & Consulting, Inc. (Olympia)
ARI Work Order:18E0079

Analysis	Due	Expires	Sub Laboratory ID	Comments
Sample ID: 18E0079-10 **Sampled: 04/25/18 09:55 Matrix: Solid**			S18-0783	
Grainsize ASTM D422/421 (Subc)	05/17/18	04/25/19 09:55		
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 09:55		
Containers Supplied:				
Sample ID: 18E0079-11 **Sampled: 04/25/18 10:05 Matrix: Solid**			S18-0784	
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 10:05		
Containers Supplied:				
Sample ID: 18E0079-12 **Sampled: 04/25/18 10:15 Matrix: Solid**			S18-0785	
Grainsize ASTM D422/421 (Subc)	05/17/18	04/25/19 10:15		
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 10:15		
Containers Supplied:				
Sample ID: 18E0079-13 **Sampled: 04/25/18 10:25 Matrix: Solid**			S18-0786	
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 10:25		
Containers Supplied:				
Sample ID: 18E0079-14 **Sampled: 04/25/18 10:35 Matrix: Solid**			S18-0787	
Grainsize ASTM D422/421 (Subc)	05/17/18	04/25/19 10:35		
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 10:35		
Containers Supplied:				
Sample ID: 18E0079-15 **Sampled: 04/25/18 10:45 Matrix: Solid**			S18-0788	
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 10:45		
Containers Supplied:				

Released By	Date	Received By	Date
	5/15/18		5-15-18

Released By Date Received By Date

SUBCONTRACT ORDER
To: Materials Testing & Consulting, Inc. (Olympia)
ARI Work Order:18E0079

Analysis	Due	Expires	Sub Laboratory ID	Comments
Sample ID: 18E0079-16 **Sampled: 04/25/18 10:55 Matrix: Solid**			S18-0789	
Moisture Content ASTM D2216 (Subc)	05/17/18	04/25/19 10:55		
Grainsize ASTM D422/421 (Subc)	05/17/18	04/25/19 10:55		

Containers Supplied:

Released By	5/15/18 Date	Received By	5-15-18 Date
Released By	Date	Received By	Date

x 15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 185010-21

Location: 18E0079 - 01

Lab#: S18-0774

Description: sand w/ silt & gravel

Color: brown

Client: ARI

Sampled by: ~~CHEM~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: NMC

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	1.0"	25.0 mm				
8	3/4"	19.0 mm				
9	5/8"	16.0 mm				
10	1/2"	12.5 mm				
11	3/8"	9.5 mm				
12	1/4"	6.3 mm				
13	#4	4.75 mm				
14	Pan					
Total Weight						

Sample Contains:

Silt: ☐

Clay: ☐

Organics: ☐

Is the Sample Crushed?

Yes:

No:

% Gravel:

% Sand:

% -#200:

MOISTURE

Tare Weight: 10.6

Wet Soil + Tare Wt.: 296.2

Dry Soil + Tare Wt.: 271.0 ☆6

% Moisture: 9.8%

WET SIEVE SECTION

Before Wash Weight: 260.4

Before Sieving Weight (A):

Soak time (10 min. minimum):

After Sieving Weight (B):

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm				
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm				
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm				
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing

D_{30} = Diameter in mm at 30% passing

D_{60} = Diameter in mm at 60% passing

D_{10} =

D_{30} =

D_{60} =

$C_c = D_{30}^2 / (D_{10} \times D_{60})$

$C_u = D_{60} / D_{10}$

C_c =

C_u =

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WD#18E0079
Project #: 185010-21
Location: 18E0079 - 02
Lab#: S18 - 0775
Description: Sand & gravel w/ silt
Color: brown

Client: ARI
Sampled by: ~~Client~~ OTHER
Date Sampled: 4-25-18
Tested by: AE/CFM
Date Tested:
Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: SI hydro / NMC

13

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	~~31.5 mm~~				
7	1.0"	25.0 mm	0	0	100%	
8	3/4"	19.0 mm	75.2			
9	5/8"	16.0 mm				
10	1/2"	12.5 mm	82.8			
11	3/8"	9.5 mm	110.4			
12	1/4"	6.3 mm				
13	#4	4.75 mm	168.6			
14	Pan		158.9			
Total Weight			327.5			

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?
Yes: ____
No: ____

% Gravel: ____
% Sand: ____
% #200: ____

MOISTURE

Tare Weight: 10.0
Wet Soil + Tare Wt. 171.4
Dry Soil + Tare Wt. 146.7
% Moisture: 18.16

#4 136.7

WET SIEVE SECTION

Before Wash Weight: 158.9
Before Sieving Weight (A): 40.3 ≈ 135.9 3
Soak time (10 min. minimum):
After Sieving Weight (B): 40.3 ≈ 135.9
Adj: 2.3280848

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm	42.1			
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm	23.1 ≈	95.9		
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm	39.9 ≈	135.0		
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing
D_{30} = Diameter in mm at 30% passing
D_{60} = Diameter in mm at 60% passing

D_{10} =
D_{30} =
D_{60} =

$C_c = D_{30}^2 / (D_{10} \times D_{60})$
$C_u = D_{60} / D_{10}$
C_c =
C_u =

x9

Materials Testing & Consulting, Inc

Remember.... One test is worth a thousand expert opinions

Geotechnical Engineering ▪ Special Inspection ▪ Materials Testing

HYDROMETER ANALYSIS

Project: Shelton Harbor Remediation ARI WO# 18E0079

Project #: 18S010-21

Lab #: S18-0775

Location/Source: 18E0079-02

Description: brn sand & g w/ silt

Equipment Used: CA-020, SA-024, SA-009

Client: ARI

Sampled by: Other

Date Sampled: 4-25-18

Tested by: AE / CFM

Date Tested:

1.) This test is to be performed in accordance with ASTM D 422, Volume 4.08

2.) This test should be performed in a room maintained at 68°F for the duration of the test.

$\boxed{\cancel{15}}$

3.) First air dry the sample and sieve over a #10 sieve.

4.) Weigh sample (about 50 grams for silts & clays, and 100 grams for sands). At the same time weigh a 10 to 20 gram sample and oven dry for the hygroscopic moisture correction.

5.) Place sample (50 to 100 grams) in 250 ml beaker and add 125 ml of sodium hexametaphosphate solution. Allow to soak at least 16 hours.

6.) After soaking, place sample and solution into stirring beaker (milk shake beaker), being careful to wash all of the solution into the beaker using distilled water. Fill the stirring beaker until it is half full with distilled water.

7.) Place on the stirring apparatus and mix for 1 minute. Immediately transfer the solution into the glass sedimentation cylinder and add distilled water until total volume is 1,000 ml. Cover the top of the cylinder with a stopper or your hand and invert 30 times within one minute. Place cylinder in a convenient place and take reading at the prescribed intervals.

8.) To take a reading carefully place the hydrometer into the solution 20 to 25 seconds before the reading is to be done. At the correct time, read and record the top of the menisous. Immediately remove the hydrometer and place it with a slight spinning motion into the glass cylinder that is full of clean distilled water.

9.) Record the Hydrometer correction factor from the graph/spreadsheet that is placed on the wall.

10.) After all hydrometer readings in the suspended solution, take and record the temperature of the solution.

12:10	Reading Time	Hydrometer Reading	Temperature Degrees C	Hydrometer Correction	Corrected Reading
12:12	2 minutes	12	68	-6.0	6
12:15	5 minutes	11			5
12:25	15 minutes	9			3
12:40	30 minutes	9			3
1:10	60 minutes	9			3
3:20	250 minutes	8			2
12:10	1440 minutes	7			1

0.99

$\boxed{3}$

Weight of Sample Placed in Solution: 50.17

Weight of Sample + Pan Placed in Oven 27.75

Weight of Sample + Pan After Drying in the Oven 27.64

12.69 4A Weight of Pan 14.95

% of Hygroscopic Moisture in Sample 0.87%

$\boxed{\cancel{25}}$

Hydrometer # 152H

Adjusted Sample Weight: 49.7g

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO#18E0079

Project #: 185010-21

Location: 18E0079 - 03

Lab#: S18-07710

Description: silt

Color: dk brn-black silt

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

DRY SIEVE SECTION

Specification: nmc

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	1.0"	25.0 mm				
8	3/4"	19.0 mm				
9	5/8"	16.0 mm				
10	1/2"	12.5 mm				
11	3/8"	9.5 mm				
12	1/4"	6.3 mm				
13	#4	4.75 mm				
14	Pan					
Total Weight						

Sample Contains:

Silt: ☐

Clay: ☐

Organics: ☐

Is the Sample Crushed?

Yes:_____

No:_____

%Gravel: _____

% Sand: _____

% #200: _____

MOISTURE

Tare Weight 9.9

Wet Soil + Tare Wt. 95.2

Dry Soil + Tare Wt. 65.3

% Moisture 54.0%

#7 55.4

WET SIEVE SECTION

Before Wash Weight:

Before Sieving Weight (A):

Soak time (10 min. minimum):

After Sieving Weight (B):

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm				
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm				
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm				
28	#270	0.053 mm				

D_{10}=Diameter in mm at 10% passing

D_{30}=Diameter in mm at 30% passing

D_{60}=Diameter in mm at 60% passing

D_{10}= _____

D_{30}= _____

D_{60}= _____

$C_c = D_{30}^2 / (D_{10} \times D_{60})$

$C_u = D_{60} / D_{10}$

C_c= _____

C_u= _____

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation
Project: ARI WO# 18E0079
Project #: 185010-21
Location: 18E0079 - 04
Lab#: S18 - 0777
Description: Sand & g w/ Silt
Color: dk brn

Client: ARI
Sampled by: ~~Client~~ OTHER
Date Sampled: 4-25-18
Tested by: AE/CFM
Date Tested:
Equipment Used: CA-016, CA-030, CA-013, SA-004, SA-009

Specification: SI hydro / NMC

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	1.0"	25.0 mm	0	0	100%	
8	3/4"	19.0 mm	36.1			
9	5/8"	16.0 mm				
10	1/2"	12.5 mm	64.9			
11	3/8"	9.5 mm	72.8			
12	1/4"	6.3 mm				
13	#4	4.75 mm	124.5			
14	Pan		172.2			
Total Weight			296.7			

10

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?
Yes: ______
No: ______

% Gravel: ______
% Sand: ______
% -#200: ______

MOISTURE

Tare Weight: 10.8
Wet Soil + Tare Wt.: 229.8
Dry Soil + Tare Wt.: 202.6
% Moisture:

*8

WET SIEVE SECTION

Before Wash Weight: 172.2
Before Sieving Weight (A): 44.2 ≈ 157.4 1
Soak time (10 min. minimum):
After Sieving Weight (B): 44.2 ≈ 157.4

2.4770825

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm	47.9			~~47.9~~
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm	33.6 ≈	~~462.2~~ Gu	131.1 ~~x2~~	~~135.3~~ 76.0
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm	43.8 ≈	156.4		~~161.8~~ 0.01
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing
D_{30} = Diameter in mm at 30% passing
D_{60} = Diameter in mm at 60% passing

D_{10} =
D_{30} =
D_{60} =

$C_c = D_{30}^2 / (D_{10} \times D_{60})$
$C_u = D_{60} / D_{10}$
C_c =
C_u =

x9

Materials Testing & Consulting, Inc

Remember.... One test is worth a thousand expert opinions

Geotechnical Engineering ▪ Special Inspection ▪ Materials Testing

HYDROMETER ANALYSIS

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 188010-21

Lab #: S18-0777

Location/Source: 18E0079-04

Description: dk brn sand & g w/ silt

Equipment Used: CA-020, SA-024, SA-009

Client: ARI

Sampled by: other

Date Sampled: 4-25-18

Tested by: AE / CFM

Date Tested:

~~16~~

1.) This test is to be performed in accordance with ASTM D 422, Volume 4.08

2.) This test should be performed in a room maintained at 68°F for the duration of the test.

3.) First air dry the sample and sieve over a #10 sieve.

4.) Weigh sample (about 50 grams for silts & clays, and 100 grams for sands). At the same time weigh a 10 to 20 gram sample and oven dry for the hygroscopic moisture correction.

5.) Place sample (50 to 100 grams) in 250 ml beaker and add 125 ml of sodium hexametaphosphate solution. Allow to soak at least 16 hours.

6.) After soaking, place sample and solution into stirring beaker (milk shake beaker), being careful to wash all of the solution into the beaker using distilled water. Fill the stirring beaker until it is half full with distilled water.

7.) Place on the stirring apparatus and mix for 1 minute. Immediately transfer the solution into the glass sedimentation cylinder and add distilled water until total volume is 1,000 ml. Cover the top of the cylinder with a stopper or your hand and invert 30 times within one minute. Place cylinder in a convenient place and take reading at the prescribed intervals.

8.) To take a reading carefully place the hydrometer into the solution 20 to 25 seconds before the reading is to be done. At the correct time, read and record the top of the meniscus. Immediately remove the hydrometer and place it with a slight spinning motion into the glass cylinder that is full of clean distilled water.

9.) Record the Hydrometer correction factor from the graph/spreadsheet that is placed on the wall.

10.) After all hydrometer readings in the suspended solution, take and record the temperature of the solution.

~~C3~~ 1

11:50

Reading Time	Hydrometer Reading	Temperature Degrees ~~C~~ F	Hydrometer Correction	Corrected Reading
11:52 2 minutes	11	68	6.0	5
11:55 5 minutes	7			1
12:05 15 minutes	7			1
12:20 30 minutes	7			1
12:50 60 minutes	7			1
4:00 250 minutes	~~6.5~~ 7 AE			~~0.5~~ 1 AE
1150 1440 minutes	7			1

Weight of Sample Placed in Solution: 50.18

Weight of Sample + Pan Placed in Oven 32.22

Weight of Sample + Pan After Drying in the Oven 32.14

12:58 AD Weight of Pan 19.56

% of Hygroscopic Moisture in Sample 0.64%

~~23~~

Hydrometer # 152H

Adjusted Sample Weight: 49.9g

x 15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 18S010-21

Location: 18E0079 - 05

Lab#: S18 - 0778

Description: Sand & gravel

Color: dk gry-brn

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: SI hydro / nml

10

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	1.0"	25.0 mm	0	0	100%	
8	3/4"	19.0 mm	0	0	100%	
9	5/8"	16.0 mm				
10	1/2"	12.5 mm	0	0	100%	
11	3/8"	9.5 mm	17.3			
12	1/4"	6.3 mm				
13	#4	4.75 mm	64.7			
14	Pan		138.4			
Total Weight			203.1			

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?

Yes: ______

No: ______

% Gravel: ______

% Sand: ______

% #200: ______

MOISTURE

Tare Weight: 11.3

Wet Soil + Tare Wt.: 196.0

Dry Soil + Tare Wt.: 161.5

% Moisture: 19.6%

P9 150.2

WET SIEVE SECTION

Before Wash Weight: 138.4

Before Sieving Weight (A): 67.9 = 133.4 9

Soak time (10 min. minimum):

After Sieving Weight (B): 67.9 = 133.6

1.962919

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm	54.6			
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm	52.3 =	115.42		
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm	67.5 =	133.1		
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing

D_{30} = Diameter in mm at 30% passing

D_{60} = Diameter in mm at 60% passing

D_{10} = ______

D_{30} = ______

D_{60} = ______

$C_c = D_{30}^2 / (D_{10} \times D_{60})$

$C_u = D_{60} / D_{10}$

C_c = ______

C_u = ______

x9

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HYDROMETER ANALYSIS

Project: Shelton Harbor Remediation ARI WO# 18E0079

Project #: 188010-21

Lab #: S18-0778

Location/Source: 18E0079-05

Description: dk gry-brn sandy gravel

Equipment Used: CA-020, SA-024, SA-009

Client: ARI

Sampled by: Dhhoy

Date Sampled: 4-25-18

Tested by: A-E / CFM

Date Tested:

~~10~~

1.) This test is to be performed in accordance with ASTM D 422, Volume 4.08

2.) This test should be performed in a room maintained at 68°F for the duration of the test.

3.) First air dry the sample and sieve over a #10 sieve.

4.) Weigh sample (about 50 grams for silts & clays, and 100 grams for sands). At the same time weigh a 10 to 20 gram sample and oven dry for the hygroscopic moisture correction.

5.) Place sample (50 to 100 grams) in 250 ml beaker and add 125 ml of sodium hexametaphosphate solution. Allow to soak at least 16 hours.

6.) After soaking, place sample and solution into stirring beaker (milk shake beaker), being careful to wash all of the solution into the beaker using distilled water. Fill the stirring beaker until it is half full with distilled water.

7.) Place on the stirring apparatus and mix for 1 minute. Immediately transfer the solution into the glass sedimentation cylinder and add distilled water until total volume is 1,000 ml. Cover the top of the cylinder with a stopper or your hand and invert 30 times within one minute. Place cylinder in a convenient place and take reading at the prescribed intervals.

8.) To take a reading carefully place the hydrometer into the solution 20 to 25 seconds before the reading is to be done. At the correct time, read and record the top of the meniscus. Immediately remove the hydrometer and place it with a slight spinning motion into the glass cylinder that is full of clean distilled water.

9.) Record the Hydrometer correction factor from the graph/spreadsheet that is placed on the wall.

10.) After all hydrometer readings in the suspended solution, take and record the temperature of the solution.

11:30

Reading Time	Hydrometer Reading	Temperature Degrees C	Hydrometer Correction	Corrected Reading
11:32 2 minutes	7	68	6.0	1
11 35 5 minutes	7			1
11 45 15 minutes	7			1
12 00 30 minutes	7			1
12 30 60 minutes	7			1
3 40 250 minutes	7			1
11 30 1440 minutes	7			1

~~WTF~~

9

Weight of Sample Placed in Solution: 72.31

Weight of Sample + Pan Placed in Oven 25.87

Weight of Sample + Pan After Drying in the Oven ~~30.52~~ 25.78 ~~2~~

3Aa Weight of Pan 14.63

% of Hygroscopic Moisture in Sample

Hydrometer # 1524

Adjusted Sample Weight:

x15

Sieve Analysis

ASTM C-33 / C-136

Project: Shelton Harbor Remediation ARI WO# 18E0079

Project #: 18S010-21

Location: 18E0079-06

Lab#: S18-0779

Description: sand w/ gravel & silt

Color: brown

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: SI hydro / NMC

9

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	1.0"	25.0 mm	0	0	100%	
8	3/4"	19.0 mm	0	0	100%	
9	5/8"	16.0 mm				
10	1/2"	12.5 mm	23.1			
11	3/8"	9.5 mm	30.7			
12	1/4"	6.3 mm				
13	#4	4.75 mm	66.4			
14	Pan		166.6			
Total Weight			233.0			

Sample Contains:

Silt: ☐

Clay: ☐

Organics: ☐

Is the Sample Crushed?

Yes:

No:

% Gravel:

% Sand:

% #200:

WET SIEVE SECTION

Before Wash Weight: 166.6

Before Sieving Weight (A): 97.0≈ 162.2 7

Soak time (10 min. minimum):

After Sieving Weight (B): 97.0≈ 162.2

1.2138383

MOISTURE

Tare Weight: 10.9

Wet Soil + Tare Wt. 224.5

Dry Soil + Tare Wt. 193.6

% Moisture 16.9%

P3 182.7

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm	44.5			
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm	69.7 ≈	129.1		
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm	96.6 ≈	161.8		
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing

D_{30} = Diameter in mm at 30% passing

D_{60} = Diameter in mm at 60% passing

D_{10} =

D_{30} =

D_{60} =

$C_c = D_{30}^2 / (D_{10} \times D_{60})$

$C_u = D_{60} / D_{10}$

C_c =

C_u =

x 9

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HYDROMETER ANALYSIS

Project: Shelton Harbor Remediation ARI WO# 18E0079
Project #: 18S010-21
Lab #: S18-0779
Location/Source: 18E0079-06
Description: Sand w/ g & silt
Equipment Used: CA-020, SA-024, SA-009

Client: ARI
Sampled by: Other
Date Sampled: 4-25-18
Tested by: A-E / CFM
Date Tested:

9

1.) This test is to be performed in accordance with ASTM D 422, Volume 4.08

2.) This test should be performed in a room maintained at 68°F for the duration of the test.

3.) First air dry the sample and sieve over a #10 sieve.

4.) Weigh sample (about 50 grams for silts & clays, and 100 grams for sands). At the same time weigh a 10 to 20 gram sample and oven dry for the hygroscopic moisture correction.

5.) Place sample (50 to 100 grams) in 250 ml beaker and add 125 ml of sodium hexametaphosphate solution. Allow to soak at least 16 hours.

6.) After soaking, place sample and solution into stirring beaker (milk shake beaker), being careful to wash all of the solution into the beaker using distilled water. Fill the stirring beaker until it is half full with distilled water.

7.) Place on the stirring apparatus and mix for 1 minute. Immediately transfer the solution into the glass sedimentation cylinder and add distilled water until total volume is 1,000 ml. Cover the top of the cylinder with a stopper or your hand and invert 30 times within one minute. Place cylinder in a convenient place and take reading at the prescribed intervals.

8.) To take a reading carefully place the hydrometer into the solution 20 to 25 seconds before the reading is to be done. At the correct time, read and record the top of the meniscus. Immediately remove the hydrometer and place it with a slight spinning motion into the glass cylinder that is full of clean distilled water.

9.) Record the Hydrometer correction factor from the graph/spreadsheet that is placed on the wall.

10.) After all hydrometer readings in the suspended solution, take and record the temperature of the solution.

11:37	Reading Time	Hydrometer Reading	Temperature Degrees C	Hydrometer Correction	Corrected Reading
11 39	2 minutes	7	68	6.0	1
11 42	5 minutes	7			1
11 52	15 minutes	7			1
12 07	30 minutes	7			1
12 37	60 minutes	7			1
3 47	250 minutes	7			1
11 30	1440 minutes	7			1

7

Weight of Sample Placed in Solution: 100.59
Weight of Sample + Pan Placed in Oven: 32.52
Weight of Sample + Pan After Drying in the Oven: 32.42
12.85 1B Weight of Pan: 19.57
% of Hygroscopic Moisture in Sample: 0.78%

Hydrometer #: 152H

7

Adjusted Sample Weight: 99.81

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO# 18E0079
Project #: 18S010-21
Location: 18E0079 - 07
Lab#: S18 - 0780
Description: sand
Color: brown

Client: ARI
Sampled by: ~~Client~~ OTHER
Date Sampled: 4-25-18
Tested by: AE/CFM
Date Tested:
Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

DRY SIEVE SECTION

Specification: SI hydro / nmc

7

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	[✓ 1.0"]	25.0 mm	0	0	100%	
8	[✓ 3/4"]	19.0 mm	0	0	100%	
9	5/8"	16.0 mm				
10	[✓ 1/2"]	12.5 mm	0	0	100%	
11	[✓ 3/8"]	9.5 mm	0	0	100%	
12	1/4"	6.3 mm				
13	[✓ #4]	4.75 mm	1.4			
14	Pan		375.6			
Total Weight			377.0			

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?
Yes: ____
No: ____

% Gravel: ____
% Sand: ____
% #200: ____

WET SIEVE SECTION

Before Wash Weight: 375.6
Before Sieving Weight (A): ~~96.2 ≈ 358.6~~ 13
Soak time (10 min. minimum):
After Sieving Weight (B): 96.2 ≈ 358.6

≈3.7067169

MOISTURE

Tare Weight: 10.0
Wet Soil + Tare Wt.: 304.4
Dry Soil + Tare Wt.: 242.3
% Moisture: 26.7%
232.3

☆3 2

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	[✓ #10]	2.00 mm	2.0			
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	[✓ #40]	0.425 mm	56.6 ≈	211.8		
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	[✓ #200]	0.075 mm	95.8 ≈	357.1		
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing
D_{30} = Diameter in mm at 30% passing
D_{60} = Diameter in mm at 60% passing

D_{10} = ____
D_{30} = ____
D_{60} = ____

$C_c = D_{30}^2 / (D_{10} \times D_{60})$
$C_u = D_{60} / D_{10}$
C_c = ____
C_u = ____

x9

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HYDROMETER ANALYSIS

Shelton Harbor Remediation

Project: ARI WO# 18E0079
Project #: 18S010-21
Lab #: S18-0780
Location/Source: 18E0079-07
Description: brown Sand
Equipment Used: CA-020, SA-024, SA-009

Client: ARI
Sampled by: DHaoV
Date Sampled: 4-25-18
Tested by: A-E / CEM
Date Tested:

~~7~~

1.) This test is to be performed in accordance with ASTM D 422, Volume 4.08

2.) This test should be performed in a room maintained at 68°F for the duration of the test.

