Pre-Remedial Design Investigation Work Plan

South State Street MGP Site
Bellingham, Washington

for
Puget Sound Energy

October 30, 2020

GeoEngineers
Earth Science + Technology

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ABBREVIATIONS AND ACRONYMS

ADCP	acoustic doppler current profiler
AO	Agreed Order
bgs	below ground surface
BNSF	Burlington Northern/Santa Fe Railroad
CAP	Cleanup Action Plan
CFR	Code of Federal Regulations
CGS	Coastal Geologic Services
City	City of Bellingham
cm	centimeters
CMS	Coastal Monitoring System
cPAHs	carcinogenic polycyclic hydrocarbons
DAHP	Department of Archaeology and Historic Preservation
DNR	Department of Natural Resources
Ecology	Washington State Department of Ecology
ENR	enhanced natural recovery
GeoEngineers	GeoEngineers, Inc.
GPS	global positioning system
HASP	Health and Safety Plan
JARPA	Joint Aquatic Resource Permit Application
MGP	Manufactured Gas Plant
MLLW	mean lower low water
MNA	monitored natural attenuation
MNR	monitored natural recovery
MTCA	Model Toxics Control Act
OHW	ordinary high water
ORP	oxidation/reduction potential
Pilot Project	Bellingham Bay Demonstration Pilot Project
PLPs	potentially liable parties
PNNL	Pacific Northwest National Laboratory
PRDI	Pre-Remedial Design Investigation
PSE	Puget Sound Energy

QAPP	Quality Assurance Project Plan
RCW	Revised Code of Washington
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SEPA	State Environmental Policy Act
Site	South State Street MGP Site
SLR	sea level rise
SMS	Sediment Management Plan
SWAC	surface weighted average concentration
SWAN	Simulating WAves Nearshore
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers
VOCs	volatile organic compounds
WAC	Washington Administrative Code
WAD	weak acid dissociable
WDFW	Washington Department of Fish and Wildlife

1.0 INTRODUCTION

A Pre-Remedial Design Investigation (PRDI) is planned at the South State Street Manufactured Gas Plant Site (Site) in Bellingham, Washington to obtain additional data to support design of the cleanup action for the Site. The Site is generally located at Boulevard Park, south[1] of the downtown business district (Figure 1). A Cleanup Action Plan (CAP) has been completed that outlines the elements of the cleanup action for the Site (Ecology 2020). The cleanup action will be completed pursuant to requirements of the Washington State Model Toxics Control Act (MTCA) (Chapter 70.105D of the Revised Code of Washington [RCW] and Chapter 173-340 of the Washington State Administrative Code [WAC]) and Sediment Management Standards (SMS) (Chapter 173-204 WAC). Remedial design and permitting activities will be conducted under Amendment #2 of Agreed Order (AO) No. DE 7655, (Ecology 2019) between the Washington State Department of Ecology (Ecology), the City of Bellingham (City), and Puget Sound Energy (PSE).

This work plan describes additional information to be collected to support the engineering analysis and design of the Site cleanup action. The planned field activities will provide information to support design of the cleanup action including the following:

- The extent of upland soil contamination requiring capping;
- Bioremediation for in-situ treatment of groundwater;
- The extent of the nearshore intertidal cap and components of the cap needed to protect surface water and sediment;
- The extent of conventional and thin layer capping and area of application of enhanced natural recovery (ENR) and monitored natural recovery (MNR); and
- Potential accretion and erosion (accretion/erosion) at the Site as a result of coastal marine processes.

The field activities and testing to be performed as part of the PRDI for each investigation element are presented in this Work Plan. Detailed descriptions of the field and laboratory testing procedures are presented in the Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) provided in Appendix A. A Health and Safety Plan (HASP) is provided in Appendix B.

1.1. General Site Description

The South State Street Manufactured Gas Plant (MGP) was formerly located on what is now Boulevard Park along the eastern shore of Bellingham Bay (Figure 1). The Site is divided into an Upland Unit and Marine Unit, separated by the mean high tide line (Figure 2). The Upland Unit encompasses the northern portion of Boulevard Park and is further divided into three areas: the upper park, the slope, and the lower park. The former MGP was located in the upper park. The Marine Unit includes aquatic lands of Bellingham Bay. The Upland Unit includes property owned by the City, Street right-of-way (ROW), Burlington Northern/Santa Fe Railroad (BNSF) and Washington State (managed by the Department of Natural Resources [DNR]) (Figure 3). The Marine Unit includes State- and BNSF-owned aquatic land and platted street ROW.

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[1] All directions are referenced relative to "project north." The relationship between project north and true north is shown in the figures.

The Site has been used as a public park since c.a. 1980. The area was constructed by placing fill on tidelands formerly occupied by a historic sawmill (lower park) and upland formerly occupied by the MGP facility. Fill in the lower park includes wood waste associated with former lumber mill and log-rafting operations, and materials from local demolition and construction projects. Pilings associated with the former lumber mill wharf likely remain beneath the lower park. The base of one of the former gas holders remains above-ground in the upper park.

1.2. Relationship to Adjacent MTCA Cleanup Sites

Twelve cleanup sites located in the general vicinity of the South State Street Site are part of the Bellingham Bay Demonstration Pilot Project (Pilot Project). The cleanup sites located closest to the South State Street Site are shown on Figure 4. The Pilot Project is a coordinated effort by federal, tribal, state, and local governments to clean up contamination around Bellingham Bay.

Portions of the Whatcom Waterway site overlap with the Marine Unit of the South State Street Site (Figure 2). In the area of overlap, the Whatcom Waterway cleanup consists of monitored natural recovery (Whatcom Waterway Units 7 and 9 in Figure 2; Anchor QEA 2015). Unit 7 (Starr Rock) encompasses an area where sediment dredged from Whatcom Waterway and adjacent berthing areas was disposed during the late 1960s. Unit 9 is an area where low-level mercury contamination exists in subsurface sediment.

1.3. Cleanup Action Summary

The components of the selected Site cleanup action are summarized below and presented on Figures 5 and 6:

- Upland permeable vegetated soil cap – A permeable vegetated soil cap will be constructed throughout most of the upper and lower park. The cap will reduce human health (direct contact) risks and provide a clean soil horizon in which park workers can conduct routine maintenance activities without encountering deeper contaminated soil.

- Groundwater bioremediation and monitored natural attenuation (MNA) – The portion of the Upland Unit where concentrations of lighter organic contaminants (primarily benzene and naphthalene) in groundwater are highest upgradient of the pocket beach, will be addressed using enhanced bioremediation. Groundwater in other portions of the Upland Unit will be addressed using MNA.

- Remove remnant gas holder – The above-ground concrete cylindrical wall of the only remaining gas holder in the upper park and MGP residuals inside this structure will be removed and disposed of off-site.

- Sediment capping – A conventional sand cap will be constructed in the intertidal and shallow subtidal zones (above -10 feet mean lower low water [MLLW]) at, and slightly beyond, locations where surface sediment concentrations exceed the upper remediation level for carcinogenic polycyclic hydrocarbons (cPAHs). A thin sand cap (1-foot-thick) will be constructed in deeper subtidal (below -10 feet MLLW) areas where surface sediment exceeds the upper remediation level for cPAHs.

- Sediment natural recovery –MNR and ENR will be used in portions of the Marine Unit where surface sediment concentrations of cPAHs are lower and natural deposition of clean sediment is anticipated to achieve cleanup levels within a reasonable timeframe on a surface weighted average concentration

(SWAC) basis. ENR will be applied in areas with cPAH surface sediment concentrations greater than the lower remediation level. The selected cleanup action relies on natural recovery to be effective in deeper offshore areas where lower energy conditions allow net deposition (accretion) of clean sediment, and where periodic high-energy events (e.g. storms) will not affect recovery on a large scale.

The cleanup action is described in further detail in the Final CAP (Ecology 2020).

2.0 INVESTIGATION TO SUPPORT UPLAND CAP DESIGN

The cleanup action includes placement of a soil cap in the upland area. The primary objective of the upland cap is to provide a barrier of clean soil between the park users and contaminants in underlying soil exceeding direct contact cleanup levels. One of the goals of the PRDI is to refine the footprint of the upland cap. The only contaminant that exceeds direct contact cleanup levels in surface soil (0 to 1 foot below the ground surface [bgs]) or shallow subsurface soil (1 to 2 feet bgs) across the upper and lower park areas is cPAHs.[2] Therefore, cPAHs are the focus of soil sampling to refine the extent of capping. Existing soil data is adequate for designing the cap in the lower park. The primary data gap for upland capping is cPAH concentrations in surface and shallow subsurface soil in the upper park.

The existing data for upper park soil indicates that cPAH concentrations meet the direct contact cleanup level in surface soil across a large portion of the upper park. However, at many of these sample locations, shallow subsurface samples were not collected. Additional soil sampling is proposed to characterize the shallow subsurface soil. These data will be used to refine the cap design to assure that the cPAH cleanup level will be achieved in at least the upper 2 feet of soil throughout the upper park. This 2-foot-thick clean horizon will consist of imported cap material or existing clean park soil. If soil data shows that cPAH concentrations in the 0 to 1-foot and 1 to 2-foot intervals meet the direct contact cleanup level in a large portion of the upper park, then imported cap material will not be necessary in that area unless soil is needed to maintain grades and functional use of the park.

A topographic survey of the upland portion of the site will also be completed to provide a basis for designing the upland cap.

The following sections summarize the investigation activities to be performed to support upland cap design.

2.1. Soil Sampling to Support Cap Design

Twenty (20) shallow hand auger borings (HA-15 through HA-34) will be completed across the upper park to collect surface and/or shallow subsurface soil samples to delineate cPAH exceedances of the direct contact cleanup level (Figure 7). In areas with no existing data, soil samples will be collected from depths of 0 to 1-foot bgs and 1 to 2 feet bgs. Soil samples collected from locations adjacent to where surface soil (0-1 foot) samples have already been collected will be collected from the 1 to 2-foot interval. Soil samples collected from the upper park hand auger borings will be analyzed for cPAHs. Sampling and analysis procedures are presented in greater detail in the SAP/QAPP provided in Appendix A.

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[2] With the exception of arsenic and lead exceedances at sample location MGP-HA-05 in the slope area, cPAHs is the only analyte that was detected in soil at concentrations greater than direct contact screening levels in the Remedial Investigation.