3.) First air dry the sample and sieve over a #10 sieve.

4.) Weigh sample (about 50 grams for silts & clays, and 100 grams for sands). At the same time weigh a 10 to 20 gram sample and oven dry for the hygroscopic moisture correction.

5.) Place sample (50 to 100 grams) in 250 ml beaker and add 125 ml of sodium hexametaphosphate solution. Allow to soak at least 16 hours.

6.) After soaking, place sample and solution into stirring beaker (milk shake beaker), being careful to wash all of the solution into the beaker using distilled water. Fill the stirring beaker until it is half full with distilled water.

7.) Place on the stirring apparatus and mix for 1 minute. Immediately transfer the solution into the glass sedimentation cylinder and add distilled water until total volume is 1,000 ml. Cover the top of the cylinder with a stopper or your hand and invert 30 times within one minute. Place cylinder in a convenient place and take reading at the prescribed intervals.

8.) To take a reading carefully place the hydrometer into the solution 20 to 25 seconds before the reading is to be done. At the correct time, read and record the top of the meniscus. Immediately remove the hydrometer and place it with a slight spinning motion into the glass cylinder that is full of clean distilled water.

9.) Record the Hydrometer correction factor from the graph/spreadsheet that is placed on the wall.

10.) After all hydrometer readings in the suspended solution, take and record the temperature of the solution.

~~WTP~~

W08

Reading Time		Hydrometer Reading	Temperature Degrees C	Hydrometer Correction	Corrected Reading
1:10	2 minutes	7	68	6.0	1
1:13	5 minutes	7			1
1:23	15 minutes	7			1
1:38	30 minutes	7			1
2:08	60 minutes	7			1
4:18	250 minutes	6.5			0.5
1:08	1440 minutes	6.5			0.5

13

Hydrometer # 152H

Weight of Sample Placed in Solution: 100.79
Weight of Sample + Pan Placed in Oven 34.67
Weight of Sample + Pan After Drying in the Oven 9 ~~34~~ 34.38 20
14.77 2B Weight of Pan 19.61
% of Hygroscopic Moisture in Sample 1.96%

Adjusted Sample Weight: 98.85

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO#18E0079
Project #: 185010-21
Location: 18E0079-08
Lab#: S18-0781
Description: sand w/ gravel &, silt
Color: brown

Client: ARI
Sampled by: ~~Client~~ OTHER
Date Sampled: 4-25-18
Tested by: AE/CFM
Date Tested:
Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: NMC

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	[✓ 1.0"]	25.0 mm				
8	[✓ 3/4"]	19.0 mm				
9	5/8"	16.0 mm				
10	[✓ 1/2"]	12.5 mm				
11	[✓ 3/8"]	9.5 mm				
12	1/4"	6.3 mm				
13	[✓ #4]	4.75 mm				
14	Pan					
Total Weight						

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?
Yes: ______
No: ______

% Gravel: ______
% Sand: ______
% -#200: ______

MOISTURE

Tare Weight: 9.9
Wet Soil + Tare Wt.: 485.4
Dry Soil + Tare Wt.: 404.1
% Moisture: 20.6%
394.2

WET SIEVE SECTION

Before Wash Weight: ______
Before Sieving Weight (A): ______
Soak time (10 min. minimum): ______
After Sieving Weight (B): ______

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	[✓ #10]	2.00 mm				
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	[✓ #40]	0.425 mm				
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	[✓ #200]	0.075 mm				
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing
D_{30} = Diameter in mm at 30% passing
D_{60} = Diameter in mm at 60% passing

D_{10} = ______
D_{30} = ______
D_{60} = ______

$C_c = D_{30}^2 / (D_{10} \times D_{60})$
$C_u = D_{60} / D_{10}$
C_c = ______
C_u = ______

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO#18E0079

Project #: 18S010-21

Location: 18E0079-09

Lab#: S18-0782

Description: Sand w/ silt

Color: dark gray

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

DRY SIEVE SECTION

Specification: NMC

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	[✓ 1.0"]	25.0 mm				
8	[✓ 3/4"]	19.0 mm				
9	5/8"	16.0 mm				
10	[✓ 1/2"]	12.5 mm				
11	[✓ 3/8"]	9.5 mm				
12	1/4"	6.3 mm				
13	[✓ #4]	4.75 mm				
14	Pan					
Total Weight						

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?
Yes: ____
No: ____

% Gravel: ____
% Sand: ____
% #200: ____

MOISTURE

Tare Weight: 10.4
Wet Soil + Tare Wt.: 166.3
Dry Soil + Tare Wt.: 108.2
% Moisture: 59.4%
97.8

#1

WET SIEVE SECTION

Before Wash Weight:
Before Sieving Weight (A):
Soak time (10 min. minimum):
After Sieving Weight (B):

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	[✓ #10]	2.00 mm				
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	[✓ #40]	0.425 mm				
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	[✓ #200]	0.075 mm				
28	#270	0.053 mm				

D_{10}=Diameter in mm at 10% passing
D_{30}=Diameter in mm at 30% passing
D_{60}=Diameter in mm at 60% passing

D_{10}= ____
D_{30}= ____
D_{60}= ____

$C_c = D_{30}^2 / (D_{10} \times D_{60})$
$C_u = D_{60} / D_{10}$
C_c= ____
C_u= ____

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 18S010-21

Location: 18E0079 - ~~[illegible]~~ 10

Lab#: S18-0783

Description: Sand w/ silt & gravel

Color: dark gray

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: SI hydro / NMC

3

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	1.0"	25.0 mm	0	0	100%	
8	3/4"	19.0 mm	0	0	100%	
9	5/8"	16.0 mm				
10	1/2"	12.5 mm	51.6			
11	3/8"	9.5 mm	69.8			
12	1/4"	6.3 mm				
13	#4	4.75 mm	124.8			
14	Pan		180.6			
Total Weight			305.4			

Sample Contains:

Silt: ☐

Clay: ☐

Organics: ☐

Is the Sample Crushed?

Yes:

No:

% Gravel:

% Sand:

% #200:

WET SIEVE SECTION

Before Wash Weight: 180.6

Before Sieving Weight (A): 36.8≃144.4 BIG

Soak time (10 min, minimum):

After Sieving Weight (B): 36.8≃144.4

2.6864187

MOISTURE

Tare Weight: 10.6

Wet Soil + Tare Wt.: 227.4 #5

Dry Soil + Tare Wt.: 198.7

% Moisture: 15.32

188.1

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm	45.5			
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm	15.1≃	86.1		
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm	36.1≃	142.5		
28	#270	0.053 mm				

D_{10}=Diameter in mm at 10% passing

D_{30}=Diameter in mm at 30% passing

D_{60}=Diameter in mm at 60% passing

D_{10}=

D_{30}=

D_{60}=

$C_c=D_{30}^2/(D_{10} \times D_{60})$

$C_u=D_{60}/D_{10}$

C_c=

C_u=

x9

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HYDROMETER ANALYSIS

Project: Shelton Harbor Remediation ARI WO# 18E0079
Project #: 188010-21
Lab #: S18-0783
Location/Source: 18E0079-102
Description: dk gry sand w/ silt & g
Equipment Used: CA-020, SA-024, SA-009

Client: ARI
Sampled by: other
Date Sampled: 4-25-18
Tested by: AE / CFM
Date Tested:

3

1.) This test is to be performed in accordance with ASTM D 422, Volume 4.08

2.) This test should be performed in a room maintained at 68°F for the duration of the test.

3.) First air dry the sample and sieve over a #10 sieve.

4.) Weigh sample (about 50 grams for silts & clays, and 100 grams for sands). At the same time weigh a 10 to 20 gram sample and oven dry for the hygroscopic moisture correction.

5.) Place sample (50 to 100 grams) in 250 ml beaker and add 125 ml of sodium hexametaphosphatte solution. Allow to soak at least 16 hours.

6.) After soaking, place sample and solution into stirring beaker (milk shake beaker), being careful to wash all of the solution into the beaker using distilled water. Fill the stirring beaker until it is half full with distilled water.

7.) Place on the stirring apparatus and mix for 1 minute. Immediately transfer the solution into the glass sedimentation cylinder and add distilled water until total volume is 1,000 ml. Cover the top of the cylinder with a stopper or your hand and invert 30 times within one minute. Place cylinder in a convenient place and take reading at the prescribed intervals.

8.) To take a reading carefully place the hydrometer into the solution 20 to 25 seconds before the reading is to be done. At the correct time, read and record the top of the meniscus. Immediately remove the hydrometer and place it with a slight spinning motion into the glass cylinder that is full of clean distilled water.

9.) Record the Hydrometer correction factor from the graph/spreadsheet that is placed on the wall.

10.) After all hydrometer readings in the suspended solution, take and record the temperature of the solution.

~~OS~~

1:14

	Reading Time	Hydrometer Reading	Temperature Degrees C	Hydrometer Correction	Corrected Reading
1:16	2 minutes	15	68	6.0	9
1:19	5 minutes	12			6
1:29	15 minutes	10			4
1:34	30 minutes	9			3
2:14	60 minutes	8			3
4:24	250 minutes	8			2
1:14	1440 minutes	7			

BJG

Weight of Sample Placed in Solution: 50.29
Weight of Sample + Pan Placed in Oven 33.36
Weight of Sample + Pan After Drying in the Oven 33.23
13.73 3C Weight of Pan 19.50
% of Hygroscopic Moisture in Sample 0.95%

200

Hydrometer # 152H

Adjusted Sample Weight: 49.82g

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO#18E0079
Project #: 185010-21
Location: 18E0079 - ~~03~~ UBC 11
Lab#: S18-0784
Description: gravel and sand
Color: dk gry-brn

Client: ARI
Sampled by: ~~Client~~ OTHER
Date Sampled: 4-25-18
Tested by: AE/CFM
Date Tested:
Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: NMC

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	[✓ 1.0"]	25.0 mm				
8	[✓ 3/4"]	19.0 mm				
9	5/8"	16.0 mm				
10	[✓ 1/2"]	12.5 mm				
11	[✓ 3/8"]	9.5 mm				
12	1/4"	6.3 mm				
13	[✓ #4]	4.75 mm				
14	Pan					
Total Weight						

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?
Yes:
No:

%Gravel:
% Sand:
% -#200:

MOISTURE

Tare Weight	10.2
Wet Soil + Tare Wt.	161.9
Dry Soil + Tare Wt.	130.7
% Moisture	25.9%
	120.5

#2

WET SIEVE SECTION

Before Wash Weight:
Before Sieving Weight (A):
Soak time (10 min. minimum):
After Sieving Weight (B):

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	[✓ #10]	2.00 mm				
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	[✓ #40]	0.425 mm				
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	[✓ #200]	0.075 mm				
28	#270	0.053 mm				

D_{10}=Diameter in mm at 10% passing
D_{30}=Diameter in mm at 30% passing
D_{60}=Diameter in mm at 60% passing

D_{10}=
D_{30}=
D_{60}=

$C_c=D_{30}^2/(D_{10} \times D_{60})$
$C_u=D_{60}/D_{10}$
C_c=
C_u=

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 185010-21

Location: 18E0079 - 02

Lab#: S18-0785

Description: Sand & gravel

Color: brown

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: SI hydro / nme

12

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	1.0"	25.0 mm	39.9			
8	3/4"	19.0 mm	77.4			
9	5/8"	16.0 mm				
10	1/2"	12.5 mm	132.0			
11	3/8"	9.5 mm	145.2			
12	1/4"	6.3 mm				
13	#4	4.75 mm	202.7			
14	Pan		176.5			
Total Weight			379.2			

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?
Yes: ______
No: ______

% Gravel: ______
% Sand: ______
% #200: ______

MOISTURE

Tare Weight: 10.1
Wet Soil + Tare Wt.: 273.0
Dry Soil + Tare Wt.: 216.7
% Moisture: 27.3%
206.6

PP

WET SIEVE SECTION

Before Wash Weight: 176.5
Before Sieving Weight (A): 43.4 ≈ 160.5 8
Soak time (10 min. minimum):
After Sieving Weight (B): 43.4 ≈ 160.5

.24001597

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm	56.3			
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm	30.9 ≈	130.5		
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm	43.0 ≈	159.5		
28	#270	0.053 mm				

D_{10}=Diameter in mm at 10% passing
D_{30}=Diameter in mm at 30% passing
D_{60}=Diameter in mm at 60% passing

D_{10}= ______
D_{30}= ______
D_{60}= ______

$C_c = D_{30}^2 / (D_{10} \times D_{60})$
$C_u = D_{60} / D_{10}$
C_c= ______
C_u= ______

x9

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HYDROMETER ANALYSIS

Project: Shelton Harbor Remediation ARI WO# 18E0079
Project #: 188010-21
Lab #: S18-0785
Location/Source: 18E0079 - ~~[illegible]~~
Description: brown Sand & gravel
Equipment Used: CA-020, SA-024, SA-009

Client: ARI
Sampled by: Other
Date Sampled: 4-25-18
Tested by: A-E / CFM
Date Tested:

~~12~~

1.) This test is to be performed in accordance with ASTM D 422, Volume 4.08

2.) This test should be performed in a room maintained at 68°F for the duration of the test.

3.) First air dry the sample and sieve over a #10 sieve.

4.) Weigh sample (about 50 grams for silts & clays, and 100 grams for sands). At the same time weigh a 10 to 20 gram sample and oven dry for the hygroscopic moisture correction.

5.) Place sample (50 to 100 grams) in 250 ml beaker and add 125 ml of sodium hexametaphosphatte solution. Allow to soak at least 16 hours.

6.) After soaking, place sample and solution into stirring beaker (milk shake beaker), being careful to wash all of the solution into the beaker using distilled water. Fill the stirring beaker until it is half full with distilled water.

7.) Place on the stirring apparatus and mix for 1 minute. Immediately transfer the solution into the glass sedimentation cylinder and add distilled water until total volume is 1,000 ml. Cover the top of the cylinder with a stopper or your hand and invert 30 times within one minute. Place cylinder in a convenient place and take reading at the prescribed intervals.

8.) To take a reading carefully place the hydrometer into the solution 20 to 25 seconds before the reading is to be done. At the correct time, read and record the top of the meniscus. Immediately remove the hydrometer and place it with a slight spinning motion into the glass cylinder that is full of clean distilled water.

9.) Record the Hydrometer correction factor from the graph/spreadsheet that is placed on the wall.

10.) After all hydrometer readings in the suspended solution, take and record the temperature of the solution.

~~9~~ 8

12:38

Reading Time	Hydrometer Reading	Temperature Degrees C	Hydrometer Correction	Corrected Reading
12:40 2 minutes	14	68	6.0	8
12:43 5 minutes	10			4
12:53 15 minutes	9			3
1:08 30 minutes	8			2
1:38 60 minutes	8			2
3:48 250 minutes	7			1
1440 minutes	7			1

Weight of Sample Placed in Solution: 50.08
Weight of Sample + Pan Placed in Oven: 36.81
Weight of Sample + Pan After Drying in the Oven: 36.65
16.86 5D Weight of Pan: 19.79
% of Hygroscopic Moisture in Sample: 0.95%

~~5~~

Hydrometer # 1524

Adjusted Sample Weight: 49.61

Corporate Office ~ 777 Chrysler Drive ◦ Burlington, WA 98233 ◦ Phone (360) 755-1990 ◦ Fax (360) 755-1980
SW Region ~ 2118 Black Lake Blvd. SW ◦ Olympia, WA 98512 ◦ Phone (360) 534-9777 ◦ Fax (360) 534-9779
NW Region ~ 2126 East Bakerview Road, #101 ◦ Bellingham, WA 98226 ◦ Phone (360) 647-6061 ◦ Fax (360) 647-8111
Website Address: www.mtc-inc.net

Rev. 12/08

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 185010-21

Location: 18E0079 - 03

Lab#: S18-07860

Description: Sand w/ gravel

Color: dk brown

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

DRY SIEVE SECTION

NMC

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Specification: Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	[✓ 1.0"]	25.0 mm				
8	[✓ 3/4"]	19.0 mm				
9	5/8"	16.0 mm				
10	[✓ 1/2"]	12.5 mm				
11	[✓ 3/8"]	9.5 mm				
12	1/4"	6.3 mm				
13	[✓ #4]	4.75 mm				
14	Pan					
Total Weight						

Sample Contains:

Silt: ☐

Clay: ☐

Organics: ☐

Is the Sample Crushed?

Yes:

No:

% Gravel:

% Sand:

% #200:

MOISTURE

Tare Weight: 10.2

Wet Soil + Tare Wt.: 160.1

Dry Soil + Tare Wt.: 136.9

% Moisture: 18.3%

126.7

?

WET SIEVE SECTION

Before Wash Weight:

Before Sieving Weight (A):

Soak time (10 min. minimum):

After Sieving Weight (B):

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	[✓ #10]	2.00 mm				
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	[✓ #40]	0.425 mm				
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	[✓ #200]	0.075 mm				
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing

D_{30} = Diameter in mm at 30% passing

D_{60} = Diameter in mm at 60% passing

D_{10} =

D_{30} =

D_{60} =

$C_c = D_{30}^2 / (D_{10} \times D_{60})$

$C_u = D_{60} / D_{10}$

C_c =

C_u =

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 18S010-21

Location: 18E0079 - 04

Lab#: S18-0787

Description: gravel & sand

Color: brown

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: SI hydro /nmc

16

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	1.0"	25.0 mm	0	0	100%	
8	3/4"	19.0 mm	11.1			
9	5/8"	16.0 mm				
10	1/2"	12.5 mm	59.1			
11	3/8"	9.5 mm	78.1			
12	1/4"	6.3 mm				
13	#4	4.75 mm	135.4			
14	Pan		178.9			
Total Weight			314.3			

Sample Contains:

Silt: ☐

Clay: ☐

Organics: ☐

Is the Sample Crushed?

Yes:______

No:______

% Gravel:

% Sand:

% #200:

WET SIEVE SECTION

Before Wash Weight: 178.9

Before Sieving Weight (A): 90.34 166.1 15

Soak time (10 min. minimum):

After Sieving Weight (B): 90.35 166.1

1.28440316

MOISTURE

Tare Weight: 10.2

Wet Soil + Tare Wt. 181.3

Dry Soil + Tare Wt. 159.8

% Moisture: 14.4%

149.6

Brwn

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm	50.1			
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm	60.55	127.8		
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm	89.75	165.3		
28	#270	0.053 mm				

D_{10}=Diameter in mm at 10% passing

D_{30}=Diameter in mm at 30% passing

D_{60}=Diameter in mm at 60% passing

D_{10}=

D_{30}=

D_{60}=

$C_c = D_{30}^2 / (D_{10} \times D_{60})$

$C_u = D_{60} / D_{10}$

C_c=

C_u=

x9

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HYDROMETER ANALYSIS

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 18S010-21

Lab #: S18-0707

Location/Source: 18E0079-04

Description: brown gravel & sand

Equipment Used: CA-020, SA-024, SA-009

Client: ARI

Sampled by: Other

Date Sampled: 4-25-18

Tested by: A.C / CFM

Date Tested:

~~10~~

1.) This test is to be performed in accordance with ASTM D 422, Volume 4.08

2.) This test should be performed in a room maintained at 68°F for the duration of the test.

3.) First air dry the sample and sieve over a #10 sieve.

4.) Weigh sample (about 50 grams for silts & clays, and 100 grams for sands). At the same time weigh a 10 to 20 gram sample and oven dry for the hygroscopic moisture correction.

5.) Place sample (50 to 100 grams) in 250 ml beaker and add 125 ml of sodium hexametaphosphate solution. Allow to soak at least 16 hours.

6.) After soaking, place sample and solution into stirring beaker (milk shake beaker), being careful to wash all of the solution into the beaker using distilled water. Fill the stirring beaker until it is half full with distilled water.

7.) Place on the stirring apparatus and mix for 1 minute. Immediately transfer the solution into the glass sedimentation cylinder and add distilled water until total volume is 1,000 ml. Cover the top of the cylinder with a stopper or your hand and invert 30 times within one minute. Place cylinder in a convenient place and take reading at the prescribed intervals.

8.) To take a reading carefully place the hydrometer into the solution 20 to 25 seconds before the reading is to be done. At the correct time, read and record the top of the meniscus. Immediately remove the hydrometer and place it with a slight spinning motion into the glass cylinder that is full of clean distilled water.

9.) Record the Hydrometer correction factor from the graph/spreadsheet that is placed on the wall.

10.) After all hydrometer readings in the suspended solution, take and record the temperature of the solution.