2.2. Upland Topographic Survey

A topographic survey of the Upland Unit will be conducted following the completion of upland soil sampling and well installation to document the position of the new sample locations (Figure 7). In addition, a full topographic survey of the Upland Unit will be completed to provide the basis for design for the upland cap.

Following completion of soil sampling described in Section 2.1, these locations will be surveyed to document the horizontal position and elevations at each location. For the new monitoring wells (discussed in Section 3 below), each new well will be surveyed, documenting the horizontal position and elevation of the top of the well casing, the well monument, as well as the adjacent ground surface.

In addition to surveying new sample locations, the current topography of the Upland Unit will be surveyed to support design of upland capping. The topographic survey will extend beyond the property boundary to the north, to capture areas addressed by the soil sampling described above. The topographic survey of the lower park will be performed down to MLLW along the entire shoreline of the property to overlap with the area where bathymetric survey will be performed as described in Section 6.1.1.

Surveying will be completed by a contracted professional surveyor licensed in the State of Washington.

3.0 INVESTIGATION TO SUPPORT USE OF GROUNDWATER BIOREMEDIATION AND NATURAL ATTENUATION

The cleanup action includes bioremediation and natural attenuation to address groundwater contamination in portions of the lower park. Enhanced bioremediation will be used to address the portion of the Upland Unit where groundwater impacts are greatest, upgradient of the pocket beach. The enhanced bioremediation will address organic contaminants (primarily benzene and naphthalene) and potentially cyanide in groundwater. Monitored natural attenuation will be used to address contaminants in groundwater in other parts of the lower park.

Soil and groundwater sampling is planned in the lower park to further characterize the lateral and vertical extent of contamination. Soil and groundwater samples will also be collected for the purpose of evaluating the geochemical conditions that support natural attenuation of contaminants. In soil, iron and copper are known to attenuate cyanide and total organic carbon (TOC) informs the potential for attenuation of organic contaminants. In groundwater, sulfate, nitrate, dissolved iron, total iron, and alkalinity are indicators of natural degradation mechanisms. Geochemical data will also support evaluation of bioremediation, including identification of amendments that might be introduced to provide the most effective in-situ treatment.

The sampling will be conducted in phases. Initial direct-push sampling will be completed to characterize the saturated thickness of soil above bedrock and the lateral distribution of contaminants in groundwater at the base of the slope between the upper and lower park areas. This will inform potential options and layouts for implementing enhanced bioremediation. Following completion of the direct-push sampling, four monitoring wells will be installed in the lower park; two new wells in the area upgradient of the pocket beach and two new wells along the western shoreline. Two Site-wide groundwater monitoring events will be completed following installation and development of new monitoring wells to evaluate spatial and temporal trends of groundwater contaminants.

The following sections summarize the investigation activities to be performed to support use of groundwater bioremediation and natural attenuation.

3.1. Direct-Push Borings, Soil and Groundwater Sampling and Analysis

Direct-push sampling is planned in the lower park near the base of the steep slope. Approximately 14 direct-push borings (GP-58 through GP-71) will be completed in this area to characterize soil conditions (Figure 7) and will also be used to sample groundwater (Figure 8). The number of borings and locations may be modified in the field based on field observations and the conditions encountered during advancement of the borings. Each proposed soil boring will be advanced to refusal at bedrock which is expected to range from approximately 8 to 15 feet bgs. Continuous soil cores will be obtained to observe and log subsurface conditions and for field screening, with a focus on characterizing soil grain size, estimated permeability, and the thickness of saturated soil above bedrock.

Temporary well screens will be installed in the borings that are selected for groundwater sampling. In borings with a sufficient volume of groundwater, samples will be collected using a peristaltic pump and polyethylene tubing. The inlet of the polyethylene tubing will be located at the mid-point of the saturated zone above bedrock. Groundwater samples will be submitted for analysis of petroleum hydrocarbons, benzene, naphthalene, and total and weak acid dissociable (WAD) cyanide.

Sampling and analysis procedures are presented in greater detail in the SAP/QAPP provided in Appendix A.

3.2. Monitoring Well Installation, Soil Sampling and Analysis

Additional groundwater monitoring wells will be installed in the lower park to more completely characterize the extent of groundwater contamination and to evaluate geochemical conditions indicative of natural attenuation. Two new pairs of monitoring wells will be installed (Figure 8) that include the following:

- Two new wells will be installed adjacent to MW-40 and MW-42 near the western shoreline of the lower park (MW-59 and MW-60; Figure 8). Existing wells MW-40 and MW-42 were constructed with short (5-foot) screens located in the lowest portion of the saturated zone, immediately above bedrock. The new wells will be screened across the groundwater table (approximately 8 feet bgs) using a 10-foot-long screen. The wells will be used to characterize shallow groundwater near the shoreline, which is expected to be more representative of groundwater that eventually discharges in the nearshore area.
- Two new monitoring wells (MW-61 and MW-62) will be installed in the area upgradient of the pocket beach to evaluate the spatial distribution of contaminants and geochemical parameters indicative of natural attenuation. The well locations shown in Figure 8 are preliminary and will likely be modified based on the results of the direct-push groundwater sampling near the base of the steep slope described above. The new wells will be screened from the bedrock to approximately 1-foot above the estimated seasonal high groundwater elevation, the depth of which will be dependent on the final location of the well.

The new monitoring wells will be completed using standard hollow-stem auger drilling equipment. Soil sampling will be completed to characterize conditions within the screened interval of the well. Continuous soil sampling will be performed at each boring. Continuous soil samples will be collected at 2.5-foot intervals using a split spoon sampler. One soil sample from each boring that is collected from the interval nearest to the midpoint of the well screen will be submitted for laboratory analyses.

The soil samples collected from the borings in the western portion of the lower park near MW-40 and MW-42 (MW-59 and MW-60) will be analyzed for total cyanide and indicators of potential cyanide attenuation (iron, copper, and TOC), but not organic contaminants as these data already exist from previous soil samples collected for wells MW-40 and MW-42. The soil samples collected from the borings advanced for the new wells upgradient of the pocket beach (MW-61 and MW-62) will be analyzed for the contaminants planned to be addressed by enhanced bioremediation of groundwater including total cyanide, petroleum hydrocarbons, and volatile organic compounds (VOCs; benzene and naphthalene) as well as geochemical indicators of natural attenuation including iron, copper and TOC.

Following completion of well installation and development for the four new wells, groundwater samples will be obtained from the four new wells as part of the Site-wide groundwater sampling events described below (Section 3.3).

3.3. Site-wide Groundwater Sampling and Analysis

The most recent Site-wide characterization of groundwater at the Site was completed in 2016 and is reported in the 2019 Remedial Investigation/Feasibility Study (RI/FS). Two Site-wide sampling events will be completed as part of the PRDI to evaluate current conditions, and spatial and temporal contaminant concentration trends.

The groundwater samples will be obtained from 21 wells shown on Figure 8 during two sampling events: one during the wet season (between December and March) and one during the dry season (between July and September). The data will be used to support technical analysis of groundwater attenuation processes that are naturally occurring at the Site and that will be augmented by the enhanced bioremediation component of the cleanup.

Prior to collecting groundwater samples, groundwater levels will be measured in all the monitoring wells. The timeframe for measuring groundwater levels in the wells will be as short as practicable to reduce the effect of tidal fluctuations on groundwater elevations in tidally influenced wells. After completing groundwater level measurements, groundwater samples will be collected using standard low-flow sampling methods following purging. Field parameters will be measured during sample collection that include dissolved oxygen; oxidation/reduction potential (ORP); specific conductance; turbidity; temperature; and pH. Data from the measurements will not only be used to support sampling but will be used to support an evaluation of natural attenuation processes currently occurring at the Site. Procedures for water level monitoring and groundwater sample collection are described in the SAP/QAPP presented in Appendix A.

Groundwater samples will be submitted to a Washington-certified laboratory for chemical analysis. The groundwater samples will be analyzed for petroleum hydrocarbons, VOCs (benzene and naphthalene), dissolved iron, lead and selenium, total iron, total and WAD cyanide, TOC, sulfate and nitrate.

4.0 SEDIMENT INVESTIGATION TO SUPPORT NEARSHORE INTERTIDAL CAP DESIGN

The cleanup action includes placement of cap material on nearshore intertidal sediment [from 0 feet MLLW up to Ordinary High Water (OHW; 10.47 feet MLLW)]. This is the zone expected to have the highest groundwater flux from the upland to the Marine Unit for which additional cap construction considerations are needed to address attenuation of contaminants. The nearshore intertidal sediment cap will protect human health and the environment from exposure (via bioaccumulation and direct contact pathways) to cPAH concentrations greater than the sediment remediation levels and protect surface water and sediment from contaminants in groundwater.

One of the goals of the PRDI is to refine the extent of the nearshore intertidal cap placement. The existing data for nearshore intertidal sediment indicates that cPAH concentrations exceed the upper and lower remediation levels in surface sediment in the pocket beach area. However, samples have not been collected from the nearshore intertidal area at locations west and south of the pocket beach and outside of the area to be capped that was identified in the CAP. Therefore, sampling is proposed to characterize sediment from the bioaccumulation compliance interval (0 to 12 centimeters [cm]) along the shoreline, west and south of the pocket beach (Figure 9) to determine if additional capping is required for the remedy to be protective. These data will be used to refine the cap design to assure that intertidal sediment with cPAH concentrations greater than the lower remediation level will be capped throughout the nearshore intertidal area.

A second data gap in the intertidal area west and south of the pocket beach is the need for cPAH sediment data in the direct contact compliance interval (0 to 45 cm). To address this data gap, sediment samples from the 0 to 45 cm interval will be collected adjacent to the locations were the 0 to 12 cm samples discussed above are collected. These samples will be used to calculate an intertidal SWAC that will be compared to risk-based concentrations protective of direct contact exposure (beach play, clamming, and net fishing). If the SWAC, which will incorporate cPAH replacement concentrations in the proposed capped area, exceeds the risk-based concentrations, the extent of the nearshore intertidal cap will be expanded.

Another objective of the nearshore intertidal cap is to provide material that inhibits transport of the more mobile contaminants present in groundwater (benzene, naphthalene, and cyanide). The data gap associated with this objective is the availability of sufficient benzene, naphthalene, and cyanide data from near surface and shallow subsurface sediment and porewater. The goal of the PRDI is to collect sediment and porewater samples that will inform and refine the thickness (need for a thick cap) and components (e.g., need for reactive amendments, etc.) of the intertidal nearshore cap design to provide protection of surface water and sediment from contaminants in groundwater.

Additional data are also needed for other parameters that effect the transport of contaminants and cap design for protection of surface water and sediment. The concentration of TOC effects transport of contaminants in sediment and the concentration of petroleum hydrocarbons can affect cap design. Physical properties including sediment grain size will provide data required for design parameters for modeling various intertidal caps.

Data do not currently exist for benzene, naphthalene, and cyanide in near surface and shallow subsurface sediment and porewater in the nearshore intertidal area and will be collected as part of the investigation of intertidal sediment. Data will also be collected for TOC, petroleum hydrocarbons and grain size in near surface and shallow subsurface sediment coincident with the locations and samples collected for benzene, naphthalene, and cyanide in the nearshore intertidal area. The rate of flow or seepage of groundwater through near surface/shallow subsurface sediment to surface water will also be evaluated using a direct measurement technique. These data will be used to inform and refine the cap design to assure that the components of the intertidal sediment cap inhibit transport of the more mobile contaminants present in groundwater.

Sampling activities below the OHW are expected to require permitting and approval and the period of activity will be limited to available in-water work windows. Permits and work restrictions are addressed in Section 8.0. The following sections summarize the investigation activities to be performed to support nearshore intertidal cap design.

4.1. Nearshore Intertidal Sediment and Porewater Sampling and Analysis

Sediment and porewater samples will be collected from 12 locations (PRDI-1 through PRDI-12) along the nearshore intertidal area as shown on Figure 9. Sediment sampling will be completed at four locations (PRDI-9 through PRDI-12) to collect samples to define the extent of cPAHs greater than the lower remediation level. At each of the 12 locations (PRDI-1 through PRDI-12) sampling will be completed to characterize concentrations of more mobile contaminants in sediment and porewater and collect data for other parameters that affect contaminant transport and cap design. Sediment cores will be advanced to collect samples from the nearshore intertidal area during low tide using hand-held coring equipment. Samples may be collected using hand tools for digging an excavation if hand-held coring equipment is not able to penetrate and/or recover sediment from the shoreline. Each sample location will require completion of multiple hand-auger cores to collect enough material to complete the desired analyses. At each location, the borings will be performed as close as possible to each other and the central location will be staked for surveying and coordinates will be collected with a portable global positioning system (GPS). Additionally, a push probe with a screened section will be used to collect porewater samples at each location. The following samples will be collected from the location shown on Figure 9:

- Sediment samples will be collected from four locations south of the pocket beach (PRDI-9 through PRDI-12) from the bioaccumulation compliance interval (0 to 12 cm) and the direct contact compliance interval (0 to 45 cm) for analysis of cPAHs. The sediment collected from the surface to a depth of 12 cm and from the surface to 45 cm will be homogenized separately and samples will be collected from the homogenized sediment for cPAH analysis.
- A sediment sample will be collected from near-surface sediment (0 to 15 cm) and another sample will be collected from shallow subsurface sediment (15 to 60 cm) at 12 locations (PRDI-1 through PRDI-12). Samples will be analyzed for benzene, naphthalene, total cyanide, petroleum hydrocarbons, and TOC. The sediment material collected from each interval will not be homogenized prior to a sample being collected for benzene and gasoline-range petroleum hydrocarbon analysis as these analytes are volatile compounds and homogenization would affect the results. The sediment material collected from each interval will then be homogenized prior to samples being collected for naphthalene, total cyanide, diesel- and heavy oil-range petroleum hydrocarbons, and TOC.
- A sediment sample will be collected from shallow subsurface sediment (15 to 60 cm) 12 locations (PRDI-1 through PRDI-12) for grain size to provide data to estimate porosity and soil type for the purposes of cap modeling. The sediment material collected from the shallow subsurface interval will be homogenized prior to a sample being collected for grain size analysis.
- A porewater sample will be collected from a handheld PushPoint mini piezometer probe at 12 locations (PRDI-1 through PRDI-12) from the shallow subsurface sediment (15 to 60 cm) interval. The probe will be pushed into the sediment so that the screened portion of the probe is located in the central portion of the depth interval. The porewater will be drawn out of the push probe using a peristaltic pump and collected in containers for analysis of gasoline and diesel range-petroleum hydrocarbons, benzene, naphthalene, and total and WAD cyanide.

Sampling and analysis procedures for nearshore intertidal sediment and porewater are presented in greater detail in the SAP/QAPP included in Appendix A.

4.2. Intertidal Seepage Velocity Measurements

Modeling will be completed to support design of the nearshore intertidal cap to identify the appropriate components (e.g., cap amendments) to contain Site contaminants. The cap model requires input for seepage velocity of groundwater to surface water in the nearshore intertidal area where the cap will be placed at the approximate elevation range of 0 to +6 feet MLLW. Cap modeling incorporates seepage velocity and contaminant concentrations to estimate the contaminant mass flowing through cap material.

The nearshore intertidal area of the Site is exposed to dynamic conditions due to tidal effects, storm waves and seasonal changes to the groundwater table elevation. The groundwater seepage velocity will be measured in the field to provide empirical data for use in nearshore intertidal cap design. Additionally, groundwater seepage velocity may be estimated using nearshore intertidal sediment grain size results, upland soil type and groundwater elevation information to compare with the measured seepage velocity.

As part of the PRDI, seepage velocity tracer testing will be completed at four locations (SV-1 through SV-4, Figure 9) to measure the seepage velocity in the nearshore intertidal area and provide input into the intertidal cap design model. Tracer testing will be completed by injecting fluorescent dye into the sediment and timing the duration from injection to when the dye appears at the sediment surface. The tracer dye will be injected into the sediment using a PushPoint mini piezometer probe. A minimum of two additional duplicate tracer tests will be performed to evaluate the reproducibility of the tracer tests. Tracer testing procedures to estimate seepage velocity in the nearshore intertidal sediment area are presented in detail in the SAP/QAPP included in Appendix A.

5.0 INVESTIGATION TO SUPPORT REMAINING CAPPING AND NATURAL RECOVERY AREAS DESIGN

The cleanup action includes application of multiple capping and natural recovery methods in the remaining portions (i.e., areas beyond the nearshore intertidal cap area) of the Marine Unit. Capping will include a combination of conventional capping (2-foot-thick sand cap) and thin layer capping (1-foot-thick sand cap) to cap sediment with cPAH concentrations greater than the upper remediation level. Natural recovery will include a combination of ENR (placement of 6-inches of sand to speed up the natural recovery process in areas with cPAH sediment concentrations greater than the lower remediation level) and MNR. Surface sediment (0 to 12 cm) samples will be collected from the remaining portion of the Marine Unit at 17 sample locations (PRDI-13 through PRDI-29) and analyzed to further characterize cPAHs exceeding the lower and upper remediation levels. Additionally, surface sediment samples (0 to 12 cm) will be collected at three additional locations (PRDI-30, -34 and -35) where sediment cores will be completed (see Section 6.0). The results will be used to refine the limits of conventional and thin layer capping and where ENR and MNR will be applied as part of the cleanup action.

The objective of conventional and thin capping is to provide clean cap material in areas where cPAH surface sediment concentrations exceed the lower and upper remediation levels. The objective of natural recovery it to ensure that cPAH surface sediment concentrations meet the cleanup level within the restoration time frame. One of the goals of the PRDI is to refine the extent of conventional and thin layer capping and application of ENR and MNR. Additional surface sediment sampling and analysis for cPAHs is being performed to provide additional data to calculate SWACs to refine the extent of conventional and thin layer capping and application of ENR and MNR at the Site. As shown on Figure 10, surface sediment samples will be collected from a total of 20 locations for cPAH analysis. These sampling activities are expected to require federal permit approval and the period of activity will be limited to available in-water work windows. Permits and work restrictions are addressed in Section 8.0.

Samples will be collected using a Power Grab sediment sampler deployed from a marine research vessel. Each sample of surface sediment will be comprised of sediment from the surface to a depth of 12 cm. The surface sediment will be homogenized prior to a sample being collected for cPAH analysis. The surface sediment sampling and analysis procedures are presented in detail in the SAP/QAPP included in Appendix A.

6.0 INVESTIGATION OF COASTAL MARINE PROCESSES TO SUPPORT CAP DESIGN

A site-specific investigation of coastal marine processes will be performed as part of the PRDI. The objective of investigating coastal marine processes is to support the design of shoreline protection and the caps to be placed as part of the remedial action and to help determine where ENR and MNR will be applied. The coastal analysis methodology includes a review of studies performed for other Bellingham Bay sites, historic data analysis, additional data collection, and modeling. The investigation of coastal marine processes will include assessment of coastal geomorphology and assessment of the parameters that effect coastal engineering design for the Site caps and shoreline protection.

6.1. Coastal Geomorphology Assessment

The coastal geomorphology assessment will include an assessment of the change in Site bathymetry, investigation and evaluation of existing sediment deposits, and sampling and analysis for grain size and selected additional analytes to support dating of sediment deposition. An assessment of changes in Site bathymetry will be based on the comparison of the current and historical Site bathymetry. The stratigraphy, grain size, and depositional history of existing sediment deposits will be evaluated based on review of the previous investigation results for the Site and additional sediment coring and analysis. Dating of sediment deposition will be based on core sample collection and radiocarbon dating analysis and/or radioisotope analysis. This part of the study will provide baseline data and a fundamental understanding of the seabed stability and accretion (deposition) and erosion potential to assist with the cap design. The following sections provide additional detail for the various coastal geomorphology investigation activities.

6.1.1. Site Bathymetric Survey

An assessment of the historical changes in Site bathymetry will be performed to evaluate bathymetric changes over time and to assess the rate of accretion/erosion of sediment at the Site. The assessment of the historical changes in Site bathymetry is to be performed based on comparison of the current bathymetry to the historical Site bathymetry. The current bathymetry at the Site will be surveyed as part of the PRDI to support the assessment. The survey of the current bathymetry will also be used as the basis for development of the cleanup action design for the Marine Unit.

The bathymetric survey of the Site will be performed using both multibeam survey and topographic survey methods. The bathymetric survey will be performed using multibeam survey methods deployed from a marine vessel and will provide survey coverage for the areas accessible by the marine vessel. Along the shoreline, land-based topographic survey methods will used to survey the area where multibeam survey methods are not able to provide coverage due to vessel access (i.e., shallow water) as well as provide topographic survey where the Marine Unit and Upland Unit connect.