~~C408~~

15

12:48	Reading Time	Hydrometer Reading	Temperature Degrees C	Hydrometer Correction	Corrected Reading
12:50	2 minutes	12	68	6.0	6
12:53	5 minutes	10			4
1:03	15 minutes	9			3
1:18	30 minutes	8			2
1:48	60 minutes	8			2
3:58	250 minutes	7			1
	1440 minutes	7			1

Weight of Sample Placed in Solution: 100.28

Weight of Sample + Pan Placed in Oven 31.51

Weight of Sample + Pan After Drying in the Oven 31.43

11.85 9A Weight of Pan 19.58

% of Hygroscopic Moisture in Sample 0.682

~~10~~

Hydrometer # 1524

Adjusted Sample Weight: 99.60

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 18S010-21

Location: 18E0079 - TB5

Lab#: S18-0788

Description: sand & gravel w/ silt

Color: brown

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

DRY SIEVE SECTION

Specification: NML

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	[✓ 1.0]	25.0 mm				
8	[✓ 3/4]	19.0 mm				
9	5/8"	16.0 mm				
10	[✓ 1/2]	12.5 mm				
11	[✓ 3/8]	9.5 mm				
12	1/4"	6.3 mm				
13	[✓ #4]	4.75 mm				
14	Pan					
Total Weight						

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?
Yes: ______
No: ______

% Gravel: ______
% Sand: ______
% #200: ______

MOISTURE

Tare Weight: 10.3
Wet Soil + Tare Wt.: 451.3
Dry Soil + Tare Wt.: 373.8
% Moisture: 21.3%
363.5

P1

WET SIEVE SECTION

Before Wash Weight: ______
Before Sieving Weight (A): ______
Soak time (10 min. minimum): ______
After Sieving Weight (B): ______

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	[✓ #10]	2.00 mm				
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	[✓ #40]	0.425 mm				
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	[✓ #200]	0.075 mm				
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing
D_{30} = Diameter in mm at 30% passing
D_{60} = Diameter in mm at 60% passing

D_{10} = ______
D_{30} = ______
D_{60} = ______

$C_c = D_{30}^2 / (D_{10} \times D_{60})$
$C_u = D_{60} / D_{10}$
C_c = ______
C_u = ______

x15

Sieve Analysis

ASTM C-33 / C-136

Shelton Harbor Remediation

Project: ARI WO# 18E0079

Project #: 18S010-21

Location: 18E0079 - 16

Lab#: S18 - 0789

Description: sand w/ Gravel & Silt

Color: brown

Client: ARI

Sampled by: ~~Client~~ OTHER

Date Sampled: 4-25-18

Tested by: AE/CFM

Date Tested:

Equipment Used: CA-016, CA-030, CA-018, SA-004, SA-009

Specification: SI hydro / nmc

5

DRY SIEVE SECTION

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
1	3.0"	75.0 mm				
2	2.5"	63.5.0 mm				
3	2.0"	50.0 mm				
4	1.75"	44.5 mm				
5	1.5"	37.5 mm				
6	1.25"	31.5 mm				
7	1.0"	25.0 mm	0	0	100%	
8	3/4"	19.0 mm	33.4			
9	5/8"	16.0 mm				
10	1/2"	12.5 mm	50.2			
11	3/8"	9.5 mm	63.2			
12	1/4"	6.3 mm				
13	#4	4.75 mm	109.1			
14	Pan		213.8			
Total Weight			322.9			

Sample Contains:
Silt: ☐
Clay: ☐
Organics: ☐

Is the Sample Crushed?
Yes: ____
No: ____

% Gravel: ____
% Sand: ____
% #200: ____

MOISTURE

Tare Weight: 10.3
Wet Soil + Tare Wt.: 193.7
Dry Soil + Tare Wt.: 165.9
% Moisture: 17.9%
155.6

X

WET SIEVE SECTION

Before Wash Weight: 213.8
Before Sieving Weight (A): 94.8 ≅ 204.8 4
Soak time (10 min. minimum):
After Sieving Weight (B): 94.7 ≅ 204.8
1.5061003 x

Sieve #	Sieve Size		Retained Weight	Cumulative Percent Retained	Percent Passing	Sample Specifications
15	#4	4.75 mm				
16	#8	2.36 mm				
17	#10	2.00 mm	56.3			
18	#16	1.18 mm				
19	#20	0.850 mm				
20	#30	0.600 mm				
21	#40	0.425 mm	71.0 ≅	167.6		
22	#50	0.300 mm				
23	#60	0.250 mm				
24	#80	0.180 mm				
25	#100	0.150 mm				
26	#140	0.104 mm				
27	#200	0.075 mm	94.1 ≅	203.9		
28	#270	0.053 mm				

D_{10} = Diameter in mm at 10% passing
D_{30} = Diameter in mm at 30% passing
D_{60} = Diameter in mm at 60% passing

D_{10} =
D_{30} =
D_{60} =

$C_c = D_{30}^2 / (D_{10} \times D_{60})$
$C_u = D_{60} / D_{10}$
C_c =
C_u =

x9

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HYDROMETER ANALYSIS

Project: Shelton Harbor Remediation ARI WO# 18E0079
Project #: 18S010-21
Lab #: S18-0789
Location/Source: 18E0079 - 06
Description: Brn Sand w/ gravel & silt
Equipment Used: CA-020, SA-024, SA-009

Client: ARI
Sampled by: Other
Date Sampled: 4-25-18
Tested by: AE / CFM
Date Tested:

~~5~~

1.) This test is to be performed in accordance with ASTM D 422, Volume 4.08

2.) This test should be performed in a room maintained at 68°F for the duration of the test.

3.) First air dry the sample and sieve over a #10 sieve.

4.) Weigh sample (about 50 grams for silts & clays, and 100 grams for sands). At the same time weigh a 10 to 20 gram sample and oven dry for the hygroscopic moisture correction.

5.) Place sample (50 to 100 grams) in 250 ml beaker and add 125 ml of sodium hexametaphosphatte solution. Allow to soak at least 16 hours.

6.) After soaking, place sample and solution into stirring beaker (milk shake beaker), being careful to wash all of the solution into the beaker using distilled water. Fill the stirring beaker until it is half full with distilled water.

7.) Place on the stirring apparatus and mix for 1 minute. Immediately transfer the solution into the glass sedimentation cylinder and add distilled water until total volume is 1,000 ml. Cover the top of the cylinder with a stopper or your hand and invert 30 times within one minute. Place cylinder in a convenient place and take reading at the prescribed intervals.

8.) To take a reading carefully place the hydrometer into the solution 20 to 25 seconds before the reading is to be done. At the correct time, read and record the top of the meniscus. Immediately remove the hydrometer and place it with a slight spinning motion into the glass cylinder that is full of clean distilled water.

9.) Record the Hydrometer correction factor from the graph/spreadsheet that is placed on the wall.

10.) After all hydrometer readings in the suspended solution, take and record the temperature of the solution.

~~4~~ 4

12:54

Reading Time	Hydrometer Reading	Temperature Degrees C	Hydrometer Correction	Corrected Reading
12:54 2 minutes	8	68	6.0	2
12:59 5 minutes	7			1
1:09 15 minutes	7			1
1:24 30 minutes	7			1
1:54 60 minutes	7			1
5:04 250 minutes	6.5			0.5
1440 minutes	6.5			0.5

Weight of Sample Placed in Solution: 100.44
Weight of Sample + Pan Placed in Oven: 33.03
Weight of Sample + Pan After Drying in the Oven: 32.95
13, 24 2A Weight of Pan: 19.71
% of Hygroscopic Moisture in Sample: 0.60

~~21~~

Hydrometer #: 152H

Adjusted Sample Weight: 99.84

Certified Analyses included in this Report

Analyte	Certifications

Code	Description	Number	Expires
ADEC	Alaska Dept of Environmental Conservation	17-015	02/07/2019
CALAP	California Department of Public Health CAELAP	2748	06/30/2018
DoD-ELAP	DoD-Environmental Laboratory Accreditation Program	66169	02/07/2019
NELAP	ORELAP - Oregon Laboratory Accreditation Program	WA100006-011	05/12/2019
WADOE	WA Dept of Ecology	C558	06/30/2018
WA-DW	Ecology - Drinking Water	C558	06/30/2018

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
[2C]	Indicates this result was quantified on the second column on a dual column analysis.

Attachment B-4

Bearing Capacity

User values

SMA-1, VST-01		
Test depth, ft	Peak, psf	Residual, psf
1	167	104
2	355	188
2.7	439	209
Average, psf	320	167

SMA-1, VST-03		
Test depth, ft	Peak, psf	Residual, psf
1	334	146
2	313	188
2.7	355	146
Average, psf	334	160

ave all rds, psf	280	140
lowest rdg, psf	167	104
highest rdg, psf	439	209
median rdg, psf	344.5	167

Bearing Capacity on Clay/Silt Sediment

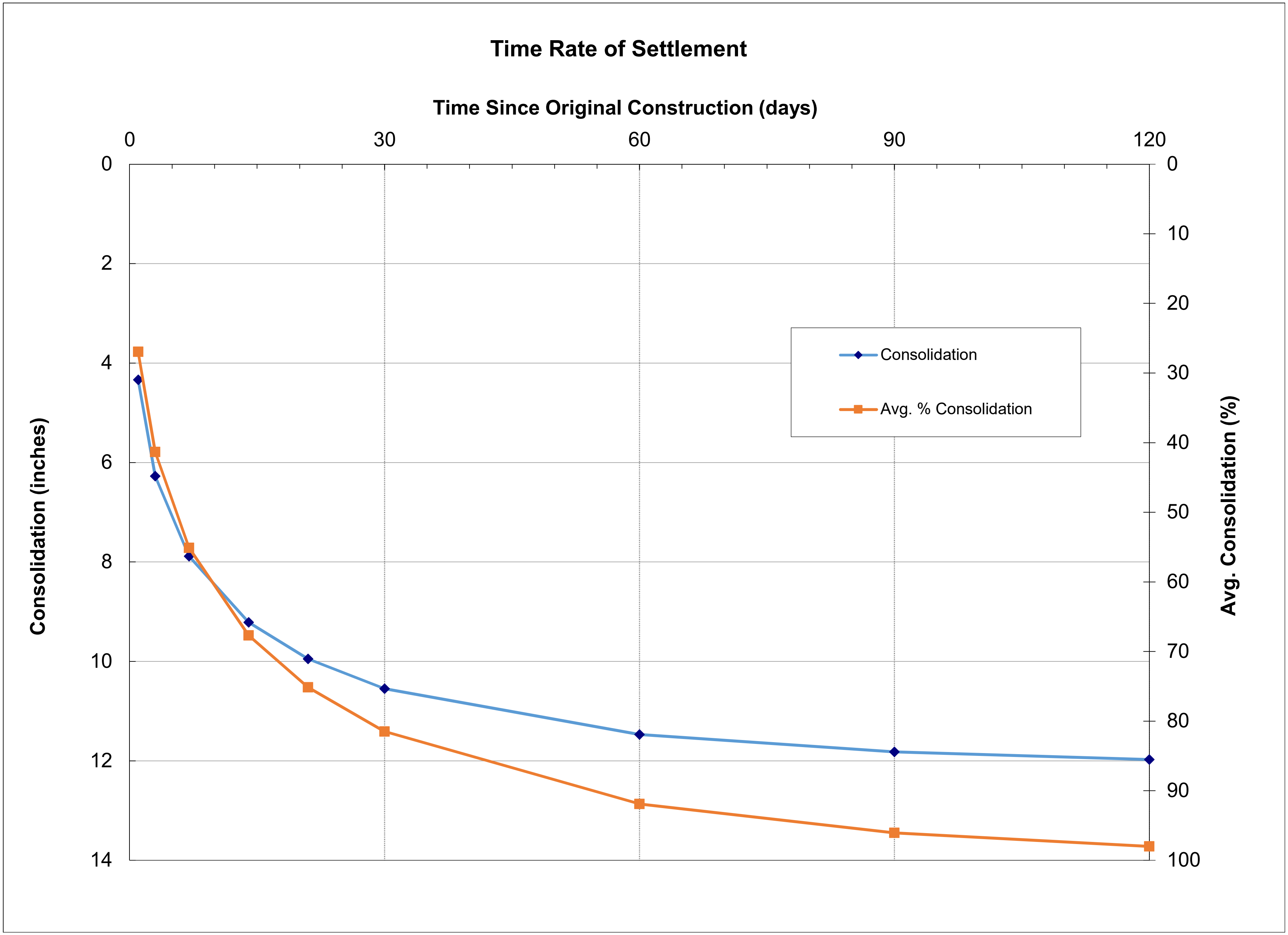
Das, 1994

Soil Type	γ'_cap, pcf	ϕ, deg	c, psf	Cap thickness, ft	Δq (surcharge), psf	Df, feet
Shelton cap	67.6	25	0	2.5	169	0

Cap Area	B	L	B/L	0.195*B/L	Df/B	q_ult(net)_peak	FOS	q_all(net)
A	423	478	0.88	0.17	0	1007	3	336
B	324	623	0.52	0.10	0	945	3	315
C	85	200	0.43	0.08	0	930	3	310
D	142	349	0.41	0.08	0	926	3	309

Attachment B-5

Consolidation


Time Rate of Settlement
Time Since Original Construction (days)
0
30
60
90
120
Consolidation (inches)
0
2
4
6
8
10
12
14
Avg. Consolidation (%)
0
10
20
30
40
50
60
70
80
90
100
Consolidation
Avg. % Consolidation

Shelton Harbor

Settlement and Consolidation with Remediation Cap

Cap Thickness (ft)	2.5	Shelton cap (ft)	2.5
Total Unit Wt. of Berm Material (pcf)	130	Overbuild (ft)	0
Total Unit Wt. of Layer 1 (pcf)	77		
Total Unit Wt. of Layer 2 (pcf)	77		
Unit Wt. of Water (pcf)	62.4		

sample depth 2 to 4.125ft

Physical Parameters

SMA1-PC01

	Water	Cap	Layer 1 OH
e_o	-	-	3.001
c_c	-	-	0.896224
c_v (ft^2/day)	-	-	2.00E-01
Top Elevation (ft)	14.2	4.0	1.5
Layer Thickness in feet	12.7	2.5	5.3
Bouyant unit weight in pcf:	-	67.6	14.4
Total Estimated Settlement in inches:	12	1.0	ft

			Existing Condtions				**Delta Stress from Modifications**		**Post Cap Placement**			**Evaluation**
Unit		Thickness in feet	σ'_v in psf	in kPa	Void Ratio	Permeability k (m/s)	$\Delta\sigma_v$ in psf	in kPa	in psf	kPa	Void Ratio	Consolidation in inches
Layer 1 OH		0.53	3.81	0.18			169.00	8.09	172.81	8.27		2.4
		0.53	11.42	0.55			169.00	8.09	180.42	8.64		1.7
		0.53	19.03	0.91			169.00	8.09	188.03	9.00		1.4
		0.53	26.64	1.28			169.00	8.09	195.64	9.37		1.2
		0.53	34.25	1.64			169.00	8.09	203.25	9.73		1.1
		0.53	41.87	2.00			169.00	8.09	210.87	10.10		1.0
		0.53	49.48	2.37			169.00	8.09	218.48	10.46		0.9
		0.53	57.09	2.73			169.00	8.09	226.09	10.83		0.9
		0.53	64.70	3.10			169.00	8.09	233.70	11.19		0.8
	5.30	0.53	72.32	3.46			169.00	8.09	241.32	11.55		0.7

Total Estimated Settlement	Inches	12.1
	Feet	1.0

Hdr max 5.3 ft Assume single drainage

	Total Consol, inches	Depth from mudline, ft	Permeability k	m_v	m_v	cv	Hdr	Time	Tv	% Consol	Settlement
Layer Total in inches			m/s	kPa	psf	ft2/day	ft	days		%	in inches
						2.00E-01	0.53	1	0.71	86.012	2.03
						2.00E-01	1.06	1	0.18	47.606	0.81
						2.00E-01	1.59	1	0.08	31.738	0.45
						2.00E-01	2.12	1	0.04	23.803	0.29
						2.00E-01	2.65	1	0.03	19.043	0.21
						2.00E-01	3.18	1	0.02	15.869	0.16
						2.00E-01	3.71	1	0.01	13.602	0.12
						2.00E-01	4.24	1	0.01	11.902	0.10
						2.00E-01	4.77	1	0.01	10.579	0.08
12.1		5.3				2.00E-01	5.30	1	0.01	9.521	0.07
										Total	4.34

Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement
days		%	in inches	days		%	in inches	days		%	in inches
3	2.14	99.584	2.35	7	4.98	100.000	2.36	14	9.97	100.000	2.36
3	0.53	78.295	1.34	7	1.25	96.255	1.64	14	2.49	99.827	1.70
3	0.24	54.971	0.78	7	0.55	79.329	1.12	14	1.11	94.730	1.34
3	0.13	41.228	0.51	7	0.31	62.414	0.77	14	0.62	82.576	1.02
3	0.09	32.983	0.36	7	0.20	50.382	0.56	14	0.40	69.693	0.77
3	0.06	27.485	0.27	7	0.14	41.985	0.42	14	0.28	59.375	0.59
3	0.04	23.559	0.22	7	0.10	35.987	0.33	14	0.20	50.893	0.47
3	0.03	20.614	0.18	7	0.08	31.489	0.27	14	0.16	44.532	0.38
3	0.03	18.324	0.15	7	0.06	27.990	0.22	14	0.12	39.584	0.31
3	0.02	16.491	0.12	7	0.05	25.191	0.19	14	0.10	35.625	0.27
			6.27				7.88				9.22

Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement
days		%	in inches	days		%	in inches	days		%	in inches
21	14.95	100.000	2.36	30	21.36	100.000	2.36	60	42.72	100.000	2.36
21	3.74	99.992	1.71	30	5.34	100.000	1.71	60	10.68	100.000	1.71
21	1.66	98.656	1.40	30	2.37	99.768	1.41	60	4.75	99.999	1.42
21	0.93	91.922	1.13	30	1.33	96.994	1.20	60	2.67	99.889	1.23
21	0.60	81.470	0.90	30	0.85	90.157	0.99	60	1.71	98.805	1.09
21	0.42	70.910	0.71	30	0.59	81.252	0.81	60	1.19	95.665	0.96
21	0.31	61.819	0.57	30	0.44	72.351	0.66	60	0.87	90.571	0.83
21	0.23	54.540	0.46	30	0.33	64.422	0.55	60	0.67	84.388	0.72
21	0.18	48.480	0.39	30	0.26	57.945	0.46	60	0.53	77.939	0.62
21	0.15	43.632	0.33	30	0.21	52.150	0.39	60	0.43	71.750	0.53
			9.95				10.55				11.47

Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement
days		%	in inches	days		%	in inches	days		%	in inches
90	64.08	100.000	2.36	120	85.44	100.000	2.36	150	106.80	100.000	2.36
90	16.02	100.000	1.71	120	21.36	100.000	1.71	150	26.70	100.000	1.71
90	7.12	100.000	1.42	120	9.49	100.000	1.42	150	11.87	100.000	1.42
90	4.00	99.996	1.23	120	5.34	100.000	1.23	150	6.67	100.000	1.23
90	2.56	99.855	1.10	120	3.42	99.982	1.10	150	4.27	99.998	1.10
90	1.78	98.998	0.99	120	2.37	99.768	1.00	150	2.97	99.946	1.00
90	1.31	96.785	0.89	120	1.74	98.903	0.91	150	2.18	99.626	0.92
90	1.00	93.149	0.79	120	1.33	96.994	0.83	150	1.67	98.681	0.84
90	0.79	88.493	0.70	120	1.05	93.997	0.75	150	1.32	96.869	0.77
90	0.64	83.324	0.62	120	0.85	90.157	0.67	150	1.07	94.190	0.70
			11.82				11.97				12.05

Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement
days		%	in inches	days		%	in inches	days		%	in inches
180	128.16	100.000	2.36	210	149.52	100.000	2.36	240	170.88	100.000	2.36
180	32.04	100.000	1.71	210	37.38	100.000	1.71	240	42.72	100.000	1.71
180	14.24	100.000	1.42	210	16.61	100.000	1.42	240	18.99	100.000	1.42
180	8.01	100.000	1.23	210	9.34	100.000	1.23	240	10.68	100.000	1.23
180	5.13	100.000	1.10	210	5.98	100.000	1.10	240	6.84	100.000	1.10
180	3.56	99.988	1.00	210	4.15	99.997	1.00	240	4.75	99.999	1.00
180	2.62	99.872	0.92	210	3.05	99.957	0.92	240	3.49	99.985	0.92
180	2.00	99.421	0.85	210	2.34	99.746	0.85	240	2.67	99.889	0.85
180	1.58	98.367	0.78	210	1.85	99.148	0.79	240	2.11	99.556	0.79
180	1.28	96.570	0.72	210	1.50	97.975	0.73	240	1.71	98.805	0.74
			12.09				12.11				12.12

Time	Tv	% Consol	Settlement	Time	Tv	% Consol	Settlement
days		%	in inches	days		%	in inches
270	192.24	100.000	2.36	365	259.88	100.000	2.36
270	48.06	100.000	1.71	365	64.97	100.000	1.71
270	21.36	100.000	1.42	365	28.88	100.000	1.42
270	12.01	100.000	1.23	365	16.24	100.000	1.23
270	7.69	100.000	1.10	365	10.40	100.000	1.10
270	5.34	100.000	1.00	365	7.22	100.000	1.00
270	3.92	99.995	0.92	365	5.30	100.000	0.92
270	3.00	99.951	0.85	365	4.06	99.996	0.85
270	2.37	99.768	0.79	365	3.21	99.970	0.79
270	1.92	99.295	0.74	365	2.60	99.867	0.74
			12.12				12.13

Appendix C

Cap Stability Design

July 2018
Shelton Harbor Sediment Cleanup Unit
Oakland Bay and Shelton Harbor Sediments Cleanup Site (Cleanup Site ID: 13007)

Appendix C: Cap Stability Design

Prepared for
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Project Number: 110008-01.03
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1 Purpose

This appendix provides details on physical site conditions, design calculations, and constructability considerations that have been used to develop a stable sediment cap design within the Shelton Harbor sediment cleanup unit (SCU). Maps showing the proposed cap placement areas are provided in the main body of the Basis of Design Report (BODR; Figure 2-1). Section 2 discusses the physical conditions of Shelton Harbor related to sediment cap stability. Section 3 develops a stable layered cap design based on the U.S. Army Corps of Engineers (USACE) Coastal Engineering Manual (USACE 2002). Section 4 discusses the design implications for a blended cap (e.g., single-layer of mixed grain-size material) for Shelton Harbor.

2 Shelton Harbor Physical Site Conditions

Shelton Harbor is located in Shelton, Washington, in the southwestern region of Puget Sound, on the southwestern end of Oakland Bay (Figure C-1). The coastal environment, including tides, wind, and waves will dictate the cap stability considerations for the SCU. Specifically, the SCU is exposed to tidal currents, wave forces from the northeast across Oakland Bay, and wave-induced currents. Stream flows from Goldsborough Creek and Lower Shelton Creek run near the capping areas during low tide; however, capping material will not be placed within the creek beds, and will not be required to withstand forces from creek flows (see Section 2.2 in main body of the report). The following sections further detail the environmental elements that govern the SCU cap design.

2.1 Tidal Water Levels

National Oceanic and Atmospheric Administration (NOAA) tidal stations were used to establish the water levels expected within Shelton Harbor. The closest benchmark station is located at Barron Point on Totten Inlet (#9446742), southeast of Oakland Bay and Shelton Harbor. Table C-1 outlines the benchmark water levels from this station.

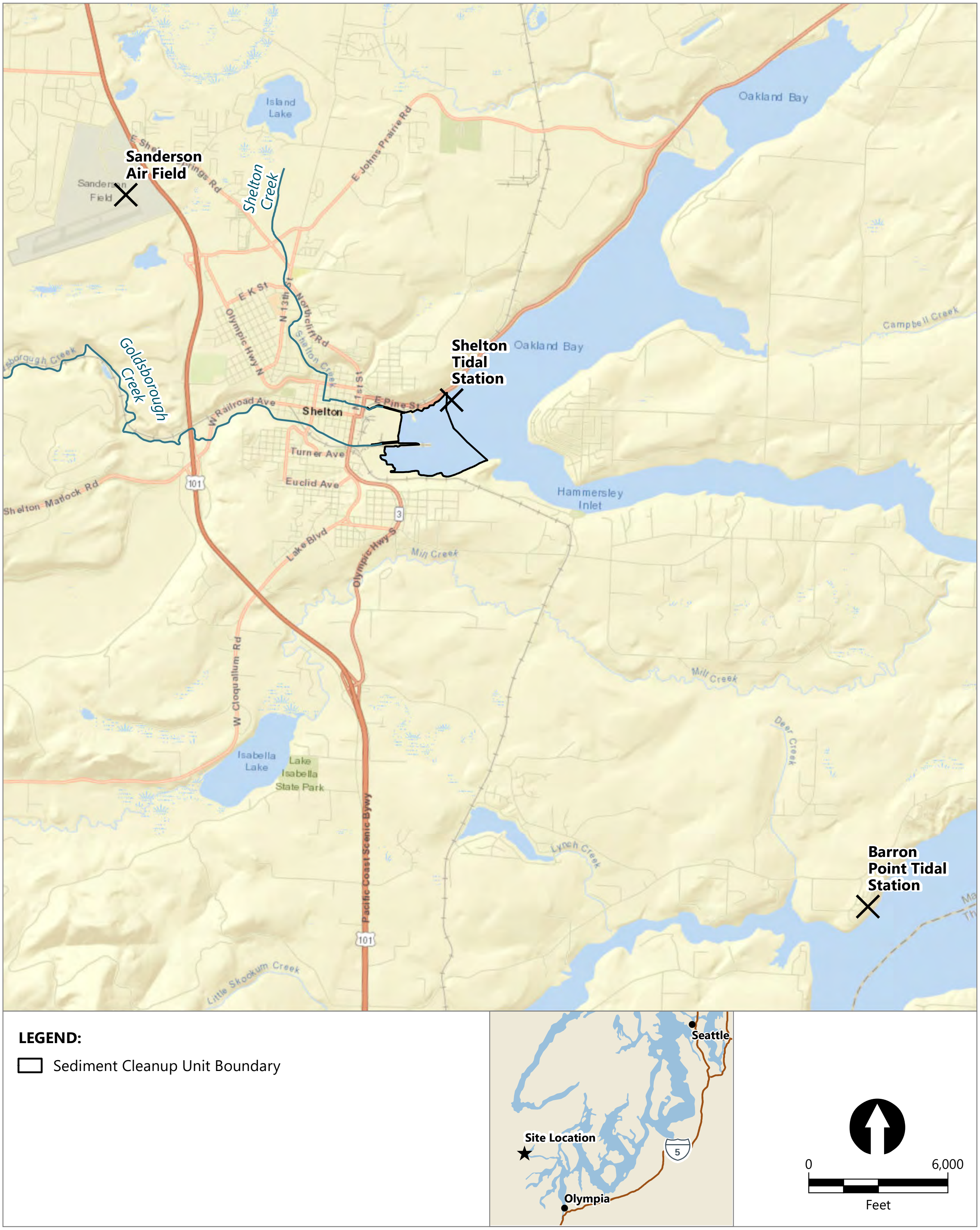
While there is no local NOAA tide station with a Highest Astronomical Tide (HAT) estimate[1], a review of the 2018 tidal predictions for Shelton, Washington (Station #9446628), reveals high tides regularly above 15 feet mean lower low water (MLLW) in November through March, reaching as high as 16.6 feet MLLW (predicted for January 4 and 5).

Regional sea level rise predictions[2] are available from NOAA for years 2020 through 2100 through the NOAA Sea Level Rise Viewer (https://coast.noaa.gov/digitalcoast/tools/slr.html). Intermediate values of sea level rise for the year 2100 for the site are 1.3 feet (intermediate low), 3.0 feet (intermediate mid-range), and 5.1 feet (intermediate high). Based on these predictions, mean higher high water (MHHW) elevation at the project site could range from 15.8 feet MLLW to 19.6 feet MLLW (based on 2018 MLLW datum).

---

[1] The closest published HAT estimate for the southern Puget Sound is the Budd Inlet station (#9446807), with an elevation of 16.5 feet MLLW.

[2] The Port Townsend location/scenario is the closest location to the project site.



Publish Date: 2018/07/27, 2:14 PM | User: ckiblinger
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ANCHOR QEA

Figure C-1
Vicinity Map
Appendix C: Shelton Harbor Cap Stability Design
Oakland Bay and Shelton Harbor Sediments Cleanup Site

Table C-1
Tidal Water Levels (2018): NOAA Station Barron Point, #9446742

Water Level	Feet, MLLW
MHHW[1]	14.5[2]
MHW	13.5
MSL	8.3
MLW	3.0
MLLW	0.0

Notes:

1. MHHW elevation in Oakland Bay from NOAA VDatum tool for Puget Sound is 14.2 feet MLLW.
2. Tides in Shelton Harbor can be higher than MHHW elevation, with maximum astronomical tide of about 16.6 feet MLLW based on tidal predictions available for the NOAA Shelton Station (#9446628).

MHHW: Mean Higher High Water
MHW: Mean High Water
MSL: Mean Sea Level
MLW: Mean Low Water
MLLW: Mean Lower Low Water

2.2 Wind

Hourly sustained wind data (speed and direction) from the Sanderson Field Airport were used for the coastal evaluation. The airport is located 2.9 miles to the northwest of the site. Figure C-2 shows the wind rose[3] for the airport data from January 1999 to July 2016. The majority of the wind for the area is from the southwest and, for the time period, has a maximum sustained speed of 35 miles per hour (mph). For the direction that impacts the site (30 to 90 degrees) the maximum sustained wind speed (for the observed time period) is 16 mph. Wind speeds used in the analysis are 2-minute average sustained wind speeds (one each hour); with the largest sustained wind speed recorded for each year extracted for use in the analysis. An extreme wind analysis[4] was conducted and resulted in the following predicted extreme wind conditions for Shelton Harbor:

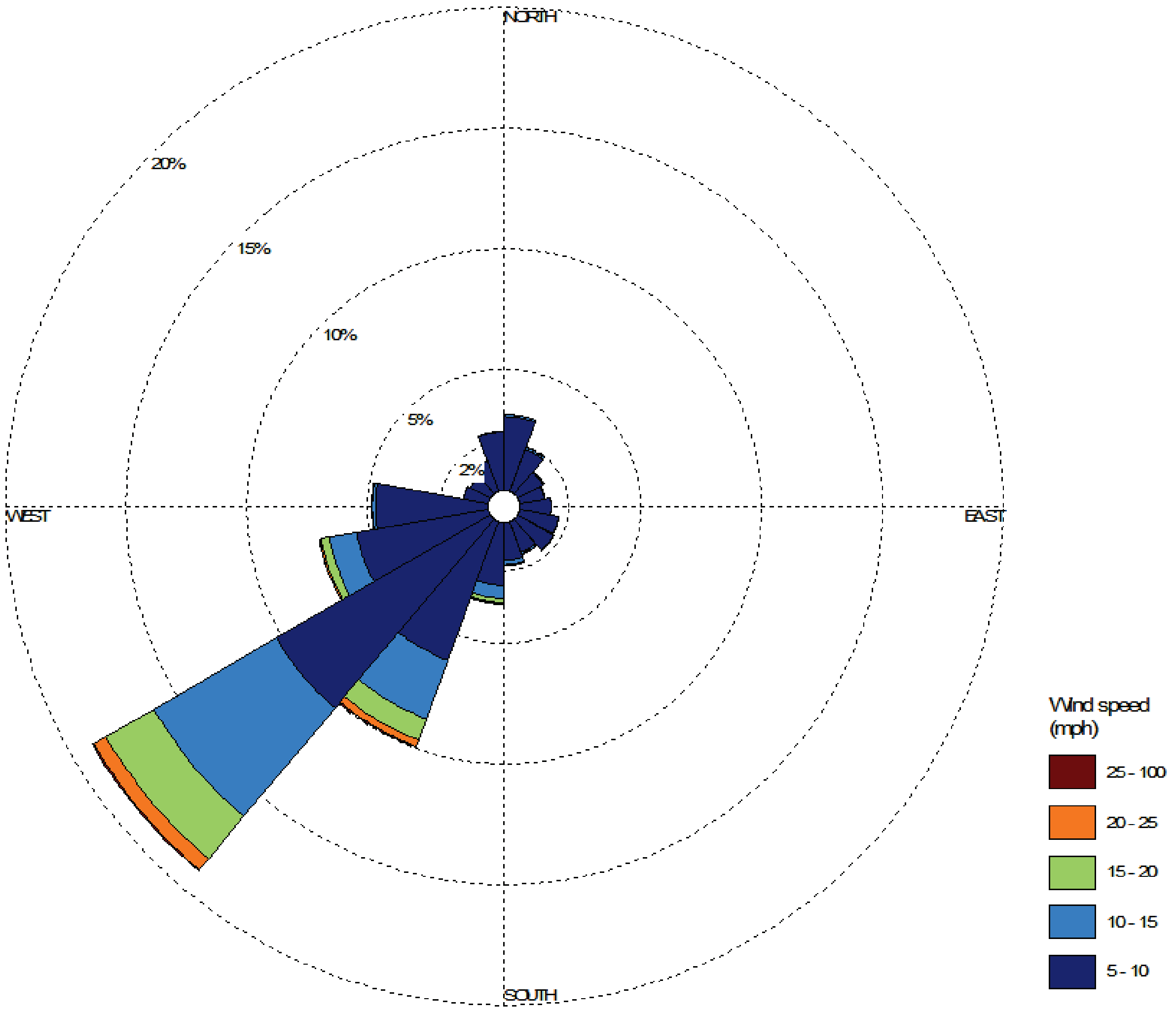
- Sustained winds from the northeast (30 to 60 degrees):
  - 2-year wind speed of 14 mph
  - 10-year wind speed of 16 mph
- Sustained winds from the east (60 to 90 degrees):
  - 2-year wind speed of 12 mph
  - 10-year wind speed of 14 mph

---

[3] A wind rose is a visual representation of the wind directions and speeds over a period of data record.

[4] The extreme value analysis was conducted on the wind data assuming a Gumbel Distribution.

Figure C-2
Sanderson Field Airport Wind Distribution



Data from January 1999 to July 2016

2.3 Wave

A wave hindcast analysis was performed to estimate storm wave heights in the SCU, based on the wind data. The orientation of the SCU within Oakland Bay means only a small portion of the wind field results in generated waves that can impact the SCU. Table C-2 shows the parameters input into the Automated Coastal Engineering System (ACES) wave prediction module, which uses methodologies from many sources[5] to estimate wave height and wave periods from wind speeds.

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[5] Resio et al. 1982; Vincent 1984; Shore Protection Manual 1984; Smith 1991.

Table C-2
Wind Hindcast Input Data and Results

Parameter	Storm Condition No. 1	Storm Condition No. 2
Wind Direction	Northeast (30 to 60 degrees)	East (60 to 90 degrees)
10-year Wind Speed	16 mph	14 mph
Average Depth over Fetch	15 feet	40 feet
Fetch Distance	2.3 miles	0.8 mile
Significant Wave Height	0.7 foot	0.4 foot
Peak Wave Period	1.6 seconds	1.2 seconds

3 Stable Layered Cap Design

This section provides estimates of the size of surface material (armor) that would be stable (i.e., sustain no damage) due to predicted wave attack described in Section 2. This section also provides thickness and sediment gradations of cap layers following design guidance as outlined in the USACE Coastal Engineering Manual (USACE 2002).

3.1 Stable Sediment Size

Two methods were used to evaluate stable sediment sizes depending on physical forcing. The ACES revetment module was used to estimate stable sediment/rock size under design breaking wave conditions. Hydraulic Design of Flood Control Channels (Engineering Manual 1110-2-1601) was used to analyze stable sediment under design non-breaking wave conditions (based on bottom currents caused by waves[6]).

The ACES revetment module (Leenknecht et al. 1992) was used to estimate the stable sediment sizes under wave attack, using a stability formula similar to the one developed by Hudson (1958). This method takes wave height, period, depth, and slope of material placement into account. The calculations were completed based on the assumption of no movement[7] of cap material under design wave conditions as defined by the methodology.

The Hydraulic Design of Flood Control Channels manual is referenced in the Coastal Engineering Manual for the calculation of "blanket stability in current fields," and was used to develop stable cap armor design parameters based on design non-breaking wave conditions using predicted bottom currents caused by the waves. This method also accounts for wave height, period, depth, and slope of material placement.

The calculated stable cap armor sizes under design wave conditions (see Table C-2) are as follows:

- Stable sediment size under breaking waves:
  - Wave Height: 0.65 foot
  - Wave Period: 1.6 seconds
  - Slope: 6 horizontal to 1 vertical (6H:1V)[8]
  - Median (D_{50}) Stable Sediment Size: 1.3 inches
- Stable sediment size under non-breaking waves (i.e., bottom wave currents):
  - Wave Height: 0.65 foot
  - Wave Period: 1.6 seconds

---

[6] For non-breaking waves, horizontal velocities are induced on the bed by the wave passing by. They are oscillatory and are generally in the direction of wave propagation under the crest and opposite the direction of wave propagation under the trough.

[7] Methods used in the calculation of stable armor size define no movement as "no damage" as defined empirically in Leenknecht et al., 1992).

[8] Stable cap armor size calculated using placed slope of 6H:1V is applicable for placement slopes o 6H:1V or flatter.

- Bottom Current: 1.6 feet per second in shallow water conditions[9]
- D_{50} Stable Sediment Size: 0.25 inch

3.2 Stable Cap Geometry

The geometry requirements for a stable cap as outlined by the Coastal Engineering Manual (USACE 2002) and other relevant published guidance (Maynord 2012), result in a cap design as outlined in Table C-3. Figure C-3 shows a sketch of the stable cap placement details. The stable cap consists of an armor layer and one or more filter layers sized to prevent potential winnowing of finer sediments through larger overlying cap material pore spaces due to wave action The number of filter layers depends upon the difference in size and gradation between the in situ sediment and the design armor size. One of the filter layers also generally acts as the chemical isolation layer in the cap.

The armor layer for the stable cap should have a minimum D_{50} of 1.3 inches in areas impacted by waves only (see Figure C-3).

Existing surface sediments in parts of the SCU have a D_{50} as low as approximately 0.002 inch. Based on winnowing criteria under waves[10] (USACE 2002), two filter layers would be necessary between the in situ sediments and the armor layer to prevent the potential movement of existing surface material vertically through the cap due to wave action or during placement. Median diameter of filter materials and thickness of filter layers is provided in Table C-3. If filter no. 2 is not used, some mixing of the filter no. 1 material and in situ sediments will occur during placement, which will result in some thinning of the filter no. 1 layer.

Table C-3
Shelton Harbor Stable Cap Layer Design

Parameter	Requirement
Armor D_{50}	1.3 inches
Armor Thickness	1 foot
Filter 1 D_{50}	0.16 inch
Filter 1 Thickness	1 foot
Filter 2 D_{50}	0.02 inch
Filter 2 Thickness	6 inches to 1 foot

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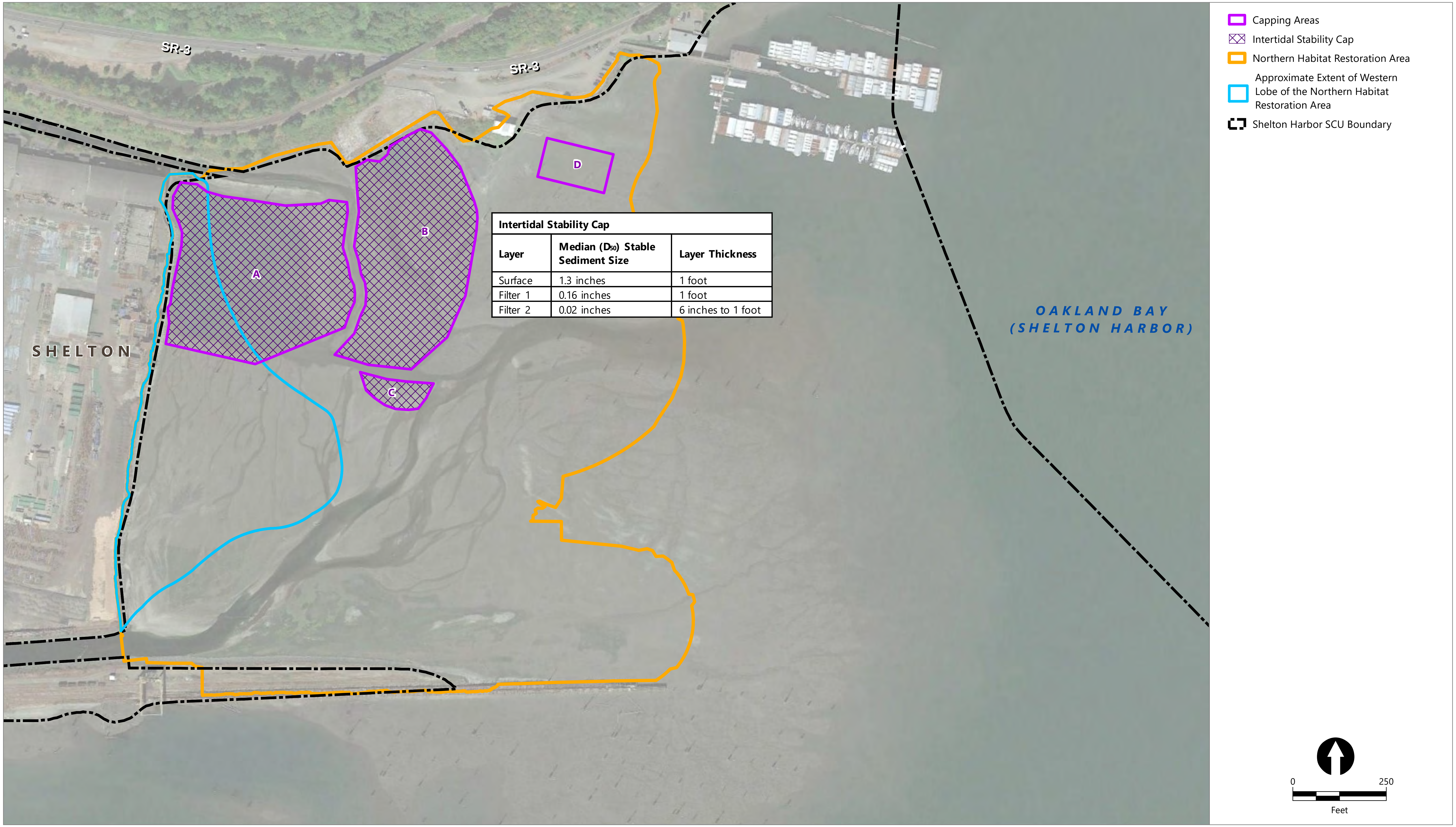
[9] Shallow water conditions refer to water depths just before the design wave would break.

[10] Winnowing criteria is based on comparison of sediment gradation between the two adjacent layers; specifically, the D_{15} and D_{85} values for the gradation.



Intertidal Stability Cap

Layer	Median (D_{50}) Stable Sediment Size	Layer Thickness
Surface	1.3 inches	1 foot
Filter 1	0.16 inches	1 foot
Filter 2	0.02 inches	6 inches to 1 foot

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Figure C-3
Shelton Harbor Cap Stability Requirements Diagram
Appendix C: Shelton Harbor Cap Stability Design
Oakland Bay and Shelton Harbor Sediments Cleanup Site

4 Engineered Design for Blended Cap Material

In Shelton Harbor, a blended filter and armor layer is preferred, compared to a traditional multi-layer cap, for several reasons. First, the existing surface sediments are primarily fine-grained, so increasing the amount of fine-grained material within the cap surface layer is expected to provide habitat benefit over an armor-only surface layer. Second, a single, combined layer for the filter and armor layers will be more constructible and efficient for the contractor to build. Based on this preference, a local source of material has been identified for use as the blended cap material within the SCU. The following sections provide gradation information for the locally available quarry material and outline two design options for generally meeting stable cap requirements outlined in Section 3 using the locally available material, including a blended cap option.

4.1 Local Quarry Material Gradation

The locally available material ranges in size from about 0.003 inches (very fine sand) to 6 inches (cobble), with a D_{50} of approximately 0.6 inches (medium gravel). The material gradation for the locally available material is graphically shown in Figure C-4. As a comparison, the gradations for the stable cap armor and filter layer materials (from Section 3.2) are also shown in Figure C-4.

4.2 Cap Design Options

4.2.1 Layered Cap Using Sorted Locally Available Material

The locally available material could be sorted via sieving to create two separate materials that are close in gradation to the stable cap armor and filter no. 1 layer materials described in Section 3.2. The material would need to be separated into the material larger than 0.5 inch and material smaller than 0.5 inch. This would result in one material with a median diameter of about 1 inch (the cap armor layer) and one material with a median diameter of 0.1 inch (cap filter no. 1 layer). The anticipated gradations of the sieved materials are also provided in Figure C-4.

These sieved materials could then be used to construct a stable cap design as described in Section 3.2, with the larger sieved material used for the armor layer and the smaller sieved material used as filter no. 1 material. A second filter layer (filter no. 2 in Section 3.2), consisting of a 6-inch-thick sand layer, would still be required to meet winnowing criteria based on fine gradation of in situ sediments. If the filter no. 2 material is not available, then filter no. 1 thickness should be increased approximately 3 to 6 inches to account for mixing of filter no. 1 material into the in situ sediments during placement (which would decrease thickness of layer no. 1).