The multibeam survey will be performed in accordance with the U.S. Army Corps of Engineers (USACE), Engineering and Design Hydrographic Surveying Engineer Manual (EM 1110-2-1003). The land-based topographic survey will be performed in accordance with WAC 332-130 and other Washington State requirements for land surveys. The bathymetric and topographic surveys will be performed by a professional surveyor licensed in the State of Washington.

The multibeam survey will be scheduled to be performed during a high tide, to the extent practical, to provide the greatest coverage along the shoreline. Topographic survey of the shoreline will be performed at low tide using upland surveying methods. The results of the multibeam and topographic surveys will be combined to provide a complete bathymetric survey of the Site.

6.1.2. Core Sampling and Analysis to Assess Sediment Deposition

The depositional history of existing sediment deposits and potential for accretion and erosion will be evaluated based on the review of previous investigations of the Site and additional sediment coring and analysis that will be performed as part of the PRDI. A sediment core will be collected from eight locations (PRDI-30 through PRDI-37) generally positioned along two east-west transects extending from approximately MLLW to the western Site boundary (Figure 10). The sediment cores will be collected using vibracore sampling equipment deployed from a marine research vessel. The locations of each core will be recorded using the research vessel's GPS. The following observations and samples will be collected from each core location shown on Figure 10:

- Visual observations and sample collection for grain size analysis and sediment dating will be collected from one core advanced to a depth of approximately to 5 feet or refusal, at each location. The core will be capped and the undisturbed core will be delivered to Coastal Geologic Services (CGS) for inspection by a geotechnical engineer and principal engineering geologist who will perform preliminary visual classification of the sediment layers and stratigraphy and identify the depth intervals to be sampled for laboratory analysis.
- Samples will be collected from up to five depth intervals to characterize grain size of the sediment deposits and to perform radiocarbon dating analysis and/or radioisotope analysis to assess depositional history. Laboratory analyses will be performed by a laboratory licensed and accredited in the State of Washington.
- At five of the eight sediment core location (PRDI-31, -32, -33, -36 and -37) an additional sediment core will be completed to a depth of approximately 3 to 5 feet or refusal to sample discrete intervals and analyze for cPAHs. The objective of the cPAH sampling and analysis is to evaluate the existing concentration gradient of cPAHs in the surface and near surface sediment to inform how sediment deposition has affected the concentration of cPAHs in the upper sediment intervals. Sediment will be collected on 15 cm intervals generally estimating the interval that would be deposited over a 10-year timeframe (assuming a deposition rate of 1.5 cm per year) in the Marine Unit. Fifteen-centimeter sample intervals will be collected to a total depth of approximately 90 cm (3 feet). Samples will be collected from each 15 cm interval and homogenized prior to sample collection. The samples will be transported to a laboratory licensed and accredited in the state of Washington.

CGS will estimate recent sedimentation rates by analyzing the results of sediment dating versus sample depths and by comparing grain size distributions and sediment type observations from the proposed sediment cores and sediment cores collected in previous investigations (Herrenkohl & Landau 2010 and

Hart Crowser 2009), with consideration for any updated bathymetric survey information. The estimate of recent sedimentation rates will be considered against historically measured accretion and erosion rates within Bellingham Bay to identify design sediment accretion/erosion rates for different areas of the Marine Unit and a general concept of sedimentation patterns within the Site boundaries. The results of the assessment will be used to refine the limits of conventional and thin layer capping and where ENR and MNR will be applied as part of the cleanup action.

The sediment core sampling and analysis procedures are presented in detail in the SAP/QAPP included in Appendix A.

6.2. Assessment of Coastal Engineering Design Parameters

The assessment of coastal engineering design parameters will include the following:

- Review of previous coastal engineering assessments for sites in Bellingham Bay;
- Wind and wave conditions;
- Design water levels taking into account tides, storm surge and sea level rise (SLR) effects;
- Design currents based on past field data and data from past modelling studies; and
- Coastal wave modeling.

As part of the assessment of coastal engineering design parameters, previous coastal assessments for other cleanup sites in Bellingham Bay will be reviewed. The sites will include the Cornwall Avenue Landfill, Whatcom Waterway, and R. G. Haley.

The available data to be analyzed includes long-term wind data from the Bellingham Airport, the Pacific Northwest National Laboratory (PNNL) hindcast wave data (5-year time series), acoustic doppler current profiler (ADCP) current measurement data in Bellingham Bay. New bathymetry data and additional sediment sampling data are proposed to be collected for this study (discussed in previous sections).

The assessment will include identification of the MetOcean conditions to support the cap design. MetOcean conditions will be developed through utilizing existing data for extremal/reoccurrence analysis, and in reference/comparison to previous studies at other cleanup sites. The design parameters identified by this part of the assessment will include design wind and wave conditions, design water levels, and design currents. Localized wave modeling will be performed to identify the design wave conditions at different locations of the Site. The impact of future sea level rise will be taken into account in developing design water level conditions. The most recent city and state guidelines and relevant publications will be adopted for considering the effect of sea level rise. The risk of tsunami impacts and potential mitigation measures will be reviewed to support development of design parameter for the Site.

The assessment will include Site-specific wave modeling to identify wave conditions at the project Site. The USACE Coastal Monitoring System (CMS)-WAVE model or the equivalent, such as the Simulating WAves Nearshore (SWAN) model, will be adopted for the assessment. The type of spectral wave model(s) used is capable of modeling wind-fetch wave generation and wave transformation in the nearshore at the same time, taking into account both wave refraction and diffraction. The purpose of wave modeling is to determine the design wave conditions for assessing bed erosion potential and cap stability design.

7.0 PROCEDURES FOR THE INADVERTENT DISCOVERY OF CULTURAL RESOURCES

The PRDI includes ground disturbing activities within an area of potential historic archaeological resources. Previous cultural resources work was completed at the Site and according to a 2019 archaeological assessment, “past archaeological work in the local and regional area suggests the project area to be within an area of very high risk for historic archaeological resources” (Drayton Archaeology 2019). The 2019 archaeological assessment included a field visit and found no new cultural materials.

If potential archaeological resources are identified during the PRDI field investigation activities, work will be stopped immediately and the potentially liable parties (PLPs) notified. If it is determined that the discovery is not culturally significant, work activities will resume. In the unanticipated event of a potential archaeological discovery, the following steps shall be taken:

1. **Stop Work and Protect the Discovery Site –** If any GeoEngineers, PLP, agency, or subcontractor personnel believes that he or she has uncovered any cultural resources, all work within a minimum of 50 feet of the discovery (“discovery site”) will be stopped to provide for its total security, protection and integrity. The discovery site shall be secured, and vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site.
2. **Notify the PLPs –** The individual making the discovery will immediately contact GeoEngineers, Inc. (GeoEngineers) who will then notify the Project Coordinators for the PLPs (contact information presented in the table below).
3. **Identify the Find –** The PLPs will retain a Project Archaeologist on an on-call basis who will be responsible for ensuring that appropriate steps have been taken to protect the discovery site. The Project Archaeologist shall be qualified as a professional archaeologist under the Secretary of Interior’s Professional Qualification Standards (as outlined in 36 Code of Federal Regulation [CFR] Part 61). As such, the Project Archaeologist shall be qualified to examine the find to determine if it is archaeological. If it is determined not to be archaeological, work may proceed at the discovery site with no further delay.
4. **Notify Additional Parties –** If the discovery is determined by the Project Archaeologist to be a cultural resource, the PLPs or their designee will provide notification to Ecology, Department of Archaeology and Historic Preservation (DAHP), and the Samish and Lummi Tribes. Confidentiality of the find will be maintained by Project leads.
5. **Obtain Consent to Proceed with Investigation Activities –** Investigation work will not recommence at the discovery site until treatment has been completed and the Tribes, DAHP, and/or jurisdictional agencies, as appropriate, have provided written or verbal consent to proceed.

Contact information for key personnel for the inadvertent discovery of cultural resources is summarized in the following table.

CONTACT LIST FOR THE INADVERTENT DISCOVERY OF CULTURAL RESOURCES

Contact Name	Organization	Title	Contact Number
Neil Morton (Primary Contact)	GeoEngineers, Inc.	Project Manager	(o) 206.728.2674 (c) 206.818.4861
TBD (Alternate Contact)	GeoEngineers, Inc.	Field Coordinator	(o) 206.728.2674 (c) TBD

Contact Name	Organization	Title	Contact Number
Greg Andrina	PSE	Supervisor – Environmental Program	(o) 425.462.3198
Gina Austin	City of Bellingham	Park Project Engineer	(o) 360.778.7000
John Guenther	Ecology	Project Coordinator	(o) 360.255.4381
Stephanie Jolivette	DAHP	State Archaeologist	(o) 360.586.3080
Jackie Ferry	Samish Nation	Cultural Resources	(o) 360-293-6404
Lena Tso	Lummi Nation	Lummi Tribal Historic Preservation Office	(o) 360.384.2259

8.0 PERMITS AND AUTHORIZATIONS

Under RCW 70.105D.090, remedial actions conducted under a consent decree, order, or agreed order are exempt from the procedural requirements of Chapters 70.94, 70.95, 70.105, 77.55, 90.48, and 90.58 RCW, and the procedural requirements of laws requiring or authorizing local government permits or approvals for the remedial action. However, exempted remedial actions still must comply with the substantive requirements of these laws. These exemptions apply to the proposed sediment sampling activities. DNR has previously indicated that no authorization is necessary from DNR for sediment sampling conducted on state-owned land under a MTCA investigation. DNR will be contacted to confirm the applicable requirements for the proposed sampling in this work plan.

As stated under WAC 197-11-800(17), the proposed sampling activities are categorically exempt from State Environmental Policy Act (SEPA) review. In addition, under RCW 77.55.061, the proposed sampling activities are expected to be exempt from the procedural requirements of Chapter 77.55 RCW (Construction Projects in State Waters). In particular, the proposed sampling is not expected to require a hydraulic project approval from the Washington Department of Fish and Wildlife (WDFW) or a Shoreline Substantial Development Permit from the City of Bellingham, but sampling activities will meet substantive requirements of both permits. Following Ecology review of this Work Plan for compliance with the substantive requirements of Chapter 77.55 RCW, SEPA requirements for investigation activities will be evaluated further to meet substantive requirements.

Exemptions for activities conducted for a MTCA cleanup action do not apply for federal permits. Sediment investigations typically fall under the Nationwide Permit #6, which governs survey activities. Because of the federal nexus, a biological evaluation will likely be required to allow consideration of potential impacts to protected species and critical habitats. Accordingly, a Joint Aquatic Resource Permit Application (JARPA) will be completed to comply with federal regulations under the Clean Water Act and Endangered Species Act. The JARPA will also be used to coordinate with state and local agencies to identify substantive requirements for the investigation activities.

9.0 HEALTH AND SAFETY PLAN

Site cleanup-related activities need to be performed in accordance with the requirements of the Washington Industrial Safety and Health Act (RCW 49.17) and the federal Occupational Safety and Health Act (29 CFR 1910, 1926). These applicable regulations include requirements that workers are to be protected from exposure to contaminants. A HASP for project personnel implementing the field work is provided in Appendix B.

10.0 REPORTING

Following completion of investigation activities described in this work plan, a Pre-Remedial Design Investigation Data Report (PRDI Report) will be prepared that will describe the results of the investigation activities. In addition, the PRDI Report will describe the degree to which existing data gaps described in the sections above have been addressed and if further data gaps remain. The PRDI Report will also include conclusions regarding recommended modifications to the scope of the cleanup action, if any, as presented in the CAP.

11.0 SCHEDULE

The 2019 second amendment to the Agreed Order (AO 2nd Amendment) for the Site establishes a schedule for tasks associated with the CAP through cleanup action design. The schedule for specific project milestones going forward is provided in the following table. Ecology will be notified at the time unanticipated conditions or changed circumstances are discovered which might result in a schedule delay to implementation of the Work Plan. Any requests for a schedule extension will be undertaken as required by the Agreed Order.

PROJECT MILESTONES	SCHEDULE
Pre-Remedial Design Investigation	
Complete PRDI Field Work, Laboratory Analysis, and Data Validation	120 calendar days of Ecology's approval of the Final PRDI Work Plan. The schedule for completing the PRDI field work and surveys may be subject to regulatory constraints (e.g., fish window).
Draft PRDI Data Report	90 calendar days following availability of validated investigation data.
Final PRDI Data Report	60 calendar days following receipt of Ecology's final comments on the Draft PRDI Data Report.

12.0 REFERENCES

Anchor QEA 2015. Final Engineering Design Report, Whatcom Waterway Cleanup in Phase 1 Site Areas. February 2015.

Drayton Archaeology 2019. Archaeological Review for the City of Bellingham's South State Street Manufactured Gas Plant MTCA cleanup site, Bellingham, Whatcom County. DAHP Project Code: 2019-04-02701 ECY. April 30, 2019.

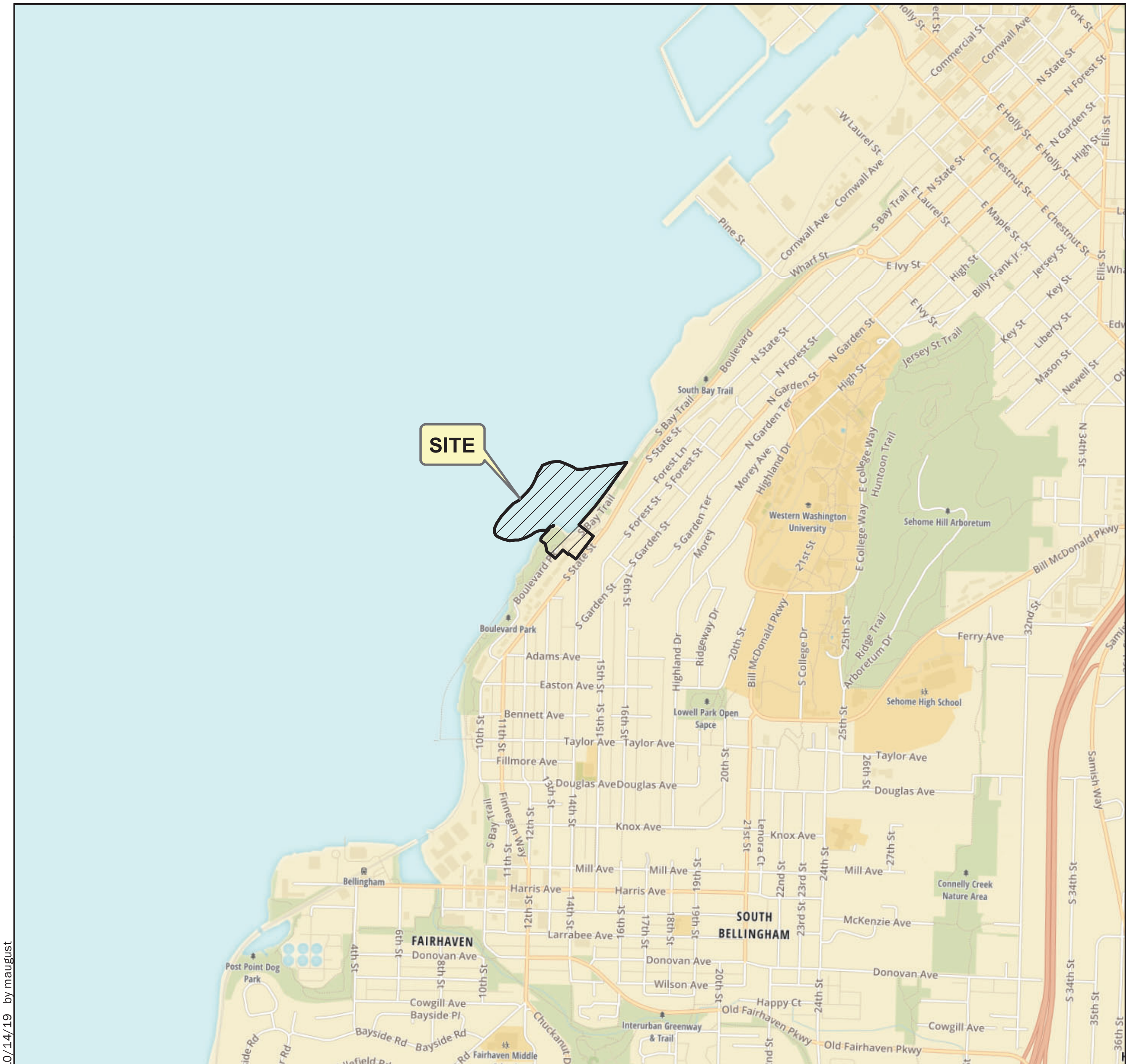
Ecology 2019. Second Amendment to Agreed Order No. DE 7655. Effective Date May 21, 2019.

Ecology 2020. Final Cleanup Action Plan, South State Street MGP Site, Bellingham, Washington.

Hart Crowser 2009. Sediment Site Characterization Evaluation of Bellingham Bay Creosote Piling and Structure Removal, Cornwall Avenue Landfill Mapping, Boulevard Park Overwater Walkway Feasibility, and Dioxin Background Sampling and Analysis, Bellingham, Washington. June 26, 2009.

Herrenkohl Consulting and Landau Associates 2010. Work Plan, South State Street Manufactured Gas Plant Remedial Investigation and Feasibility Study, Bellingham, Washington. August 6.

FIGURES



Legend

South State Street MGP Site

Project North

True North

2,000 0 2,000

Feet

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2017

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

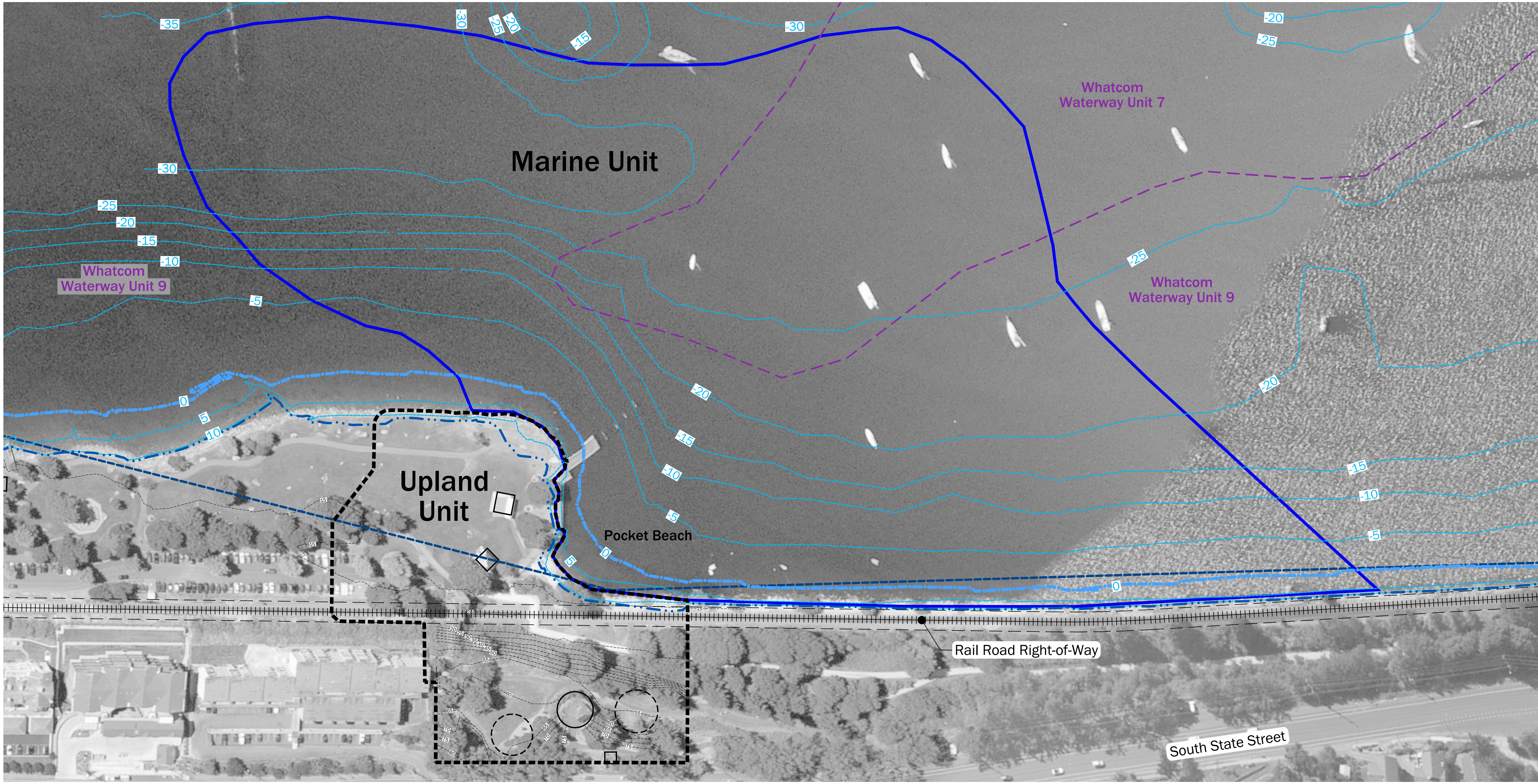
Vicinity Map

South State Street MGP Site
Bellingham, Washington

GeoEngineers

Figure 1

P:\0\0186890\GIS\MXDs\018689001_F01_VicinityMap_MGP.mxd Date Exported: 10/14/19 by maugust



Notes:
1. The locations of all features shown are approximate.
2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.