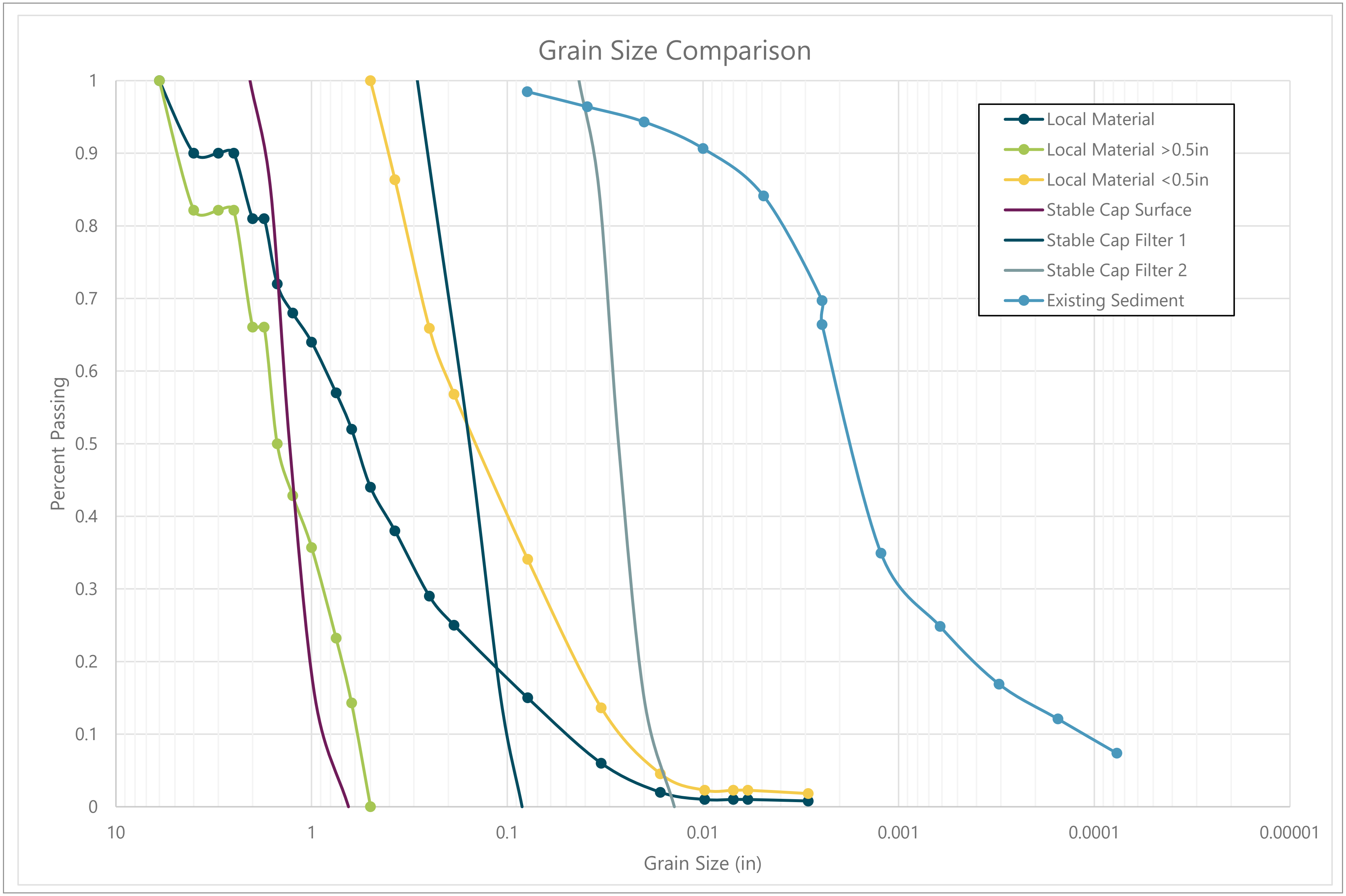

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Figure C-4
Grain Size Distributions

Appendix C: Shelton Harbor Cap Stability Design
Oakland Bay and Shelton Harbor Sediments Cleanup Site

4.2.2 Blended Cap Using Locally Available Material

This option proposes to use the locally available material without additional processing (i.e., sorting) to construct a blended cap for the site. This blended cap will have some mobility under design wave conditions since a portion of the material in the surface layer of the cap will be smaller than the stable sediment size estimated for design wave conditions. There are three general physical processes by which this material could be mobilized under wave attack, as described below:

1. The finer materials in the surface layer of the placed cap material will be mobilized and moved away from where they were placed; movement would occur in suspension or by bedload processes during wave events.[11] This will continue until the surface layer of the placed material consists of only the larger material (> 1 inch). This process is called "self-armoring."
2. The finer material could also move vertically up through the cap matrix under wave attack, which is called winnowing. This is caused by the complex turbulent flows at the sea bed under breaking waves. Once the fine material is moved close to the surface of the cap, it can be mobilized and moved away from the placement site (see bullet number 1).
3. The shape of the initial placement of the placed material could deform under direct wave attack on sloped areas. Once the blended cap has a self-armored surface layer (primarily gravels), breaking waves can mobilize gravels and move them upslope during the uprush. This results in an s-shaped profile following storm events, with loss of material downslope and subsequent gain of material on the upslope (van der Meer 1988). This s-shape can move up or down the slope over time dependent on the strength, and frequency of storm events and the tidal elevations that occur over the duration of the storm event. This process will be generally less significant in flat placement areas.

These processes will result in a thinning of the blended cap after placement as the smaller material is mobilized under design wave conditions and redistributed within the SCU and beyond. To account for this, the design guidance report "Filter Design Criteria for Sediment Caps in Rivers and Harbors" (Wright et. al 2001), outlines methods for replacing the traditional layered cap (Section 4.2.1) with a single layer that consists of 80% armor material and 20% filter layer material. The locally available material is approximately equivalent to a mix of 50% armor-sized material and 50% filter no. 1-sized material. Based on engineering best professional judgement, the placed thickness of the locally available material cap (in a single layer) will need to be increased by a factor of 1.6 to provide the required volume of armor sized materials within the blended cap. For example, the 1-foot armor layer thickness outlined in Section 3.2 would need to be increased to a minimum 1.6-foot thickness to account for thinning of the layer over time due to hydrodynamic forces.

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[11] The locally available material consists of <1% fines (silts and clays) by weight. Therefore, turbidity plumes are not anticipated to be a concern following placement of this material.

The blended cap does not include the finer filter (filter no. 2) suggested for use in the layered cap option (Section 4.2.1). In order to minimize the potential for winnowing, a second filter layer (filter no. 2 in Section 3.2), consisting of a 6-inch sand layer, would be required to meet winnowing criteria based on fine gradation of in situ sediment. If the filter no. 2 material is not available, then filter no. 1 thickness should be increased approximately 3 to 6 inches to account for mixing of filter no. 1 material into the in situ sediments during placement (which would decrease thickness of layer no. 1).

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Appendix D

Construction Quality Assurance Plan

July 2018
Shelton Harbor Sediment Cleanup Unit
Oakland Bay and Shelton Harbor Sediments Cleanup Site
(Cleanup Site ID: 13007)

Appendix D:
Construction Quality Assurance Plan

Prepared for
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Prepared by
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TABLE OF CONTENTS

FIGURES

ABBREVIATIONS

Agreed Order	2017 Agreed Order DE 1409
BODR	Basis of Design Report
CAR	Cleanup Action Report
CHASP	Contractor's Health and Safety Plan
contractor	general contractor
CQA	construction quality assurance
CQAP	*Construction Quality Assurance Plan*
CQAO	Construction Quality Assurance Officer
CQC	construction quality control
CWP	Construction Work Plan
Ecology	Washington State Department of Ecology
EPP	Environmental Protection Plan
IAP	*Shelton Harbor Interim Action Plan*
MTCA	Model Toxics Control Act
SCU	Shelton Harbor Sediment Cleanup Unit
Simpson	Simpson Timber Company
SMS	Sediment Management Standards
WAC	Washington Administrative Code

1 Introduction

This *Construction Quality Assurance Plan* (CQAP) describes quality assurance protocols and methods that will be used to verify that remedial actions in Shelton Harbor Sediment Cleanup Unit (SCU) are implemented in accordance with the cleanup design and associated permitting requirements. The SCU is located within the Oakland Bay and Shelton Harbor Sediments Cleanup Site (Ecology Cleanup Site ID 13007) as further described in the 2017 Agreed Order DE 14091 (Agreed Order) between the Washington State Department of Ecology (Ecology) and the Simpson Timber Company (Simpson).

This CQAP is a supplement to the accompanying *Basis of Design Report* (BODR), which describes the approach and criteria for the engineering design of sediment cleanup actions at the SCU, as set forth in the *Shelton Harbor Interim Action Plan* (IAP; Anchor QEA 2018). This CQAP also supplements the Shelton Harbor Interim Action Joint Aquatic Resources Permit Application and Biological Assessment prepared in February 2018. The actions described in this CQAP will be performed by Simpson under Ecology oversight, consistent with Agreed Order requirements. Implementation of this CQAP will also be performed consistent with the requirements of the Model Toxics Control Act (MTCA), Chapter 70.105D in the Revised Code of Washington, as administered by Ecology under the MTCA Cleanup Regulation, Chapter 173-340 of the Washington Administrative Code (WAC), and the Sediment Management Standards (SMS) Chapter 173-204 WAC.

Construction activities to be performed at the SCU include the following:

- Site improvements necessary for construction (e.g., preparation of stockpile and transload area for capping material)
- Sediment capping
- Pile removal

Separate from this CQAP, the selected general contractor (contractor) will develop detailed construction work plans (CWPs) that describe the construction schedule; a Constructor's Health and Safety Plan (CHASP); quality control plans; transload and placement of capping material; and environmental protection plans (EPPs). Simpson will perform borrow source characterization.

The remainder of this CQAP is organized into the following sections:

- **Section 2 – Definitions and Use of Terms:** Defines key terms of the Quality Management System.
- **Section 3 – Project Organization and Responsibilities:** Presents the roles and responsibilities of the parties involved in the remedial action, including Ecology and other agencies.
- **Section 4 – Contractor and Construction Quality Assurance Officer Qualifications:** Describes the qualifications and experience required for the contractor and any selected

subcontractors, as well as the qualifications of the Construction Quality Assurance Officer (CQAO) and supporting inspection personnel.

- **Section 5 – Quality Assurance Program:** Describes the performance objectives and criteria, quality assurance measures, inspection and verification activities, and contingency actions for construction.
- **Section 6 – Documentation and Reporting:** Describes the reporting requirements for construction quality assurance (CQA) activities.
- **Section 7 – References:** Provides references cited in this report.

2 Definitions and Use of Terms

Construction quality control (CQC) and CQA are defined as follows:

- CQC is the planned system of inspections and testing by the contractor's team (or their subcontractors) to monitor and control the characteristics of an item, service, removal, or installation in relation to design requirements. The CQC activities provide for a collection of construction condition measurements.
- CQA is the planned and systematic means and actions that provide confidence that construction materials, methods, and results meet or exceed design criteria and requirements. The CQA activities provide for collection of independent measurements of construction conditions, as well as review and confirmation of the quality of data collected as part of the CQC activities, performed by Simpson.

In the context of this document, CQC refers to the following:

- Those actions taken by the contractor's team (or their subcontractors) to determine compliance with the requirements of the approved design

In the context of this document, CQA refers to the following:

- Means and actions to independently (e.g., by Simpson) assess conformity with the requirements of the approved design

3 Project Organization and Responsibilities

The roles and responsibilities of the parties involved in the cleanup action activities are described in Sections 3.1 through 3.6 and presented in Figure D-1.

3.1 Washington State Department of Ecology and Other Agencies

Ecology is the regulatory authority and is the responsible agency for overseeing and authorizing the cleanup action activities described herein. In this capacity, Ecology will review information described in the BODR and Construction Specifications and Drawings, and this CQAP for consistency with the cleanup standards presented in the IAP, including applicable or relevant and appropriate requirements as set forth in the IAP. The Ecology Project Coordinator, or their designee, will exercise project oversight for Ecology, coordinate comments developed by Ecology and other agencies, and communicate agency observations with Simpson and the Project Engineer. The Ecology Project Coordinator will notify Simpson if they identify any concerns regarding the implementation of the cleanup action. Simpson, or their designated representative, will propose response measures or recommendations, as appropriate, to Ecology and the Ecology Project Coordinator. Ecology, as appropriate, will make final decisions to resolve such issues or problems that may change the cleanup action scope. Ecology will work cooperatively with other government agencies as necessary.

3.2 Simpson

Simpson is ultimately responsible for implementing the cleanup action in accordance with the Agreed Order and IAP. Simpson, or their designated representative, will implement the CQAP, review contractor work products, and be the point of contact with Ecology.

CQA monitoring activities will be the responsibility of Simpson, who will be acting in coordination with Ecology. CQC monitoring activities will be performed by the contractor and overseen by Simpson to ensure that the contractor’s construction and monitoring work is completed as stipulated by project permits, approvals, and contract documents.

3.3 Project Engineer

The Project Engineer is responsible for two main tasks:

1. Preparing the design of the interim remedial action such that successful implementation of the design will result in achieving the objectives of Agreed Order and the IAP
2. Providing consultation and observations during construction to assist with implementation of the interim remedial action in conformance with the Ecology-approved design documents

During implementation of the remedial action, noncompliant construction activities will be referred to the Project Engineer. The Project Engineer is responsible for determining whether the noncompliant construction is unacceptable, or acceptable with a design modification. Ecology will have final authority to approve design modifications proposed by the Project Engineer.

3.4 Construction Quality Assurance Officer

The CQAO will be identified by Simpson and is responsible for overseeing the implementation of the CQAP. In overseeing implementation of the CQAP, the CQAO is responsible for monitoring construction performance for compliance with construction performance standards and design requirements during implementation of the cleanup action, and is responsible for overseeing the required inspection and verification activities. The CQAO will review documentation submitted by and work completed by the contractor for adherence to performance standards and design requirements. The CQAO will be sufficiently familiar with the Ecology-approved design documents and the construction operations to recognize deviations from those documents. The CQAO will also have the ability to manage and maintain the integrity of the data generated during implementation of the remedial action.

The CQAO will be responsible for identifying those field conditions that may warrant deviation from the Ecology-approved design documents. In such circumstances, the CQAO will coordinate with the Project Engineer and the Ecology Project Coordinator to identify and agree upon any necessary changes to meet the overall objectives of the design. Any agreed-upon changes will be documented in the weekly progress reports to Ecology.

The CQAO may use inspectors with the requisite expertise and experience to help perform the duties described above.

3.5 General Contractor

One or more construction contractors will be selected to perform construction activities including site preparation; placement of cap material; and other required cleanup activities. The selected contractor(s) will have demonstrable experience with material handling and capping. The contractor is responsible for its own means and methods in the execution of its work, and is responsible for ensuring that the work complies with the requirements of the contract Construction Specifications and Drawings pursuant to the remedial action requirements and associated permits.

As part of the remedial action implementation, the contractor will be responsible for developing and implementing the CQC Plan, including the required monitoring, sampling, testing, and reporting needed to implement the project in accordance with the Construction Specifications and Drawings. Independent of the contractor’s quality control program, Simpson will implement this CQAP to verify that the remedial action is implemented in accordance with the design.

The contractor will use key personnel to help with the tasks described above, including an on-site Superintendent, CQC Supervisor, and Health and Safety Manager.

3.5.1 Contractor On-Site Superintendent

Direction of the work for the contractor will be through an on-site Superintendent who will be responsible for executing the work in full compliance with the Construction Specifications and Drawings. The Superintendent will work to resolve work-related problems and day-to-day project management. The Superintendent may utilize one or more foremen to directly supervise the major construction activities. The Superintendent will exercise supervision over subcontractors, if subcontractors are utilized.

3.5.2 Contractor Construction Quality Control Supervisor

A CQC Supervisor will be provided by the contractor as required in the Construction Specifications. The CQC Supervisor will develop and implement the CQC Plan through which the contractor ensures compliance with the requirements of the Construction Specifications and Drawings. The CQC Plan will identify the duties and responsibilities assigned by the contractor to the CQC Supervisor and additional quality control staff, as needed to monitor that the remedial action is implemented in accordance with the Construction Specifications and Drawings. The CQC Plan will state the chain of command for the CQC team, including identification of responsibilities for each member, to ensure that any actions related to the quality of work will be executed in an accurate and expeditious manner.

3.5.3 Contractor Health and Safety Manager

The contractor will employ a Health and Safety Manager to develop and implement a CHASP. The CHASP will contain details of the chain of command and personnel responsibilities, as discussed in the Construction Specifications. The Health and Safety Manager will be required to have the appropriate current federal and state health and safety training necessary to perform the work.

3.6 Subcontractors

The contractor will either perform construction elements or use subcontractors to perform selected phases of the work for which special expertise is required. The subcontractors are responsible to the contractor for the quality of their work, protection of the environment, and adherence to the CQC Plan, EPP, and CHASP. The subcontractors' principals will each designate a job foreman with responsibility to see that the work is conducted in accordance with the contract requirements and the Construction Specifications and Drawings.

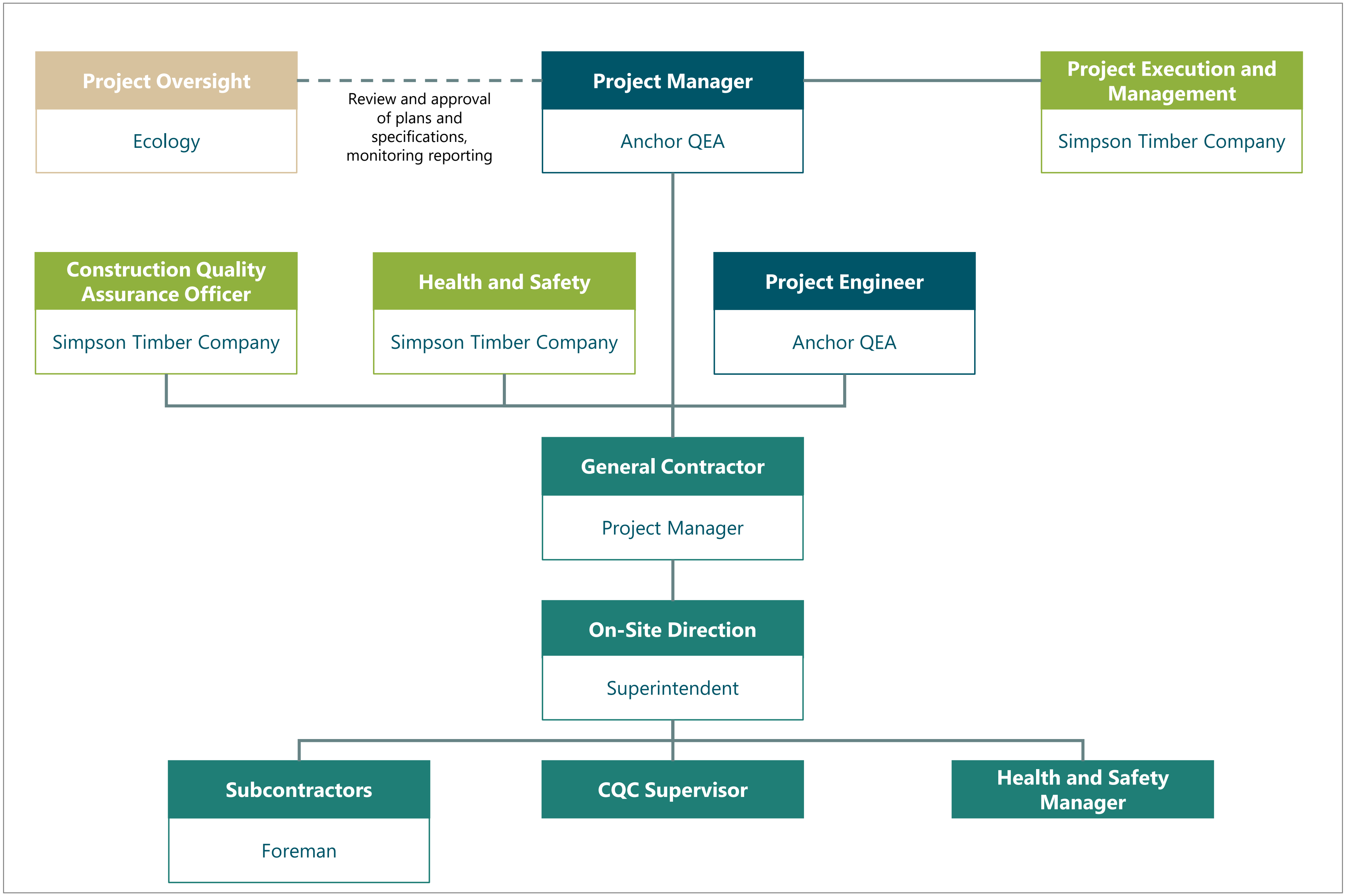

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Figure D-1
Organizational Chart

Appendix D: Construction Quality Assurance Plan
Oakland Bay and Shelton Harbor Sediments Cleanup Site

4 Contractor and Construction Quality Assurance Officer Qualifications

This section summarizes the qualifications and minimum training and experience that will be required of the Project Manager, CQAO, and contractor.

4.1 Project Manager

The Project Manager will have demonstrated experience in managing environmental projects of a complexity and magnitude similar to or greater than the SCU remedial actions described in the BODR. The Project Manager will be thoroughly familiar with the Agreed Order and IAP, applicable environmental laws, and the requirements of the Ecology-approved design documents.

4.2 Construction Quality Assurance Officer

The CQAO will be identified prior to start of work. The CQAO will have demonstrated experience managing remedial construction projects with similar quality assurance requirements. The CQAO will be required to have the appropriate current federal and state health and safety training necessary to perform the task. Additionally, the CQAO will be sufficiently familiar with the Ecology-approved design documents and the construction operations to recognize deviations from those documents and operations. The CQAO will also have the ability to manage and maintain the integrity of the data generated during the project. The CQAO may use additional inspectors as necessary to complete the work. These inspectors will have experience inspecting construction activities for environmental cleanup projects.

4.3 Contractor

The contractor will be selected through a competitive qualifications-based selection process. Each potential contractor proposing on the project will be required to provide a statement of qualifications to Simpson with its proposal. This will allow Simpson to evaluate whether the proposer is qualified, in terms of experience and capability, to perform the work.

The contractor will employ (as part of its permanent organization) senior, knowledgeable, and experienced personnel to oversee the project. The journeyman operators, surveyors, and other contractor personnel performing key jobs must also have the demonstrated ability and skills to satisfactorily perform their respective assignments.

The CQC Supervisor must have documented qualifications and experience to perform independent checks on the contractor’s operations as necessary to determine compliance with the Construction Specifications and Drawings. These documented qualifications will be submitted to Simpson for approval of the CQC Supervisor. Additionally, any subcontractors utilized in the work must have demonstrated to the satisfaction of Simpson that they are qualified and have satisfactorily performed the type of work for which they will be engaged. However, responsibility for the subcontractor performance rests with the contractor.

5 Quality Assurance Program

The CQA program is described in this section for each major construction activity. For each activity, the following is provided:

- Description of construction activities to be implemented
- Specific performance objectives and criteria for the activity
- Inspection and verification activities
- Quality assurance measures
- Contingency actions

Remedial action construction elements subject to the quality assurance program include the following:

- Capping using a protective layer of clean silt, sand, gravel, cobble, and/or armor materials
- Demolition and disposal of creosote-treated piles

For each of these construction elements, inspection and verification activities will be implemented to confirm performance objectives have been met. The construction quality assurance program will also address compliance with permit requirements during construction (e.g., USACE permit requirements and transload construction stormwater requirements).

During the remedial action, the quality assurance program will progress as follows:

- The contractor will submit a CQC Plan as detailed in Section 6. The CQC Plan will be subject to Simpson approval before cleanup action field work begins.
- The contractor and the CQAO will conduct inspection and verification activities (i.e., sampling, testing, and monitoring) to ensure compliance with the Ecology-approved design documents and to ensure that performance objectives have been met. Simpson will have final approval authority for all such inspections and for verifying that corrective actions, if any are warranted, are implemented.
- Any changes to Ecology-approved design requirements or protocols will require Ecology review and approval.
- The contractor will provide documentation to the CQAO to demonstrate that specific components of the Ecology-approved design documents have been properly implemented. Simpson will determine whether the components of the cleanup action are acceptable and complete.

The remainder of this section details each construction element and associated performance objectives and criteria, along with quality assurance measures and specific inspection and verification activities that will be performed to confirm that performance objectives have been met. Sediment capping will be performed in the capping areas shown in Figure D-2.

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Figure D-2
Capping Areas
Appendix D: Construction Quality Assurance Plan
Oakland Bay and Shelton Harbor Sediments Cleanup Site

5.1 Pile Removal

This section describes the construction oversight activities that will be undertaken to verify that pile removal, if necessary, has been completed in accordance with the Ecology-approved design documents.

5.1.1 Description of Construction Activities

Existing piles will be removed from capping areas; this work will be sequenced to occur shortly before capping actions to maximize control of pile removal residuals.

Pile removal will follow well-established DNR protocols. In the contractor work plan, the contractor will provide additional detail on pile removal, transloading, storage, and disposal protocols, with the objective of maximizing the success of the pile extraction and concurrently minimizing pile breakage. As exceptions to DNR best management practices (BMPs), piles that cannot be practicably removed will be cut (and then covered by the sediment cap), and barges may be grounded, provided they are in areas that will be capped. While the IA does not include ground-disturbing construction activities that have the potential to affect potential cultural resources, site-specific cultural resource protection protocols may be included as appropriate under forthcoming Nationwide 38 Permit conditions for the IA.