Projection: NAD83 WA State Planes, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Legend
- Marine Unit Boundary
- Upland Unit Boundary
- Inner Harbor Line
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- -15 Bathymetry Contours (5ft Interval - MLLW)
- 15 Topographic Contours (5ft Interval - MLLW)

W S N E
Project North

W N S E
True North

150 0 150
Feet

South State Street and Whatcom Waterway Site Units

SSS MGP Site
Bellingham, Washington

GEOENGINEERS

Figure 2

Legend

- Inner Harbor Line
- Upland Unit Boundary
- Marine Unit Boundary

Parcel Ownership

- Right-of-Way (ROW)
- Private Residence
- City of Bellingham
- BNSF Railway (BNSF)
- State Owned Aquatic Land (SOAL)

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Ownership information provided by Landau.
Aerial imagery provided by ERSI.

Projection: NAD83 WA State Plane, N Zone, US Foot

Project North

True North

80 0 80

Feet

South State Street Site and Property Ownership

SSS MGP Site
Bellingham, Washington

GeoEngineers

Figure 3

P:\0\0186890\GIS\MXDs\0186890001_F03_PropertyBoundaries.mxd Date Exported: 08/13/20 by maugust

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Aerial imagery provided by ESRI.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

- South State Street MGP Site
- Whatcom Waterway MTCA Cleanup Site Unit
- Other MTCA Cleanup Site

* The in-water portion of the Cornwall Avenue Landfill Site may be expanded in the future.

Project North   True North

1,000   0   1,000
Feet

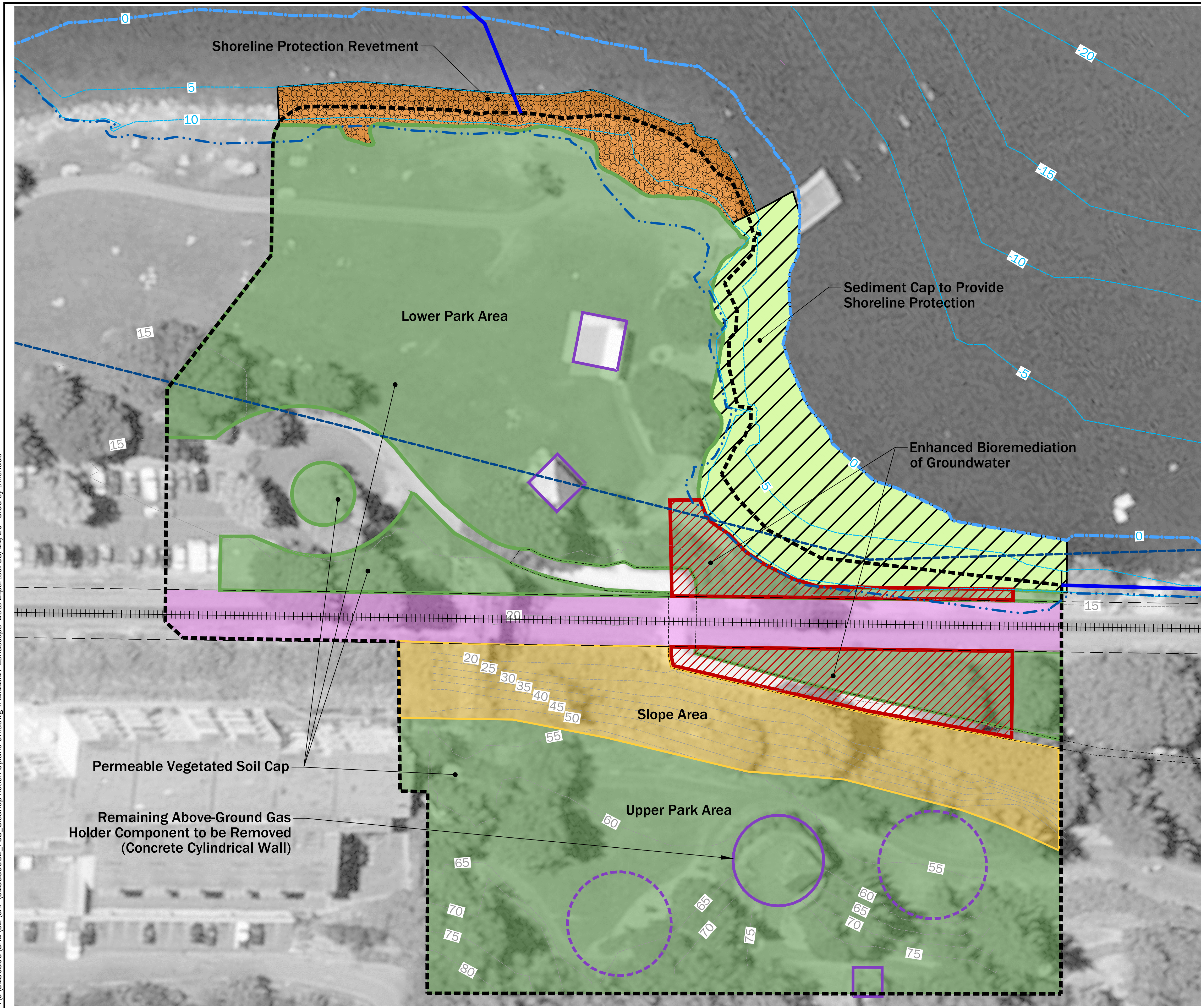
MTCA Cleanup Sites in Bellingham Bay

SSS MGP Site
Bellingham, Washington

GeoEngineers

Figure 4

P:\0\0186890\GIS\MXDs\018689001_Fig_04_MTCA_Sites.mxd Date Exported: 04/14/20 by maugust



Legend

- Permeable Vegetated Soil Cap
- Enhanced Bioremediation (Groundwater)
- Shoreline Protection Revetment
- Sediment Cap to Provide Shoreline Protection
- Slope Area - Monitor Vegetation and Slope Stability
- Railroad Right-of-Way Institutional Controls
- Site Structures
- Former Gas Holder
- Gravel Path
- -15 Bathymetry Contours (5ft Interval - MLLW)
- 15 Topographic Contours (5ft Interval - MLLW)
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- Inner Harbor Line
- Upland Unit Boundary
- Marine Unit Boundary

Notes:

1. The locations of all features shown are approximate.
2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.

Projection: NAD83 WA State Planes, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Project North   True North

60   0   60
Feet

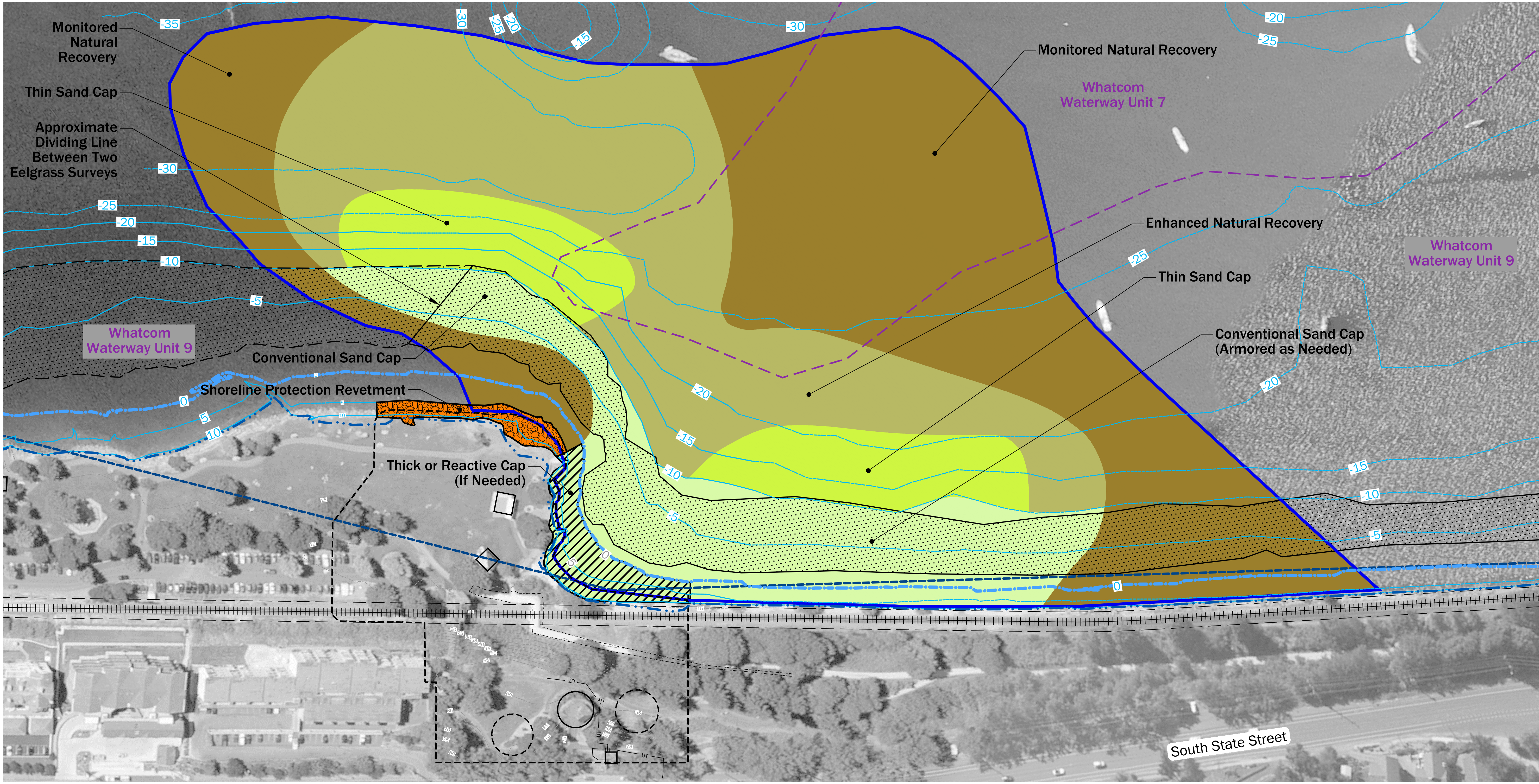
Cleanup Action Upland Unit

SSS MGP Site
Bellingham, Washington

GEOENGINEERS

Figure 5

P:\0\0186890\CAD\02\CAP\018689002_F05_Cleanup Action Upland Unit.dwg TAB:11x17 Landscape Date Exported: 08/11/20 - 9:56 by tmichaud



Legend

- Conventional Sand Cap (Armored as Needed)
- Cap Modification as Needed (Thick Cap or Reactive Cap)
- Thin Sand Cap
- Enhanced Natural Recovery
- Monitored Natural Recovery
- Shoreline Protection Revetment
- Marine Unit Boundary
- Upland Unit Boundary
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- -15 Bathymetry Contours (5ft Interval - MLLW)
- 15 Topographic Contours (5ft Interval - MLLW)
- Surveyed Extent of Eelgrass (Grette and Associates, 2008a and 2009)
- Estimated Extent of Eelgrass (Grette and Associates, 2008b)

150 0 150
Feet

Project North
True North

Notes:

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2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
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Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.

Projection: NAD83 WA State Planes, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Cleanup Action Marine Unit

SSS MGP Site
Bellingham, Washington

GeoEngineers

Figure 6

P:\0\0186890\CAD\02\CAP\018689002_F06_Cleanup Action Marine Unit.dwg TAB:11x17 Landscape Date Exported: 08/11/20 - 9:59 by tmichaud

Path: P:\0\0186890\GIS\MXDs\018689000_F07_PRDI_SoilLocations.mxd Map Revised: 13 August 2020 maugust

Site Features

- Railroad
- Topographic Contours (5ft Interval MLLW)
- Bathymetry Contours (5ft Interval MLLW)
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el 10.47' MLLW)
- Inner Harbor Line
- Site Structure
- Former Gas Holder
- Slope Area
- Upland Unit Boundary

Sample Location Type

- Proposed Shallow (2-foot) Soil Sample Location - Hand Auger Boring
- Proposed Soil Sample Location - Direct-Push Boring
- Proposed Soil Sample Location - Hollow Stem Auger Boring
- Existing RI Soil Sample Location - Borehole
- Existing RI Soil Sample Location - Hand Augered

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.
Projection: NAD83 WA State Plane, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Notes:
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2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
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Project North True North

60 0 60

Feet

Soil Sample Locations

SSS MGP Site
Bellingham, Washington

GEOENGINEERS

Figure 7

Path: P:\0\0186890\GIS\MXDs\018689000_F08_PRDI_DP_MW_GWLocations2.mxd Map Revised: 13 August 2020 maugust

Site Features

- Railroad
- Topographic Contours (5ft Interval MLLW)
- Bathymetry Contours (5ft Interval MLLW)
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- Inner Harbor Line
- Site Structures
- Former Gas Holder
- Slope Area
- Upland Unit Boundary

Sample Location Type

- Proposed Direct-Push Groundwater Sample Location
- Proposed New Monitoring Well
- Existing Monitoring Well
- Surface Water Outfall

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.
Projection: NAD83 WA State Plane, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Notes:
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3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Project North   True North

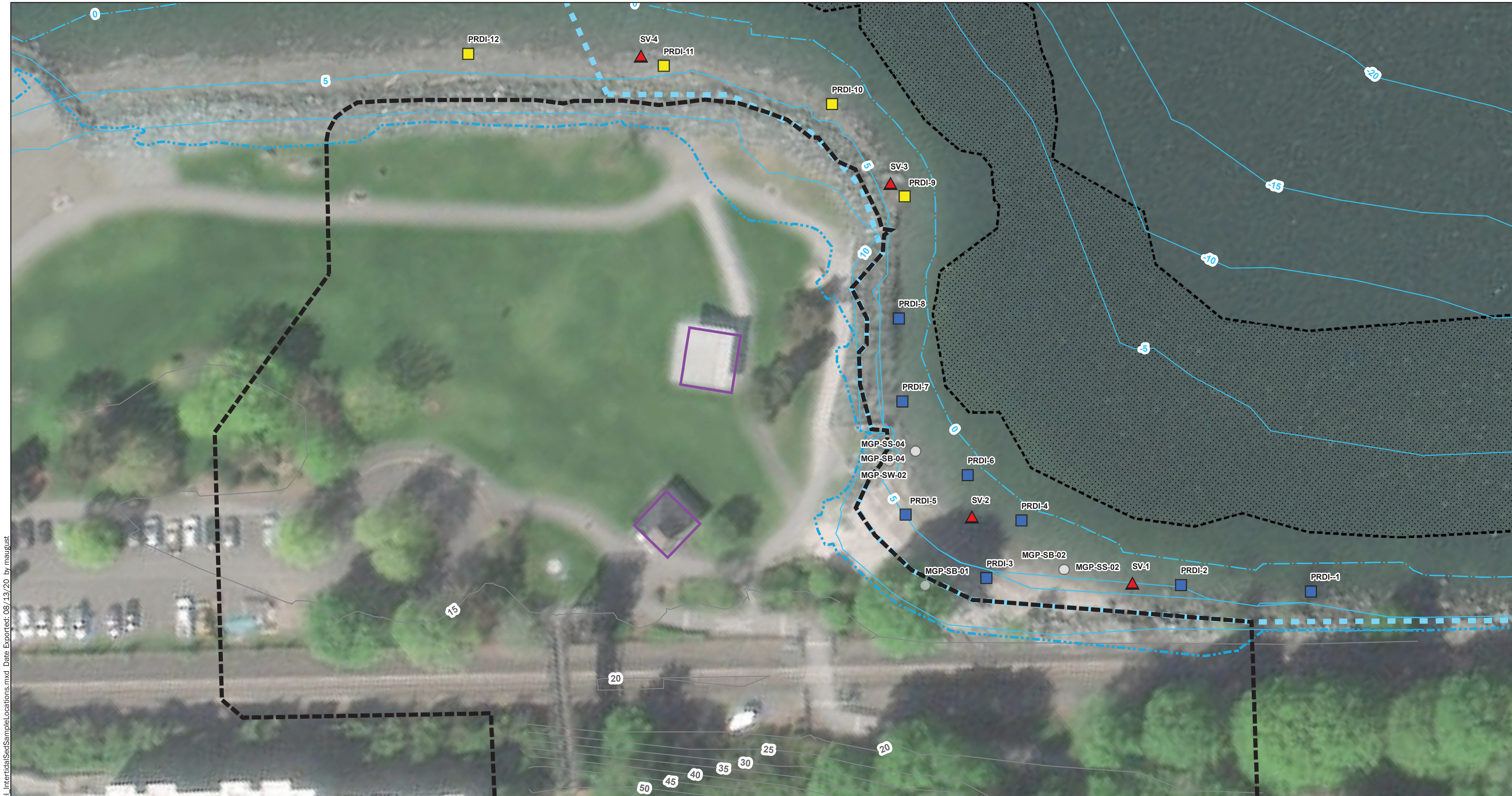
60   0   60
Feet

Groundwater Sample Locations

SSS MGP Site
Bellingham, Washington

GeoEngineers

Figure 8



Notes:
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2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.
Projection: NAD83 WA State Plane, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Legend

- Marine Unit Boundary
- Upland Unit Boundary
- Site Structure
- Surveyed Extent of Eelgrass (Grette and Associates, 2008a and 2009)
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- Topographic Contours (5ft Interval MLLW)
- Bathymetric Contour (5ft Interval MLLW)
- Proposed Sediment Location - Sediment Core and Porewater Samples
- Proposed Sediment Location - Surface Sediment, Sediment Core, and Porewater Samples
- Proposed Seepage Velocity Measurement Location
- RI Subsurface Sediment Sample Location