5.1.2 Performance Objectives

The following performance objectives apply to pile removal:

- Remove piles from capping areas to the maximum extent practicable
- Minimize potential residual contamination from creosote-treated pile removal
- Ensure that post-extraction processing of creosote-treated timber and piles on the uplands or barges minimizes spread of sawdust or creosote residues

5.1.3 Inspection and Verification

As part of the CQC program, extraction, breaking, and cutting of piles will be documented, and protective caps placed following these activities. Documentation will include photographs of the demolition activities, as appropriate, and counts will be made of piles pulled and cut off.

Daily and weekly pile removal reports will be prepared to track cumulative progress. In addition, weekly progress reports will be prepared and submitted to Ecology during construction.

5.1.4 Contingency Actions

Contingency actions are built into the demolition protocol. Creosote-treated piles will be removed in areas that will be capped, thereby minimizing potential residual contamination from removal.

5.2 Cap Material Placement

This section describes the construction oversight activities that will be undertaken to verify that cap material placement has been completed in accordance with the Ecology-approved design documents.

5.2.1 Description of Construction Activities

An engineered cap will be placed using a protective layer of clean silt, sand, gravel, cobble, and/or armor materials, as appropriate for specific areas of the SCU (Figure D-2).

Caps will be placed in lifts of a maximum thickness based on the cap design. Some material will likely be placed from the water during high tide. However, cap material may be placed from land, if the area is accessible from an upland work area. The contractor means and methods will be outlined in the approved contractor's Construction Work Plan (CWP).

5.2.2 Performance Objectives

The following performance objective applies to cap construction:

- For caps, ensure that the minimum design thickness has been achieved for at least 95% of the cap surface area.

5.2.3 Inspection and Verification

5.2.3.1 Cap Material Selection

Cap material selection will be performed by Simpson, provided the proposed material meets chemical quality and gradation requirements determined by the engineer and presented in the Construction Specifications.

5.2.3.2 Cap Material Placement Verification

Cap material placement thickness will be verified by a lines-of-evidence approach:

- The contractor will be required to track the volume and/or weight of cap material placed on a daily basis and to make this information available to Simpson as part of their daily reports.
- The contractor will be required to conduct bathymetric surveys before and after cap construction to assess material coverage across the area.
- For in-water placement, the contractor will use an electronic tracking method (e.g., bucket maps), to assess material coverage across the placement area. The contractor will be required to make this information available to Simpson.
- Simpson will perform cap probing and/or coring, if needed, to verify that the cap has been placed to the specified thickness.

Based on experience at other projects, these methods for verifying accuracy will be considered together by the CQAO and Project Engineer to determine if the required cap thickness has been achieved.

5.2.4 Quality Assurance Measures

The CQA program will include the following measures for capping material placement, conducted by Simpson:

- Review results for particle size (grain size) distribution testing, and chemical analysis. Compare the results to the requirements in the Construction Specifications.
- Conduct on-site visual observations of materials on a periodic basis to evaluate whether a notable visual change has occurred in the type of material being used for capping.
- Review data from the four cap verification methods described above:
  - Review contractor-provided daily measurements of material placed (cubic yard or tons) compared to design quantities
  - Review contractor-provided daily electronic tracking files (i.e., bucket maps)
  - Review bathymetric surveys to evaluate cap thickness and coverage
  - Review as-placed thicknesses measured by probing or coring, when conducted

5.2.5 Contingency Actions

If the chemistry or grain size of the proposed capping material does not meet the requirements of the contract, the material will be rejected and an alternate source will be used.

If, based on visual observations, the cap material appears to have changed compared to the material for which particle size and chemistry results have been submitted, additional tests will be run to confirm that the material continues to meet requirements.

If one or more lines-of-evidence indicate that the cap thickness has not been met, then additional information may be collected (e.g., targeted probing or coring). If additional information indicates a likely chance that cap thickness does not meet the performance objective in Section 5.2.2, then the contractor will be directed to place more cap material in areas noted as deficient.

6 Documentation and Reporting

Documentation and reporting for CQA activities will include pre-construction documentation, construction documentation, and post-construction documentation as detailed below. The contractor and the CQAO will work closely on a daily basis during the cleanup action to complete the project as specified in the Ecology-approved design documents and to collect the documentation required. The following sections describe documentation that will be required throughout the cleanup action.

6.1 Pre-Construction Documentation

The contractor will be required to submit a CWP for approval by Simpson and Ecology. The CWP will contain the following elements:

- Project work plan
- CQC Plan
- CHASP
- Construction EPP
- Project Construction Schedule
- Survey Control Plan
- Cap Material Handling Plan (will be submitted by Simpson)

Ecology's approval authority for these plans is defined in the Agreed Order. CQA and CQC procedures will be addressed in various elements of the CWP. A brief description of the contents of each plan component of the CWP is provided below.

6.1.1 Project Work Plan

The project work plan will describe, in narrative form, the methods to be employed in the cleanup action including equipment types, modes of operation, schedules, sequence of activities, and other aspects necessary to describe how and when the specified work will be performed. The project work plans will have specific sections detailing how the following elements will be completed:

- Pile removal
- Waste management, transportation, and disposal
- Spill prevention, control, and countermeasures
- Air pollution and odor control
- Capping material placement
- Marine water quality criteria compliance
- Temporary facilities and controls
- Construction stormwater pollution prevention measures
- Transloading

The project work plans will describe how each of the quality assurance measures and verification activities identified in Section 5 will be addressed in the field.

6.1.2 Construction Quality Control Plan

The CQC Plan will present the system through which the contractor ensures that construction activities are being implemented in compliance with the requirements of the contract and specifically how each of the quality assurance measures and verification activities identified in Section 5 will be addressed in the field. The CQC Plan will identify personnel, procedures, methods, instructions, inspections, records, and forms to be used in the CQC system. Specifically, the CQC Plan will include a description of procedures for maintaining and updating daily activity logs, procedures for reporting out-of-spec conditions, recordkeeping procedures for personnel, equipment maintenance and calibration, and daily and weekly reporting requirements.

6.1.3 Construction Health and Safety Plan

The contractor will submit its CHASP presenting the necessary health and safety requirements for job site activities, and the measures and procedures to be employed for protection of on-site personnel. The plan will cover the controls, work practices, personal protective equipment, and other health and safety requirements that will be implemented by the contractor in connection with the cleanup action construction activities. The contractor will be required to use personnel that are trained to maintain the necessary health and safety protocols for this type of cleanup work.

6.1.4 Construction Environmental Protection Plan

The contractor will be required to submit an EPP describing the environmental protection measures and monitoring activities that will accompany all construction activities. The EPP will cover potential environmental releases as a result of the contractor operations, as well as monitoring and corrective actions necessary to control and mitigate such releases. The EPP will contain separate sections addressing contamination prevention, containment and cleanup, erosion and turbidity control, sound level control, air pollution and dust control, and BMPs for protection of water quality as they pertain to the construction activities described in Section 5.

6.1.5 Project Construction Schedule

A detailed Project Construction Schedule will be submitted by the contractor for each construction element prior to construction. Periodic schedule updates will be submitted by the contractor following progress meetings.

6.1.6 Survey Control Plan

The contractor will submit a Survey Control Plan prior to construction. The plan will detail the specific procedures, equipment, and personnel to be used for all landside and in-water surveying work. The plan will also discuss the quality assurance and quality control measures to confirm surveying results.

6.1.7 Cap Material Handling Plan

Simpson will submit a Cap Material Handling Plan to describe collection, hauling, and stockpiling of capping material. The plan will describe haul routes, and a City of Shelton Right of Way – Heavy Haul Permit will be obtained by Simpson prior to construction. City of Shelton ordinances (Chapter 9.18) require no construction noise between 10 p.m. and 7 a.m. on weekdays and 10 p.m. and 9 a.m. on weekends. If it becomes necessary to work later or earlier than these hours to accommodate project schedule or tidal factors, Simpson will work with the City of Shelton to determine potential mitigating measures.

6.2 Construction Documentation

During construction activities, the contractor will be required to provide a variety of documentation to the CQAO, including weight tickets for shipments of materials removed or imported, survey results, and documentation of pay items completed. The contractor will also maintain a daily log of activities, as described in Section 6.2.1. The CQAO will maintain a field report of daily activity and complete an internal weekly report. The contents of the report are described in Section 6.2.2. Weekly progress reports will be submitted to Ecology. Additional documentation is described in Sections 6.2.3 through 6.2.6. The records described in this section will be maintained in the project files. Monitoring data will be provided electronically to Ecology in the Cleanup Action Report (CAR).

If, during the course of construction, modification of the approved design is required, modifications will be documented in writing. Undocumented modifications of the design or other deviations from the approved design will not be permitted. Construction surveys, including as-built surveys, will be documented on drawings using the same datum, unit, and scale as design Drawings. Record drawings will allow for a direct visual assessment of the quality and completeness of construction.

6.2.1 Contractor’s Daily Quality Control Report

During construction activities, the contractor will prepare a Daily Quality Control Report and submit it to the CQAO. The contractor’s daily report will record the following information at a minimum:

- Date
- Weather conditions
- Identification of personnel on site
- Description of activities completed (identified by stationing and offset if applicable)
- Any changes to BMPs or environmental controls

- Materials delivered or used
- Equipment used
- Period covered by the report and hours worked
- Area and quantity of piling removed and disposed of off site
- Area and quantity of materials placed on site
- Surveys completed and progress survey data
- Weight tickets and/or barge displacement measurements
- Results of any quality control inspections, tests, or other monitoring activities
- On-site/off-site loading facility activities
- Problems encountered and resolution of problems
- Downtime and delays to the operation
- Health and safety status

The Daily Quality Control Reports will be sent to Ecology on a weekly basis as part of the Weekly Summary Reports as discussed in Section 6.2.3.

6.2.2 Construction Quality Assurance Officer's Daily Report

The CQAO will maintain a daily field log to record observations, measurements, inspections completed, data received, communications with other members of the project team or Ecology, any water quality exceedances, additional environmental controls that were implemented, problems encountered, and resolutions. The daily field log will be supported by submittals received from the contractor, such as survey results and weigh tickets, chain-of-custody forms for water quality monitoring samples collected, laboratory data received, inspection reports, and written communication from members of the project team or Ecology. Water quality results will also be separately recorded and reported as defined in the *Water Quality Monitoring Plan*.

6.2.3 Weekly Summary Reports

The CQAO, in cooperation with the contractor, will prepare weekly summaries of progress. These summaries will facilitate the preparation of the Weekly Summary Reports. The Weekly Summary Report will identify progress organized by activity, as follows:

- Pile demolition
    - Area worked (supported by contractor's log)
    - Quantity of demolition
    - Problems encountered
    - Corrective actions
- Capping material placement
    - Area worked (supported by contractor's log)
    - Weight/volume of material placed

    - Schedule confirmation (i.e., confirm that production is compliant with scheduled activity)
    - Problems encountered
    - Corrective actions
- Environmental controls
    - Samples collected
    - Summary of visual results
    - Summary of water quality monitoring
    - Problems encountered
    - Corrective actions

6.2.4 Ecology Coordination

Periodic progress meetings will be coordinated with Ecology including pre-notification of the time and place of meetings. Conference call access will be provided as needed and meeting minutes will be prepared and made available to attendees.

6.2.5 Import Material Characterization

Prior to any on-site placement of import materials, Simpson will perform borrow site characterization, including identification of the source (including a map documenting the origin of the material), site inspection, and material sample and characterization (physical and chemical testing, as specified) to ensure that the import material will meet the chemical and physical specifications of its intended use.

6.2.6 Post-Construction Documentation

Within 120 days of Ecology confirmation that all of the cleanup action requirements have been fulfilled (excluding long-term post-construction monitoring requirements), Simpson will submit the Draft CAR. The Draft CAR will contain the following information:

- Introduction
    - Site location
    - Environmental setting
    - Relevant operational history
    - Summary of previous investigations and actions
- Cleanup action background
    - Basis for the cleanup action (i.e., the Agreed Order and IAP)
    - Cleanup standards
    - Summary of design basis
    - Summary of deviations from the design, if any

- Construction activities
  - Description of pile demolition
  - Description of cap placement
  - Description of transport, offloading, and off-site disposal
  - Description of construction monitoring activities
  - Description of completion and demobilization
- Chronology of events
  - Description of the timing of construction activities, identifying milestones with reference to a tabular summary of a more detailed construction timeline
- Performance standards and CQC
  - Description of performance objectives and verification activities performed to confirm the cleanup action was implemented in accordance with the Construction Specifications and Drawings
  - Description of actual construction performance relative to performance objectives, including a summary of the results of CQA measurements and analyses
  - Description of contingency actions implemented, if any were necessary
  - Description of Ecology's oversight activities
  - (Note: quality assurance for water quality monitoring analytical data will be included in the final Water Quality Monitoring Report)
- Final inspection and certifications
  - Description of final inspections, noting any deficiencies identified and corrective actions implemented
  - Summary of health and safety monitoring during the implementation of the cleanup action with notation of deviations or incidents, if applicable
  - Identification of any institutional or engineering controls that are implemented to maintain the integrity of the cleanup action, including identification of parties responsible for maintaining and enforcing controls
  - If applicable, summary of close out requirements for off-site offloading facility
- Operation and maintenance activities
  - Description of post-construction monitoring and maintenance requirements
  - Description of contingency measures that would be implemented if post-construction monitoring indicates such measures are warranted
- Observations and lessons learned
  - Identification of problems encountered, if any, in implementing the cleanup action and corrective actions
  - Identification of successes in implementing the cleanup action
  - Analysis of lessons learned that may be applied to future activities
- Cleanup action contact information

  - Identification of individuals (contact names, addresses, and phone numbers) for design and remediation contractors, Ecology oversight contractors, and key personnel at Simpson, Ecology, and other agencies

The CAR will also include copies of as-built drawings, summaries of waste disposal and analytical results, the final Water Quality Monitoring Report, and the certification statement required by the Agreed Order.

If applicable, Simpson will submit a final CAR within 90 days of receipt of Ecology comments on the draft CAR.

7 References

Anchor QEA (Anchor QEA, LLC), 2018. *Shelton Harbor Interim Action Plan*. Shelton Harbor Sediment Cleanup Unit. Oakland Bay and Shelton Harbor Sediments Cleanup Site (Cleanup Site ID: 13007). Prepared for Simpson Timber Company and The Washington State Department of Ecology. January 2018.

Appendix E

Water Quality Monitoring Plan

September 2018
Shelton Harbor Sediment Cleanup Unit
Oakland Bay and Shelton Harbor Sediments Cleanup Site
(Cleanup Site ID: 13007)

Appendix E:
Water Quality Monitoring Plan

Prepared for
Simpson Timber Company
1305 5th Avenue Suite 2700
Seattle, Washington 98101

Prepared by
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, Washington 98101

Project Number: 110008-01.03
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ABBREVIATIONS

BMP	best management practice
Ecology	Washington State Department of Ecology
FC	Field Coordinator
FL	Field Lead
IA	Interim Action
NTU	nephelometric turbidity unit
Simpson	Simpson Timber Company
WDNR	Washington State Department of Natural Resources
WQMP	*Water Quality Monitoring Plan*

1 Introduction

This document presents the *Water Quality Monitoring Plan* (WQMP) for Sediment Management Area (SMA)-1 and SMA-2 areas of the Shelton Harbor Interim Action (IA; Figure E-1). The IA is a sediment capping project to remediate contaminated sediments as part of the Oakland Bay and Shelton Harbor Sediments Cleanup Site (Ecology Cleanup Site ID 13007). The IA is being performed by Simpson Timber Company (Simpson) under Agreed Order DE 14091 with the Washington State Department of Ecology (Ecology). The IA will place a clean sand and gravel cap over approximately 9 acres of contaminated sediment, and a total of approximately 40,000 cubic yards of clean sand and gravel will be placed within the inner portion of Shelton Harbor.

Water quality monitoring will be conducted to assess the selected remediation contractor's (Contractor's) adherence to federal, state, and local regulations pertaining to water quality. This WQMP describes monitoring to be used to verify compliance with applicable water quality criteria and contingency measures to be implemented based on the monitoring findings.

1.1 Water Quality Monitoring Plan Objectives

The objectives of the WQMP are as follows:

- Ensure that water quality conditions are within the prescribed limits required by Ecology and described in Section 3.1 of this WQMP.
- Allow for appropriate adjustment of construction activities in a manner that ensures protection of the environment during and after construction activities.

1.2 Document Organization

The remainder of this document includes the following information:

- **Section 2, Project Team and Responsibilities:** This section describes project organization and team member responsibilities for implementing the WQMP.
- **Section 3, Field Monitoring Plan:** This section describes the monitoring locations, depths, frequency, schedule, and equipment.
- **Section 4, Response Actions and Contingency Measures:** This section describes response actions if water quality measurements are elevated above criteria.
- **Section 5, Best Management Practices**: This section describes procedures the Contractor will follow to minimize negative impacts to the aquatic environment during cap material placement.
- **Section 6, Quality Assurance/Quality Control**: This section describes quality assurance/quality control procedures for the project.
- **Section 7, Reporting:** This section provides project reporting requirements.

2 Project Team and Responsibilities

This section includes project team members and responsibilities for project oversight.

2.1 Project Oversight

Mr. Greg Brunkhorst, of Anchor QEA, LLC, will be the overall Project Manager responsible for coordinating activities between Anchor QEA, Simpson, and Ecology. Mr. Brunkhorst will provide oversight for the water quality monitoring program and any other considerations associated with planning and performing water quality monitoring.

Ms. Sara Potter will be Anchor QEA's Field Coordinator (FC). Ms. Potter will be responsible for administrative coordination to verify the timely and successful completion of water quality monitoring. Ms. Potter will prepare the weekly reports and Water Quality Monitoring Results Report described in Section 7, and will facilitate communication between the field monitoring team and Ecology.

2.2 Field Monitoring

Ms. Potter of Anchor QEA, or her designee, will serve as the Field Lead (FL) and will be responsible for day-to-day field operations. The FL will be responsible for ensuring accurate positioning and recording of monitoring locations, depths, water quality parameters, and the collection of measurements in accordance with this WQMP.

3 Field Monitoring Plan

This section describes field methods for conducting in situ water quality monitoring as summarized in Table E-1.

3.1 Water Quality Standards

The water quality standards used in this plan are based on the requirements of Washington State's Water Quality Standards for Surface Water (Washington Administrative Code [WAC] 173-201A) for waters designated as "good" marine quality.

At the point of compliance (i.e., at the boundary of the approved mixing zone), turbidity must not exceed 10 nephelometric turbidity units (NTU) over background turbidity when the background turbidity is 50 NTU or less, or there must not be more than a 20% increase in turbidity when the background turbidity is more than 50 NTU. In addition, visible turbidity anywhere at the compliance monitoring station attributable to in-water activity is considered an exceedance of the standard. The standard default area of mixing (i.e., point of compliance) established for marine waters is a 150-foot radius surrounding the in-water activity. However, based on project experience and the analysis in Attachment E-1, "Extended Area of Mixing Request for Clean Material Placement in Shelton Harbor," a point of compliance of 900 feet from the in-water activity has been proposed and approved by Ecology for cap placement activities. Any removal activities (e.g., pile removal) would require a 150-foot area of mixing.

3.2 Monitoring Locations and Depths

This section includes information regarding monitoring locations and depths.

3.2.1 Background Monitoring Locations

Representative Background Stations will be located at least 1,000 feet from active in-water work during both pile removal and cap placement activities. Measurements collected at these stations during each round of monitoring will be used as background data for determining the appropriate turbidity exceedance criteria and for comparing to the Early Warning and Compliance Stations during each round of monitoring. The location of Background Stations will be determined in the field based on the following considerations:

- The location should be unaffected by the active work.
- The location should be of a similar water depth to the compliance monitoring station to the extent practicable.
- The location should be affected by the Goldsborough and Shelton creeks to a similar degree as the work area to the extent practicable.

Figure E-2 shows conceptual locations of the background stations for an example work area.

3.2.2 Placement Activity Monitoring Locations

During material placement, the monitoring distances for water quality measurements are 500 and 900 feet from the active work area (defined as the location of the placement of material at any given time), toward Oakland Bay (Figure E-2). If tidal currents from the work area are observable, monitoring will target locations directly down-current from the work area. Safety considerations (e.g., proximity to working barges) will also be weighed in determining final field monitoring locations.

The Early Warning Station will be located 500 feet from the work area. Measurements at the Early Warning Station will serve as an interim indicator of water quality closer to the site work activity. Elevated measurements indicate the potential for a subsequent exceedance at the Compliance Station, and this "early warning" would allow modification of the operation of the activity to potentially avoid exceedances.

The Compliance Station will be located 900 feet from the work area. Measurements from the Compliance Station will be used to determine if water quality conditions meet water quality standards for the project.

A description of actions that will be performed if elevated readings are confirmed at the Early Warning Station or if exceedances are confirmed at the Compliance Station is provided in Sections 4.1 and 4.2, respectively.

3.2.3 Pile Removal Activity Monitoring Locations

During pile removal, the Early Warning and Compliance stations serve the same purposes as described above for material placement, but the stations are closer to the work area. Water quality monitoring distances are 100 (early warning) and 150 (compliance) feet from the work area, toward Oakland Bay (Figure E-2). If tidal currents from the work area are observable, monitoring will target locations directly down-current from the work area.

3.2.4 Monitoring Depths

At each station, in situ water quality parameter measurements will be collected at 2 feet below the water surface, the mid-point of the water column, and at 2 feet above the sediment bed. Water depth will be determined using a lead line or fathometer at the monitoring location and will be recorded on the Water Quality Monitoring Form (Attachment E-2). If the water depth is less than 10 feet, then only the top and bottom water depths will be monitored. If the water depth is less than 5 feet, then only the mid-depth will be monitored.

3.3 Field Monitoring Frequency and Schedule

Water quality monitoring will be conducted during cap material placement and pile removal activities. The frequency of monitoring will be phased and dependent on whether confirmed water quality exceedances at the point of compliance are measured. The monitoring phases are divided into two distinct levels, as described as follows:

- *Intensive* – Collect turbidity measurements twice daily for 4 days during in-water work. If no confirmed exceedances are measured, then shift to the routine schedule.
- *Routine* – Collect turbidity measurements twice daily 1 day per week during in-water work.

Intensive monitoring will be performed during the start of new activities (i.e., at the start of capping or pile removal activities). In addition, if a confirmed exceedance at the point of compliance is measured, the schedule will revert to intensive monitoring and the phased approach will be repeated. Monitoring will be performed during daytime work activities only. Monitoring will not be required for work performed in the dry (i.e., work in intertidal areas while the tide is lower than the elevation of the work area).

3.4 Field Monitoring Methods and Equipment

This section includes information regarding monitoring location determination, water quality monitoring methods, and equipment calibration and use.

3.4.1 Monitoring Location Determination and Documentation

A range finder will be used to determine station locations at target monitoring distances in relation to cap material placement activities. Once the vessel is on station, the vessel operator will maintain the position while monitoring occurs. GPS coordinates and monitoring station name will be recorded on the Water Quality Monitoring Form (Attachment E-2). In each round of monitoring, the Background Station will be monitored first, followed by the Compliance Station, followed by the Early Warning Station.

3.4.2 Turbidity Measurements

Turbidity measurements will be taken using a Hydrolab MS5 multi-parameter water quality sonde, or equivalent. The depth at each station will be measured and turbidity measurements will be collected at the appropriate depths at each of the three monitoring stations (Table E-1).

3.4.3 Monitoring Equipment Calibration and Use

Field monitoring equipment will be calibrated daily and allowed to equilibrate prior to use. Calibration information will be recorded on the Multimeter Calibration Worksheet (Attachment E-2). Monitoring equipment will be used according to the manufacturer's recommendations. Unusual or questionable readings will be noted and duplicate readings will be collected.

3.4.4 Sample Documentation

All monitoring results will be entered directly on the Water Quality Monitoring Form (Attachment E-2). Field datasheets will be checked for completeness and accuracy. Data generated in the field on hard copy will be provided to the database manager, who is responsible for data entry into the database. Manually entered data will be checked by a second party. Field documentation will be filed in the main project file after data entry and checking are complete. All field data will be stored in an electronic project folder.

3.4.5 Station and Sample Nomenclature

Monitoring stations will be identified by the sample station designations as follows:

- BG = Background Station
- During cap material placement:
    - 500EW = 500-foot Early Warning Station
    - 900C = 900-foot Compliance Station
- During pile removal:
    - 100EW = 100-foot Early Warning Station
    - 150C = 150-foot Compliance Station

4 Response Actions and Contingency Measures

This section describes response actions to an elevated measurement at the Early Warning Station or an exceedance at the Compliance Station.

4.1 Water Quality Elevation at Early Warning Station

If turbidity is elevated above the criterion at the Early Warning Station, the following sequence of responses will be initiated:

1. A confirmation measurement will be taken 5 to 10 minutes after the initial reading.
    a. If the confirmation measurement meets the water quality criterion, the monitoring crew will continue with the monitoring program.
    b. If the elevated measurement is confirmed, the FL will visually assess the station vicinity for potential outside influences, such as storm drains or sediment disturbance from nearby vessels.
        i. If outside influences are observed, the FL will inform the Project Manager, who will consult with Simpson. Additional discretionary measurements may be taken to understand the nature of the outside influence.
        ii. If the elevated measurement is attributed to construction activities, the FL will contact the Project Manager to report the measurement. The Project Manager will notify Simpson. Simpson will notify the Contractor to refine their work activity or their existing best management practices (BMPs; see Section 5) to minimize the chance for a confirmed exceedance at the Compliance Station.
2. The field crew will continue with the monitoring program.

4.2 Water Quality Exceedance at Compliance Station

If turbidity is measured above the criterion at the Compliance Station, the following sequence of responses will be initiated (Figure E-3):

1. The FL will wait 5 to 10 minutes and take a confirmation measurement at the station.
    a. If the confirmation measurement does not confirm exceedance of water quality criterion, the monitoring crew will resume the scheduled monitoring activities.
    b. If the exceedance is confirmed, the FL will visually assess the station vicinity for potential outside influences, such as storm drains or sediment disturbance from nearby vessels.
        i. If outside influences are observed, the FL will inform the FC, who will consult with the Simpson. Additional discretionary measurements may be taken to understand the nature of the outside influence, and compliance monitoring may be modified as necessary with approval from Ecology.

ii. If the elevated measurement is attributed to construction activities, the FL will contact the FC to report the measurement. The FC will notify Simpson. Simpson will notify the Contractor, and the Contractor will modify its work activity using BMPs (see Section 5) to reduce water quality impacts.
iii. The FL will retake measurements within 30 minutes to 1 hour of the initial exceedance at the Compliance Station. Additional confirmation measurements will be taken every 2 hours until compliance is met (or it gets dark).
iv. Ecology will be informed of the exceedance within 24 hours, and a written report will be submitted within 5 days.

In addition, the observation of a turbidity plume at the Compliance Station will trigger monitoring of the plume. The FC, FL, and Contractor will be continuously observing the environs for visible plume in the vicinity of the Compliance Station.

4.3 Stop Work Response

Some conditions require an immediate Stop Work response. These are as follows:

- Evidence of a significant oil sheen
- Evidence of distressed or dying fish
- Repeated confirmed exceedances of water quality criteria at the Compliance Station requiring Stop Work to control water quality

If distressed or dying fish are observed, Simpson will immediately report to Ecology’s Southwest Regional 24-hour Spill Response Office at (425) 649-7000. The U.S. Army Corps of Engineers may also require notification depending on the Nationwide Permit 38 language.

5 Best Management Practices

BMPs will be employed during construction to avoid or minimize potential adverse impacts. The Contractor will be required to develop an Environmental Protection Plan, which will include site-specific considerations and will outline the Contractor BMPs. At a minimum, the following BMPs will be implemented during construction:

- Pile removal will be conducted in accordance with Washington State Department of Natural Resources (WDNR) Guidelines and BMPs. These BMPs serve to minimize disturbance of sediment, resuspension of sediment into the water column, or loss of debris to the water. Project-specific exceptions to the WDNR BMPs include the following:
    - Should piles require cutting, they may be cut at mudline (rather than below grade, as specified by the WDNR BMPs) because the area will be capped. Capping should be phased to prioritize cut piles, to the extent practicable.
    - It is acceptable to ground barges (contrary to the WDNR BMPs) as an alternative to using spuds, as long as grounding occurs in an area targeted for subsequent capping.
    - Pile storage and processing (on the barge or uplands) will be performed in a containment basin, and stormwater collected in the containment basin will be considered contaminated and will be disposed of at an off-site facility.
- Material placement will be conducted in a controlled manner to minimize suspension of materials.
- Material placement will be conducted in lifts determined by the geotechnical analysis to minimize the disturbance to native sediments.
- The cap material barge will not be overfilled to the point where material overtops the sidewalls.
- Any storm water accumulating on the barge will be managed in a manner to comply with water quality turbidity standards.
- During construction, a boat will be available on site to retrieve debris from the water.
- In-water maintenance activities will be limited to periods determined appropriate by participating state and federal agencies to avoid potential adverse effects on migratory fish.
- All equipment will be inspected daily to ensure that it is in proper working condition.
- The Contractor will be responsible for the preparation and implementation of a Spill Prevention, Control, and Countermeasures Plan to be used for the duration of the project.
- On-site equipment using oil, gasoline, or diesel will be checked periodically for evidence of leakage. If evidence of leakage is found, the further use of such equipment will be suspended until the deficiency has been satisfactorily corrected.
- Excess or waste materials, petroleum products, chemicals, or other toxic or deleterious materials will not be allowed to enter waters of the state.

- An oil containment boom will be stocked on site. If there is a potential that floating debris may enter the aquatic area, the boom will be employed to collect floating debris prior to commencing work. The boom will also be utilized in the event of an oil spill, in which case the boom must remain in place until all oily materials and floating debris have been collected and sheen(s) dissipated.
- Oil-absorbent materials will be employed if floating oil sheen is observed on the surface of the aquatic area. Used absorbent materials will be collected, securely stored on site, and then properly disposed of at an approved disposal facility.

Based on the results of water quality monitoring, operational controls may be applied to pile removal and/or cap placement operations as required to meet water quality standards. These measures are largely focused on reducing sediment resuspension and turbidity in the water column. Possible contingency measures include, but are not limited to, the following:

- Operational BMPs:
  - Slowing the speed of material placement to the water column
  - Avoiding critical tidal or current conditions
  - For pile removal, operational BMPs will follow WDNR guidance
- Structural BMPs:
  - Installation of a sediment barrier such as a silt curtain

6 Quality Assurance/Quality Control

The quality assurance objective for this project is to ensure that the data collected are of known and acceptable quality so that the goals of the water quality monitoring program can be achieved.

6.1 Field Quality Assurance/Quality Control

All field staff will be experienced in water quality monitoring. Staff will be trained in standardized field monitoring and data collection procedures, requirements, data management protocols, and quality control. Data will be peer-reviewed before use in final deliverables. Staff will be fully trained in the calibration and standard operation procedures of field instruments.

Instruments and equipment will be inspected before each monitoring event. Any field equipment that is faulty or not functioning properly will not be used for monitoring. A calibration check will be performed on the water quality meter prior to monitoring each day using certified calibration standards. If water quality meter results are not consistent with standards, manufacturer's guidelines will be used to recalibrate the instrument. Standard instrument operating procedures will be used for all field instruments. A back-up meter will be available in case of equipment failure.

7 Reporting

This section describes reporting protocol for water quality monitoring activities, including communication responsibilities in the event of an exceedance, and summary reporting.

7.1 Daily Reporting

At the end of each monitoring day, a brief summary of water quality monitoring activities, field data sheets, and results of the monitoring will be provided to Simpson.

In the event that a water quality turbidity exceedance is confirmed, the field monitoring crew will report the exceedance immediately to Simpson, and Simpson will report the exceedance to the Ecology cleanup project manager within 2 hours of the initial exceedance. A change in the timeline for reporting may be modified for a repeated exceedance event, as approved by Ecology. A written report will be submitted within 5 days that summarizes the water quality measurements and the corrective actions used to meet acceptable water quality limits.

If distressed or dying fish are observed, Simpson will immediately report to Ecology's Southwest Regional 24-hour Spill Response Office at (360) 407-6300.

7.2 Weekly Quality Assurance Report

Weekly water quality monitoring data will be compiled into a summary table with a comparison to water quality compliance criteria. Reports will be provided to Simpson and Ecology. Weekly reports will also detail any elevated readings and BMPs that were employed to mitigate water quality impacts.

7.3 Water Quality Monitoring Completion Summary

After the IA and Oakland Bay Habitat Restoration Project are completed, water quality monitoring data will be summarized in a Water Quality Monitoring Results Report submitted to Simpson and Ecology. The Water Quality Monitoring Results Report will include the following sections:

- Site background
- Field monitoring and sampling methods and actual sample locations
- Method deviations from this WQMP
- Monitoring data

Table

Table E-1
Water Quality Monitoring Plan Overview

Category	Description
Water Quality Standards	Turbidity greater than 10 NTU over background (when background is 50 NTU or less), or a 20% increase in turbidity (when background is greater than 50 NTU) is above criteria.
	Visible turbidity at the point of compliance associated with in-water activity (i.e., not from outfalls, etc.) will trigger plume monitoring.
	The presence of sheen or distressed or dying fish at any distance requires stop work and response action.
Monitoring Locations	Early Warning = 100 feet (pile removal), 500 feet (material placement)
	Point of Compliance = 150 feet (pile removal), 900 feet (material placement)
	Background = 2,000 feet
Monitoring Depths	Surface (2 feet below water level), midway, and bottom (2 feet above mudline) at all locations. If the water depth is less than 10 feet, then only the top and bottom water depths will be monitored. If the water depth is less than 5 feet, then only the mid-depth will be monitored.
Monitoring Frequency	*Intensive* – Collect turbidity measurements twice per day during in-water work. If no confirmed exceedances are measured at the Compliance Station for 4 days, then shift to the routine schedule.
	Routine – Collect turbidity measurements twice daily on 1 day of each week. If a confirmed exceedance at the Compliance Station is measured, return to intensive monitoring.
Response Actions	An elevation of criteria at the Early Warning Station results in notification to Simpson and the Contractor. Simpson will notify the Contractor to refine their work activity or their existing best management practices to reduce turbidity.
	A confirmed exceedance of criteria at the point of compliance triggers modification of work (i.e., additional BMPs), follow-up monitoring to confirm the effectiveness of corrective measures, and re-initiation of intensive monitoring. The Washington State Department of Ecology will be notified within 24 hours of the exceedance event and a written report will be submitted within 5 days.

Notes:
BMP: best management practice
NTU: nephelometric turbidity unit

Figures

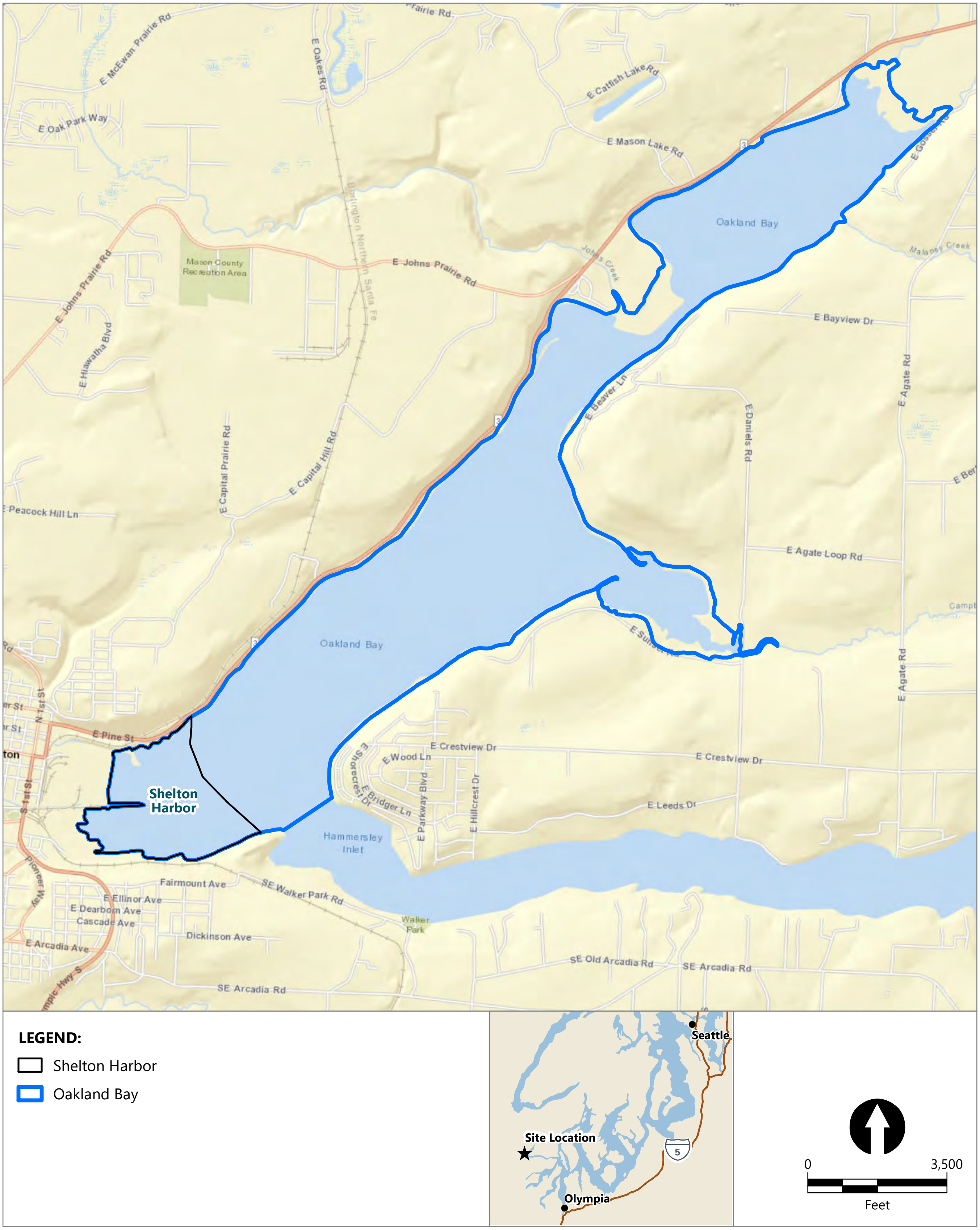

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Figure E-1
Vicinity Map
Appendix E: Water Quality Monitoring Plan
Oakland Bay and Shelton Harbor Sediments Cleanup Site

NOTES:

1. The location of the Background Station will be determined in the field based on the following considerations:
- The location should be unaffected by the active work.
- The location should be of a similar water depth to the compliance monitoring station to the extent practicable.
- The location should be affected by the Goldsborough and Shelton Creeks to a similar degree as the work area to the extent practicable.
2. Background orthoimagery provided by Google Earth.

Publish Date: 2018/08/17, 10:40 AM | User: ckiblinger
Filepath: \\orcas\gis\Jobs\Simpson_Timber_0008\SheltonHarbor\Maps\BODR\Shelton_BODR_AppxE_WQ_Stations.mxd

ANCHOR QEA

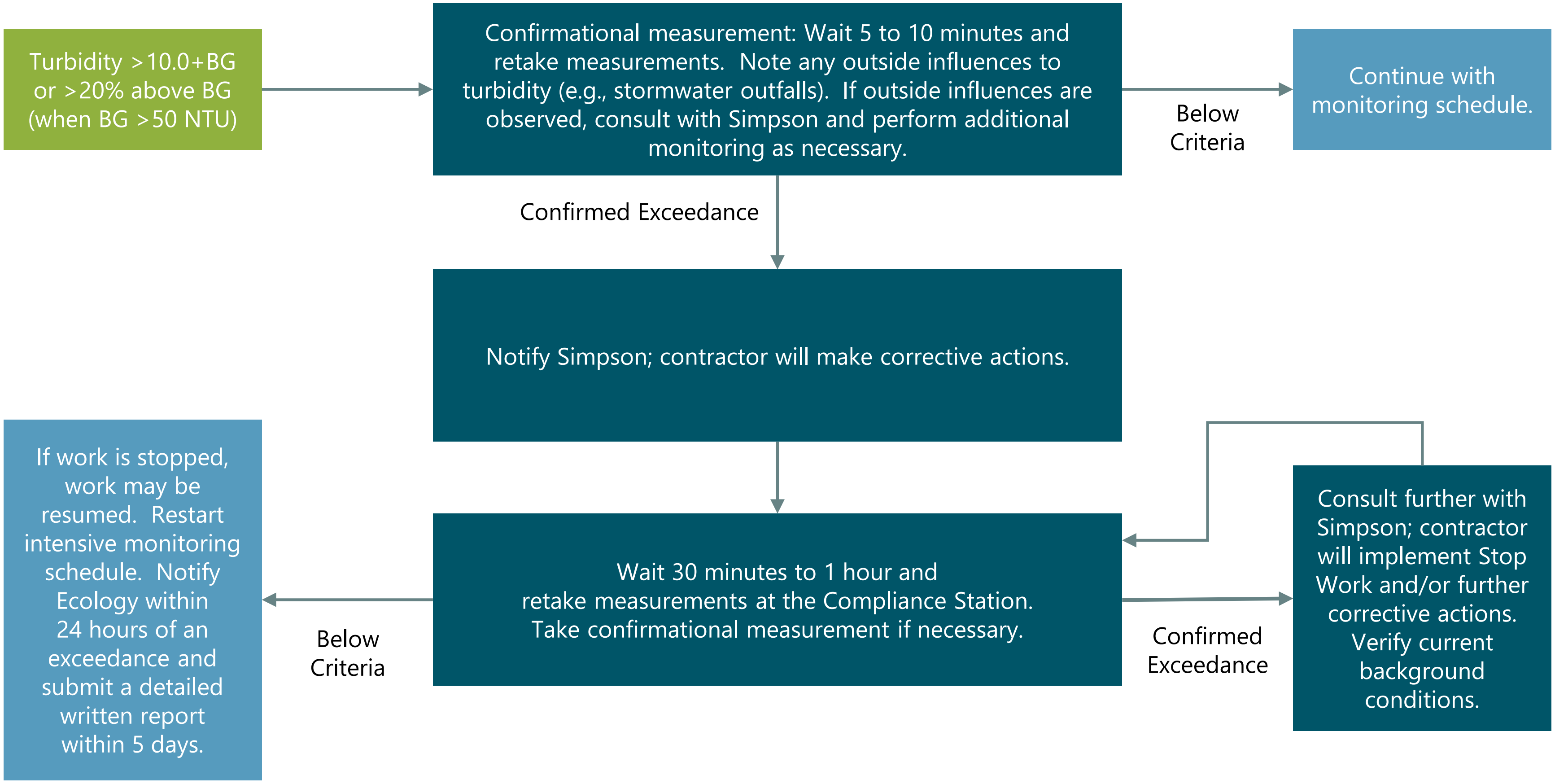
Figure E-2

Water Quality Monitoring Station Diagram

Appendix E: Water Quality Monitoring Plan
Oakland Bay and Shelton Harbor Sediments Cleanup Site

Sampling order: Measure Background Station then Compliance Station then Early Warning Station

This flow chart applies to the compliance station only.



Turbidity >10.0+BG or >20% above BG (when BG >50 NTU)

Confirmational measurement: Wait 5 to 10 minutes and retake measurements. Note any outside influences to turbidity (e.g., stormwater outfalls). If outside influences are observed, consult with Simpson and perform additional monitoring as necessary.

Continue with monitoring schedule.

Notify Simpson; contractor will make corrective actions.

Wait 30 minutes to 1 hour and retake measurements at the Compliance Station. Take confirmational measurement if necessary.

If work is stopped, work may be resumed. Restart intensive monitoring schedule. Notify Ecology within 24 hours of an exceedance and submit a detailed written report within 5 days.

Consult further with Simpson; contractor will implement Stop Work and/or further corrective actions. Verify current background conditions.

Notes:
BG: background
Ecology: Washington State Department of Ecology
NTU: nephelometric turbidity unit

Filepath: \\FUJI\Anchor\Projects\Simpson\Shelton\2018 Evaluations\Basis of Design\App E WQMP\Figure E-3

ANCHOR QEA

Figure E-3

Exceedance Procedures at 150- or 900-Foot Point of Compliance Stations

Appendix E: Water Quality Monitoring Plan
Oakland Bay and Shelton Harbor Sediments Cleanup Site

Attachment E-1

Extended Area of Mixing Request for Clean Material Placement in Shelton Harbor

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

July 30, 2018

To: Laura Inouye, Washington State Department of Ecology

From: Greg Brunkhorst, Anchor QEA, LLC

cc: Joyce Mercury, Washington State Department of Ecology
Dave McEntee, Simpson Timber Company
Clay Patmont, Anchor QEA, LLC
Brian Combs, South Puget Sound Salmon Enhancement Group

Re: Extended Area of Mixing Request for Clean Material Placement in Shelton Harbor

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Background

Two projects involving the placement of clean sand and gravel in inner Shelton Harbor are proposed to start in the 2018 to 2019 construction season. The Shelton Harbor Sediment Interim Action (IA) is a sediment capping project to clean up contaminated sediments as part of the Oakland Bay and Shelton Harbor Sediments Cleanup Site (Ecology Cleanup Site ID 13007). The IA is being performed by Simpson Timber Company (Simpson) under Agreed Order DE 14091 with the Washington State Department of Ecology. The IA will place a clean sand cap over approximately 9 acres of contaminated sediment, and a total of approximately 30,000 cubic yards (cy) of clean sand and gravel will be placed within the inner portion of Shelton Harbor.

The West Oakland Bay Restoration Project ("Restoration Project") involves the placement of clean sand and gravel over approximately 3.4 acres of inner Shelton Harbor, with a total of about 560,000 cy being placed. The work is being performed by the South Puget Sound Salmon Enhancement Group. The work will also include some piling and sediment removal.

The two projects will be performed under separate permits. The IA will be performed under a Nationwide 38 permit, and the Restoration Project will be performed under an Individual 401 permit. Both projects require separate Water Quality Certifications issued by Ecology.

Based on experience placing sand and gravel for other projects in Puget Sound, fine particles are likely to suspend in the water column during material placement, resulting in temporary localized turbidity measurements exceeding surface water quality criteria. The surface water quality criteria in Washington Administrative Code (WAC) 173-201A for "good" quality marine waters require that turbidity must not exceed 10 nephelometric turbidity units (NTU) over background when the background is 50 NTU or less, or a 20% increase in turbidity when the background turbidity is more than 50 NTU. The typical point of compliance for a temporary area of mixing is a radius of 150 feet from the activity causing the turbidity exceedance.

The rest of this memorandum follows the bullets listed in the Water Quality Area of Mixing Request Guidance received from Ecology on May 10, 2018.

Request for Area of Mixing Extension

What in-water work activities necessitate an additional area of mixing and why (may use past experiences to help explain the need).

Sand placement in Puget Sound has led to temporary turbidity impacts exceeding criteria in other projects. In a recent pilot project in Port Angeles (June 2017), material with 9% fines was placed near the Ediz Hook shoreline. Turbidity impacts above water quality criteria were observed within a narrow plume that followed the shoreline and extended approximately 900 feet from the work area. However, 20 minutes after placement activities, the plume had dissipated to below criteria.

Explain how there will be no loss of sensitive or important habitat and will not result in damage to the ecosystem within the mixing area requested.

The temporary localized turbidity exceedance will not affect habitat within the ecosystem. The elevated turbidity from the project is similar to that observed in streams in the area during storm events. Turbidity will result from the placement of clean substrate. In addition, the materials placed will result in an immediate positive effect on habitat in Shelton Harbor.

Identify any adverse effects to public health if the area of mixing is granted.

No adverse effects to the public health will occur.

What BMPs will be implemented and why do you feel that they will not be sufficient to meet water quality standards on this project?

The turbidity is a function of the inherent nature of the materials being used; fine-grained source materials are most compatible with habitat. Because turbidity is associated with the materials, modifications to construction activities will have limited impact in controlling turbidity. Best management practices (BMPs) will include placing material at a slower rate and modifying placement procedures (e.g., slow and deliberate sand placement near the surface of the water). While these BMPs will minimize turbidity impacts, experience has shown the fine-grained material are likely to become suspended during material placement and extend beyond the standard 150-foot point of compliance. The projects may perform some of the work during low tide, thereby reducing water quality impacts; however, a significant portion of the work will need to occur using marine equipment when there is sufficient water depth to access placement areas.

What are the characteristics of the waterbody that would make it difficult to meet water quality standards while performing construction activities in the waterbody. (i.e. flow, sediment type, width and depth of water body, etc.)?

Shelton Harbor is a tidally influenced waterbody within Puget Sound. Currents within inner Shelton Harbor are caused by tidal circulation within the harbor. During times of high tidal exchange, circulation could cause a turbidity plume to extend beyond the standard 150-foot point of compliance.

How long will the Applicant need the additional area of mixing? For each activity that the Applicant is requesting additional area of mixing, identify the duration needed.

The Applicants are requesting the additional area of mixing for material placement during the duration of the IA and the Restoration Project. The IA is expected to be completed in the 2018 to 2019 construction season, and the Restoration Project may extend over several construction seasons, depending on permitting and funding. The extended area of mixing would not apply to any sediment or piling removal activities.

What are the designated uses of the waterbody? Will the additional area of mixing impact these beneficial uses? If so, how?

Inner Shelton Harbor is designated as "good" for aquatic life uses, "secondary contact recreation" for recreational uses, and "wildlife habitat, harvesting, commerce and navigation, boating, and aesthetics" for miscellaneous uses (WAC 173-201A-612 Table 612). The additional area of mixing will not impact these beneficial uses.

What is the length of the additional area of mixing being requested? For each waterbody that the Applicant is requesting additional area of mixing, identify the length requested and why.

The requested length of the additional area of mixing is 900 feet from the construction area (placement area). Exhibit 1 provides a calculation with explanatory notes to support the extended area of mixing. To summarize, the calculation estimates the total suspended solids (TSS) load in the source area (construction area), then calculates the distance necessary for the TSS to achieve the water quality criterion of 10 NTU above background. A relationship of 1 NTU = 1 milligrams per liter TSS was used based on project experience. The plume transport model was based on a series of equations from Appendix C of *Evaluation of Dredge Material Proposed for Discharge in Waters of the U.S. – Testing Manual* (EPA and USACE 1998).

In the field, turbidity will be affected by additional factors that were beyond the scope of this effort (for example, localized current effects along the shoreline, hydrological effects from the freshwater inputs, tidal cycle complexities, particle settling rates, fluctuations in water depth [i.e., bathymetry], and variations in material placement production rates within the work day). However, the calculation provides a realistic estimate of the anticipated project conditions and is consistent with experience at similar projects.

Verify land access to the waterbody– if additional area of mixing is granted, water quality monitoring is required at various points along the length of the area granted as well as at the point of compliance. If land access is not possible, the Applicant needs to verify that monitoring can be done from the water via boat. Provide such verification to Ecology within the request.

Water quality monitoring will be performed by boat.

Provide written documentation verifying that the NFMS and/or US Fish & Wildlife (Services) have been notified that the Applicant is requesting additional area of mixing for turbidity – Ecology cannot grant an area of mixing in addition to what is allowed in the standards if the Services have not been notified.

The Department of Ecology (Joyce Mercury) is performing project coordination with the U.S. Fish and Wildlife Service and can provide written documentation.

References

EPA and USACE (U.S. Environmental Protection Agency; United States Army Corps of Engineers), 1998. *Evaluation of Dredge Material Proposed for Discharge in Waters of the U.S. – Testing Manual*. Appendix C Evaluation of Mixing. EPA-823-B-98-004. February 1998.

Exhibit 1

Area of Mixing Calculation

Exhibit 1

Area of Mixing Calculation

Parameter	Variable	Units	Value	Basis
TSS Plume Source Estimate				
Material Placement Rate		cy/hr	40	Estimated based on project experience. Approximately 400 cy/day.
Material Placement Rate		ton/hr	60	Calculated based on a bulk density of 1.5 ton/cy.
Percent of Material Suspended		%	4.5%	Local source material pit run has 1% fines. Alternative material source could range up to about 10% fines. Calculation based on the average.
Material Suspension Rate		ton/hr	2.7	Placement rate * percent of material suspended.
Material Suspension Rate		kg/sec	0.7	Unit conversion.
Water Depth		ft	10.0	Sufficient depth to safely work with marine equipment is approximately 10 feet.
Initial Width of Turbidity Plume		ft	10.0	Based on standard placement operations, the initial width of the plum is assumed to be 10 feet.
Cross-sectional Water Column Placement Area		ft^2	100	Depth *width.
Maximum Tidal Current	V_w	ft/sec	2.0	Tidal current in Hammersley Inlet is up to 2 ft/sec (2.5 knots). The tidal circulation in the work area in inner Shelton Harbor will be based on tidal cycle, circulation pattern, and freshwater inputs.
Flow-through Rate (Discharge Rate)	V_p	cfs	200	Calculated based on the current through the cross-sectional area.
Estimated Starting Concentration	C_0	mg/L	120	Calculated from the flow-through rate and the material suspension rate with unit conversions.
Turbidity and TSS Criteria				
Water Quality Criterion (Turbidity)	C_c	NTU	10	Turbidity criterion is 10 NTU above background for "good" quality marine water (WAC 173-201A-210).
TSS / Turbidity Relationship		(mg/L) / NTU	1	The relationship can vary from 1 NTU = 1 mg/L TSS to 1 NTU = 8 mg/L TSS depending on the site and daily conditions. 1 NTU = 1 mg/L TSS was selected for the calculation.
TSS criterion	C_c	mg/L	10	Calculated from the water quality criterion and the turbidity/TSS relationship.
Estimate of Area of Mixing Required to Meet Water Quality Criterion based on Equations in USACE 1998. Assume no settling.				
Assumed Water Column Mixing Depth	d	ft	10	Assume the mixing depth is equal to the initial water depth.
Assumed Turbulent Dissipation Parameter	ƛ	unitless	0.005	Recommended in USACE 1998 for estuary system.
Mixing Factor Required to Achieve Water Quality Criterion	D	unitless	11.01	$D = (C_0 - C_c) / C_c$
Mixing Volume to Achieve Mixing	V_a	cfs	2,203	$V_a = V_p * D$
Mixing Area Width Required to Achieve Mixing	L	ft	110	$L = V_a / (d * V_w)$
Time to Spread to Achieve Mixing Area Width	t	sec	432	t = (1/ƛ) * (0.094 * L2/3). Assumes a point discharge with an initial width of 0 feet.
Length of Mixing Required to Meet Water Quality Criteria	**X**	**ft**	**864**	**$X = V_w * t$**

Notes:

Calculation based on the Dilution Volume Method for CDF Effluent Discharges in USACE 1998.

cfs: cubic feet per second

cy/day: cubic yards per day

cy/hr: cubic yards per hour

ft: foot

ft^2: square foot

ft/sec: feet per second

kg/sec: kilograms per second

mg/L: milligrams per liter

NTU: nephelometric turbidity unit

sec: second

ton/cy: tons per cubic yard

ton/hr: tons per hour

TSS: total suspended solids

Attachment E-2

Field Forms

ANCHOR QEA

Water Quality Monitoring Form

720 Olive Way, Suite 1900
Seattle, Washington 98101
Phone 206.287.9130
www.anchorqea.com

Date:

Time Start:

Monitoring Personnel:

Monitoring Period (circle one): **Intensive** **Routine**

Weather Observations:

			Coordinates		Turbidity Reading (NTU)			Temperature (°C)			Exceed			
Station ID	**Time**	**Water Depth (ft)**	**Northing Latitude**	**Easting Longitude**	**Surface**	**Mid**	**Bottom**	**Surface**	**Mid**	**Bottom**	**Y/N***	**Water Sample Collected (Y/N)**	**Sample Name**	**Notes**

Notes: ***See attached figure markup of approximate monitoring locations***

Conversions

Feet	Meters
100	30
150	46
500	152
900	274
2000	610

Water Quality Standard: Turbidity shall be **< 10.0 NTU above BG** when BG < 50 NTU, and less than 20% over BG when BG is > 50 NTU.

During **placement** activities: 5**00EW** = 500' Early Warning Station; **900C** = 900' Compliance Station; **BG** = 2,000' Background Station
During **demolition or removal** activities: **100EW** = 100' Early Warning Station; **150C** = 150' Compliance Station; **BG** = 2,000' Background Station

Tidal Elevations	**Time**	**Elevation**	**Time**	**Elevation**	**Time**	**Elevation**	**Time**	**Elevation**
High:								
Low:								

Page _____ of _____

Multimeter Calibration Worksheet

Project Name: ______________________________

Project No.: ______________

REMINDER: ALLOW 2 MINUTES TO WARMUP BEFORE CALIBRATION OR USE.

			DO			
Calibration by:	**Date**	**Time (24 Hr)**	**Temp. (°C)**	**BP (mm Hg)**	**Initial DO (mg/L)**	**Final DO (mg/L)**

			TURBIDITY				
Calibration by:	**Date**	**Time (24 Hr)**	**Initial 0 NTU**	**Final 0 NTU**	**Temp. (°C)**	**Initial _____ NTU**	**Final _____ NTU**

Dissolved Oxygen Method (circle one):

Saturated Water Saturated Air

Source of Barometric Pressure: ___________________________

Turbidity Std (______ NTU)

Lot #___________________ Exp. Date: __________

Turbidity Std (______ NTU)

Lot #___________________ Exp. Date: __________

Turbidity Std (______ NTU)

Lot #___________________ Exp. Date: __________

Notes: ____

Daily Log

Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101
Phone 206.287.9130 Fax 206.287.9131

PROJECT NAME: ______________________ **DATE:** ______________________

SITE ADDRESS: ______________________ **PERSONNEL:** ______________________

WEATHER: **WIND FROM:**

N	NE	E	SE	S	SW	W	NW	LIGHT	MEDIUM	HEAVY
SUNNY		CLOUDY		RAIN		?		**TEMPERATURE:**	° F .	° C

[Circle appropriate units]

TIME	**COMMENTS**

Signature: ______________________

ANCHOR QEA

DATE: ____________________

PROJECT NAME: ____________________

PROJECT NO: ____________________

DAILY SAFETY BRIEFING

PERSON CONDUCTING MEETING: ____________________

HEALTH & SAFETY OFFICER: ____________________

PROJECT MANAGER: ____________________

TOPICS COVERED:

- ☐ Emergency Procedures and Evacuation Route
- ☐ Directions to Hospital
- ☐ HASP Review and Location
- ☐ Safety Equipment Location
- ☐ Proper Safety Equipment Use
- ☐ Employee Right-to-Know/MSDS Location
- ☐ Fire Extinguisher Location
- ☐ Eye Wash Station Location
- ☐ Buddy System
- ☐ Self and Coworker Monitoring
- ☐ Lines of Authority
- ☐ Communication
- ☐ Site Security
- ☐ Vessel Safety Protocols
- ☐ Work Zones
- ☐ Vehicle Safety and Driving/Road Conditions
- ☐ Equipment Safety and Operation
- ☐ Proper Use of PPE
- ☐ Decontamination Procedures
- ☐ Other:
- ☐ Lifting Techniques
- ☐ Slips, Trips, and Falls
- ☐ Hazard Exposure Routes
- ☐ Heat and Cold Stress
- ☐ Overhead and Underfoot Hazards
- ☐ Chemical Hazards
- ☐ Flammable Hazards
- ☐ Biological Hazards
- ☐ Eating/Drinking/Smoking

WEATHER CONDITIONS: ____________________

____

____

DAILY WORK SCOPE: ____________________

____

____

____

SITE-SPECIFIC HAZARDS: ____________________

____

____

____

____

SAFETY COMMENTS: ____________________

____

____

____

ATTENDEES

PRINTED NAME	SIGNATURE

Appendix F
Drawings

Appendix G

Cost Estimate

Appendix G - Cost Estimate

Cost Element	Unit Cost	Unit	Basis	Quantities	Costs
Sand and Gravel Purchase, Delivery, Transload and Place					
Preperation of Transload Area	$20,000	ls	Rough estimate.	1	$20,000
Material Delivered and Stockpiled in Upland Staging Area	$8.40	TN	Simpson estimate (1.5 tn/cy).	58,819	$494,081
Transload from Upland Stockpile to Barge	$5	cy	Recent project experience in the Puget Sound area.	39,213	$196,064
Material Placement From Barge	$25	cy	Recent project experience in the Puget Sound area.	39,213	$980,319
Pile Removal and Disposal	$400	Per pile	Removal and Disposal from Port Gamble. Preliminary Pile Counts.	23	$9,200
Subtotal Placement					**$1,699,664**
Tax	8.5%				$144,471
Additional Costs					
Mobilization/Demobilization	10.0%				$169,966
Contingency	10.0%				$169,966
Total					**$2,184,068**

Areas, Volumns, Masses

Item	Thickness (ft)
Average Cap thickness	2.5
Average Thickened Cap Thickness	3.5

Item	Area (acres)	Volume (cy)	Tonnage (tn)
Cap Area A	3.8	15,181	22,771
Thickened Cap Area A	0.6	3,194	4,791
Cap Area B	2.6	10,579	15,868
Thickened Cap Area B	1.2	6,546	9,819
Cap Area C	0.02	96	144
Thickened Cap Area C	0.2	1,357	2,036
Cap Area D	0.2	657	986
Thickened Cap Area D	0.3	1,603	2,405
Grand Total	8.8	39,213	58,819

Appendix H

WDNR Derelict Creosote Piling Removal Best Management Practices for Pile Removal and Disposal

Washington Department of Natural Resources
Derelict Creosote Piling Removal
Best Management Practices
For Pile Removal & Disposal

The following Best Management Practices (BMPs) are adapted from EPA guidance (2005), Washington State Department of Transportation (WSDOT) methods and conservation activities as included in Joint Aquatic Resources Protection Application (JARPA) 2005, and Washington State Department of Resources (WADNR) "Standard Practice for the Use and Removal of Treated Wood and Pilings on and from State-Owned Aquatic Lands" 2005, as well as WADNR's practical experience through managing piling removal projects since 2006.

The purpose of these BMPs is to control turbidity and sediments re-entering the water column during pile removal, and prescribe debris capture and disposal of removed piles and debris.

BMP 1. PILE REMOVAL

Crane operator shall be experienced in pile removal. Piles will be removed slowly. This will minimize turbidity in the water column as well as sediment disturbance. Pulled pile shall be placed in a containment basin to capture any adhering sediment. This should be done immediately after the pile is initially removed from the water.

A. Vibratory extraction

1) This is the preferred method of pile removal. Vibratory extraction shall always be employed first unless the pile is too decayed or short for the vibratory hammer to grip. After consultation with WADNR, the alternative options listed below may be used.

2) The vibratory hammer is a large mechanical device (5-16 tons) that is suspended from a crane by a cable. The hammer is activated to loosen the piling by vibrating as the piling is pulled up. The hammer is shut off when the end of the piling reaches the mudline. Vibratory extraction takes approximately 15 to 30 minutes per piling depending on piling length and sediment condition.

3) Operator will "Wake up" pile to break up bond with sediment.

- Vibrating breaks the skin friction bond between pile and soil.
- Bond breaking avoids pulling out a large block of soil – possibly breaking off the pile in the process.
- Usually there is little or no sediment attached to the skin of the pile during withdrawal. In some cases material may be attached to the pile tip, in line with the pile.

B. Direct Pull

1) This method is optional if the contractor determines it to be appropriate for the substrate type, pile length, and structural integrity of the piling. Vibratory extractor must be attempted first unless there is risk of greater disturbance of sediments.

2) Pilings are wrapped with a choker cable or chain that is attached at the top to a crane. The crane pulls the piling directly upward, removing the piling from the sediment.

C. Clamshell Removal

1) Broken and damaged pilings that cannot be removed by either the vibratory hammer or direct pull may be removed with either a clamshell bucket or environmental clamshell.

2) A clamshell is a hinged steel apparatus that operates like a set of steel jaws. The bucket is lowered from a crane and the jaws grasp the piling stub as the crane pulls up.

3) The size of the clamshell bucket shall be minimized to reduce turbidity during piling removal.

4) The clamshell bucket shall be emptied of material onto a contained area on the barge before it is lowered into the water.

D. Cutting

1) Is required if the pile breaks at or near the existing substrate and cannot be removed by other methods.

2) If a pile is broken or breaks during extraction, all of the methods listed below should be used to cut the pile.

a. Piles located in intertidal and shallow subtidal areas that are less than -10 feet deep MLLW shall be cut at least 2 feet below the mudline.

b. In subtidal areas that are greater than -10 feet deep MLLW, piles shall be cut at least 1 foot below the mudline.

c. Piles shall be cut off at lowest practical tide condition and at slack water. This is intended to reduce turbidity due to reduced flow and short water column through which pile must be withdrawn.

d. No hydraulic jetting devices shall be used to move sediment away from piles. Excavation of sediment in subtidal areas to expose broken piles shall be accomplished by divers using hand tools.

e. The contractor shall provide the location of all the broken and cut piles using a GPS.

BMP 2. BARGE OPERATIONS, WORK SURFACE, CONTAINMENT

A. Barge grounding will not be permitted.

B. Work surface on barge deck or pier, or upland staging area shall include a containment basin for all treated materials and any sediment removed during pulling. Creosote shall be prevented from re-entering the water. Uncontaminated water run-off can return to the waterway.

1) Containment basin shall be constructed of durable plastic sheeting with continuous sidewalls supported by hay bales, ecology blocks, other non-contaminated materials, or support structure to contain all sediment and creosote. Containment basin shall be lined with oil absorbent boom.

2) Work surface on barge deck and adjacent pier shall be cleaned by disposing of sediment or other residues along with cut off piling as described in BMP #4.B.

3) Containment basin shall be removed and disposed in accordance with BMP #4.B or in another manner complying with applicable federal and state regulations.

4) Upon removal from substrate the pile shall be moved expeditiously from the water into the containment basin. The pile shall not be shaken, hosed-off, left hanging to drip or any other action intended to clean or remove adhering material from the pile.

BMP 3. DEBRIS CAPTURE IN WATER

A. A floating surface boom shall be installed to capture floating surface debris. The floating boom shall be equipped with absorbent pads to contain any oil sheens. Debris will be collected and disposed of along with cut off piling as described in BMP #4.

B. The boom may be anchored with four or fewer ½ ecology blocks or a similar anchoring device. These anchors must be removed once the project is complete. The anchor system shall be located to avoid damage from vessel props to eelgrass, kelp, and other significant macroalgae species. The line length between the anchor and surface float shall not exceed the water depth as measured at extreme high tide plus a maximum of 20 percent additional line for scope. The buoy system shall include a subsurface float designed to keep the line between the anchor and surface float from contacting the bottom during low tide cycles. The subsurface float shall be located off the bottom a distance equal to 1/3 the line length

C. The boom shall be located at a sufficient distance from all sides of the structure or piles that are being removed to ensure that contaminated materials are captured. The boom shall stay in its original location until any sheen present from removed pilings has been absorbed by the boom. BMP #3B may be used to keep the boom in its original location.

D. Debris contained within boom shall be removed at the end of each work day or immediately if waters are rough and there is a chance that debris may escape the boom.

E. To the extent possible all sawdust shall be prevented from contacting beach, bed, or waters of the state. For example, sawdust on top of decking should be removed immediately after sawing operations.

F. Any sawdust that enters the water shall be collected immediately and placed in the containment basin.

G. Piles removed from the water shall be transferred to the containment basin without leaving the boomed area to prevent creosote from dripping outside of the boom.

BMP 4. DISPOSAL OF PILING, SEDIMENT AND CONSTRUCTION RESIDUE

A. Piles shall be cut into lengths as required by the disposal company.

B. Cut up piling, sediments, absorbent pads/boom, construction residue and plastic sheeting from containment basin shall be packed into container. For disposal, ship to an approved Subtitle D Landfill.

C. Creosote-treated materials shall not be re-used.

BMP 5. RESUSPENSION/TURBIDITY

A. Crane operator shall be trained to remove pile from sediment slowly.

B. Work shall be done in low water and low current, to the extent possible.

C. Removed piles shall be placed in a containment facility.

D. Sediments spilled on work surfaces shall be contained and disposed of with the pile debris at permitted upland disposal site.

E. Holes remaining after piling removal shall not be filled.

BMP 6. PROJECT OVERSIGHT

A. WADNR will have a project manager or other assigned personnel on site. Oversight responsibilities may include, but are not limited to the following:

   1) Water quality monitoring to ensure turbidity levels remain within required parameters

   2) Ensure contractor follows BMPs

   3) Ensure contractor is in compliance with contract and permit requirements

   4) Ensure correct structures are removed

   5) Maintain contact with regulatory agencies should issues or emergencies arise

BMP 7. CULTURAL RESOURCES

A. In the event that artifacts (other than the pilings or materials attached to them) that appear to be 50 years old or older are found during the project, the WADNR Aquatics archaeologist must be notified in order to evaluate the find and arrange for any necessary consultation and mitigation required by law.

B. If human remains or suspected human remains are found during the project, work in the vicinity will be halted immediately, and the County Coroner must be notified immediately. If the remains are determined to be non-forensic, then the WADNR Aquatics archaeologist will be notified to begin tribal and Washington State Department of Archaeology and Historic Preservation consultations required by law.

C. If sediment exceeding 1 cubic meter is removed, the WADNR Aquatics archaeologist will be notified and given the opportunity to examine the sediment for cultural materials before it is removed from the containment area.