Project North

True North

50 0 50

Feet

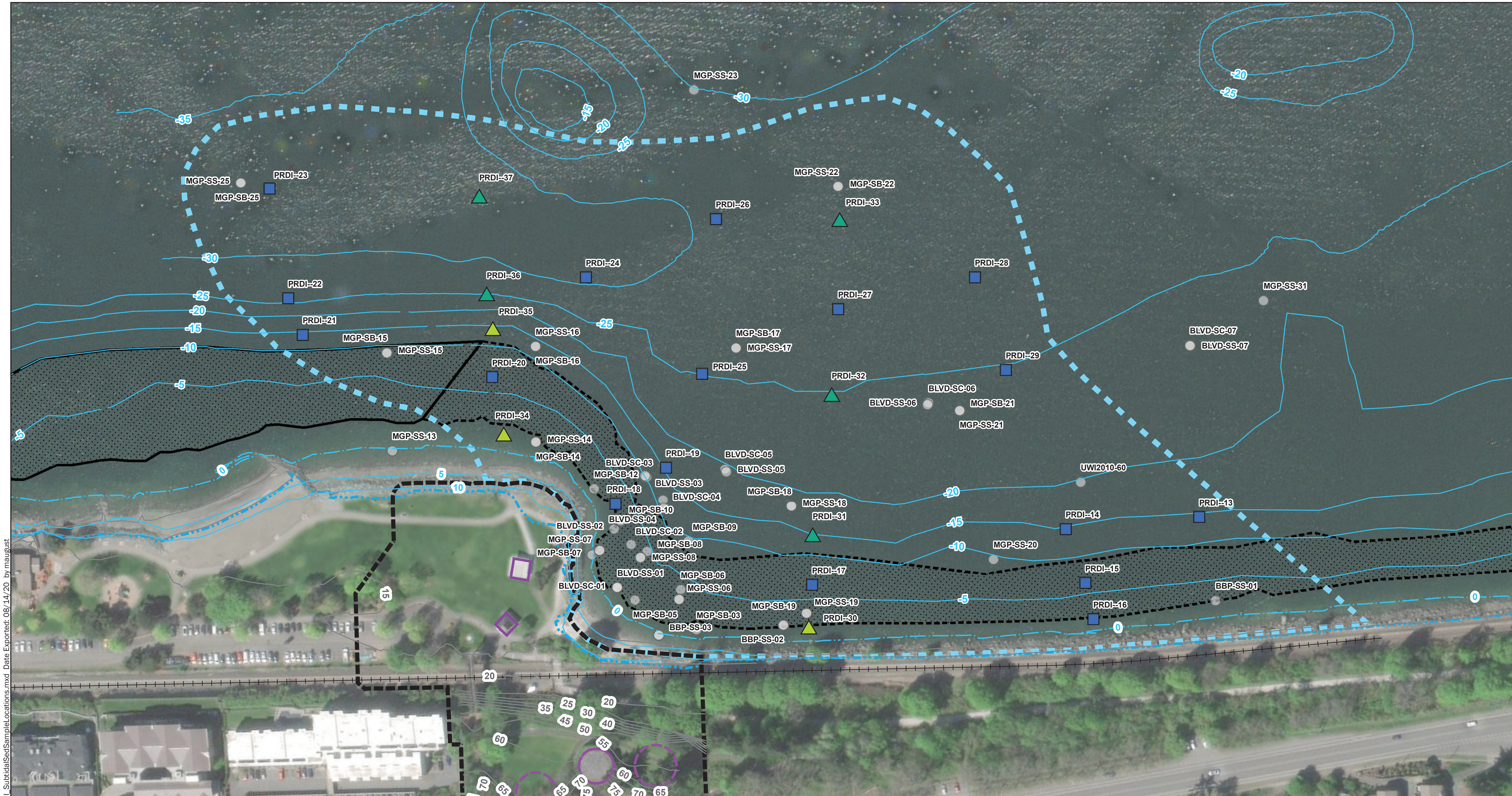
Intertidal Sediment Sample Locations

SSS MGP Site
Bellingham, Washington

GeoEngineers

Figure 9

P:\0\0186890\GIS\MXDs\018689000_F09_PRDI_IntertidalSedSampleLocations.mxd Date Exported: 08/13/20 by maugust



Notes:
1. The locations of all features shown are approximate.
2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.
Projection: NAD83 WA State Plane, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Legend

- Marine Unit Boundary
- Upland Unit Boundary
- Site Structure
- Former Gas Holder
- Estimated Extent of Eelgrass (Grette and Associates, 2008b)
- Surveyed Extent of Eelgrass (Grette and Associates, 2008a and 2009)
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- Topographic Contours (5ft Interval MLLW)
- Bathymetric Contour (5ft Interval MLLW)
- Proposed Subtidal Sediment Sample Location - Core Samples, Two Cores
- Proposed Subtidal Sediment Sample Location - Surface Power Grab Sample
- Proposed Sediment Sample Location - Core and Surface Grab Sample
- Existing RI Surface Sediment Sample Location
- Existing RI Subsurface Sediment Sample Location

Project North   True North

150   0   150
Feet

Subtidal Sediment Sample Locations

SSS MGP Site
Bellingham, Washington

GeoEngineers

Figure 10

P:\0\0186890\GIS\MXDs\018689000_F10_PRDI_SubtidalSedSampleLocations.mxd Date Exported: 08/14/20 by maugust

APPENDICIES

GeoEngineers

APPENDIX A
Sampling and Analysis Plan/ Quality Assurance Project Plan

Appendix A
Pre-Remedial Design Investigation Sampling and Analysis Plan/Quality Assurance Project Plan

South State Street MGP Site
Bellingham, Washington

for
Puget Sound Energy

October 30, 2020

GeoEngineers
Earth Science + Technology

Appendix A
Pre-Remedial Design Investigation Sampling and Analysis Plan/Quality Assurance Project Plan

South State Street MGP Site
Bellingham, Washington

for
Puget Sound Energy

October 30, 2020

GeoEngineers

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South State Street MGP Site Bellingham, Washington

File No. 0186-890-02

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LIST OF ABBREVIATIONS AND ACRONYMS

°C	degrees Celsius
%D	percent difference
AO	Agreed Order
ARI	Analytical Resources, Inc.
ASTM	ASTM International
bgs	below ground surface
bml	below mudline
CAP	Cleanup Action Plan
CFR	Code of Federal Regulations
CGS	Coastal Geologic Services
City	City of Bellingham
cm	centimeters
COC	chain of custody
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
DQOs	data quality objectives
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
Eh	redox potential
EIM	Ecology Information Management System
EPA	United States Environmental Protection Agency
GeoEngineers	GeoEngineers, Inc.
GPS	global positioning system
HASP	health and safety plan
HSA	hollow stem auger
HS	heavy sheen
IDW	investigation derived waste
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
LNAPL	light non-aqueous phase liquid
LOQ	limits of quantification
MDL	method detection limit
µL	microliters

mL	milliliters
MLLW	mean lower low water
MRL	method reporting limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MTCA	Model Toxics Control Act
MS	moderate sheen
mV	millivolts
NAVD88	North American Vertical Datum of 1988
NS	no sheen
NTU	nephelometric turbidity
OPR	Ongoing Precision and Recovery
OSHA	Occupational Safety and Health Act
PARCC	precision, accuracy, representativeness, completeness, and comparability
PID	photoionization detector
ppm	parts per million
PQL	practical quantitation limit
PRDI	Pre-Remedial Design Investigation
PSE	Puget Sound Energy
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCW	Revised Code of Washington
RI	Remedial Investigation
RPD	relative percent difference
RSD	relative standard deviations
SAP	Sampling and Analysis Plan
Site	South State Street Former Manufactured Gas Plant Site
SMS	Sediment Management Standards
SOP	standard operating procedures
SS	slight sheen
SVOCs	semi-volatile organic compounds
TOC	total organic carbon

TPH	total petroleum hydrocarbon
TPH-Gx	Gasoline total petroleum hydrocarbons
TRLs	target reporting limits
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
VOCs	volatile organic compounds
WAC	Washington Administrative Code
WAD	weak acid dissociable
WISHA	Washington Industrial Safety and Health Act

APPENDIX A
PRE-REMEDIAL DESIGN INVESTIGATION SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

1.0 INTRODUCTION

A Pre-Remedial Design Investigation (PRDI) is planned at the South State Street Former Manufactured Gas Plant Site (Site) in Bellingham, Washington to obtain additional data to support design of the cleanup action. The Site is generally located at Boulevard Park, south[1] of the downtown business district (Figure A-1). The Site is divided into an Upland Unit and Marine Unit, separated by the mean high tide line (Figure A-2). A Cleanup Action Plan (CAP) has been prepared that outlines the elements of the cleanup action for the Site. The cleanup action will be completed pursuant to requirements of the Washington State Model Toxics Control Act (MTCA) (Chapter 70.105D of the Revised Code of Washington [RCW] and Chapter 173-340 of the Washington State Administrative Code [WAC]) and Sediment Management Standards (SMS) (Chapter 173-204 WAC), Remedial design and permitting activities will be conducted under Amendment #2 of Agreed Order (AO) No. DE 7655, (Ecology 2019) between the Washington State Department of Ecology (Ecology), the City of Bellingham (City), and Puget Sound Energy (PSE).

This Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) (SAP/QAPP) serves as the primary guide for the integration of quality assurance (QA) and quality control (QC) functions for soil, groundwater, sediment, and sediment porewater sampling completed as part of this PRDI for the Site. This SAP presents the objectives, procedures, organization, functions, activities, and specific QA/QC activities designed to achieve the data quality objectives (DQOs) established for the project. Environmental measurements will be taken to produce data that are scientifically valid, of known and acceptable quality, and meet established objectives. QA/QC procedures will be implemented so that the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the data generated meet the specified DQOs to the maximum extent possible.

The QA/QC portions of this SAP/QAPP were prepared following the United States Environmental Protection Agency (EPA) Requirements for Quality Assurance Project Plans (EPA 2001), Guidance for Quality Assurance Project Plans (EPA 2002) and Ecology's Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology 2016). This SAP/QAPP has also been prepared in general accordance with requirements of the MTCA (Chapter 173-340 WAC) and SMS (Chapter 173-204 WAC).

2.0 STUDY DESIGN

Soil, groundwater, sediment, and sediment porewater will be sampled as part of the field activities for the PRDI. The objectives and how the data will be utilized for future design work is presented in the PRDI Work Plan. Table A-1 presents a detailed summary of the PRDI proposed sample locations, sample intervals and analytes. A summary of the proposed sample locations, collection, analyses, and sample designations is presented below for soil, groundwater, sediment, and sediment porewater. The subsequent sections detail field equipment and procedures to obtain the identified data.

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[1] All directions are referenced relative to "project north." The relationship between project north and true north is shown in the figures.

2.1. Soil Sampling and Analysis

2.1.1. Soil Sample Locations

Surface and shallow subsurface soil samples will be collected in the Upper Park Area for analysis of contaminants of concern. Continuous soil sampling will also be performed from direct-push and hollow stem auger (HSA) borings in the Lower Park Area to characterize the soil stratigraphy and presence of contamination. The soil boring locations and samples to be collected and analyzed are summarized in Table A-1. Soil sample collection will include the following:

- Collection of surface (0 to 1 feet below ground surface [bgs]) and shallow subsurface (1 to 2 feet bgs) soil samples using a hand auger at 20 locations (HA-15 through HA-34) shown on Figure A-3 and submitted for laboratory analysis of carcinogenic polycyclic aromatic hydrocarbons (cPAHs) using EPA Method 8270D-SIM. As indicated in Table A-1, surface samples and shallow subsurface samples are to be collected at 14 locations and only shallow subsurface samples are to be collected at six locations.
- Collection of continuous soil samples from 14 direct-push borings (GP-58 through GP-71) (Figure A-3) to log and field screen soil to characterize the stratigraphy and document evidence of contamination downgradient of the slope area and near the railroad tracks. No soil samples will be submitted for laboratory analysis at these locations.
- Collection of continuous soil samples from four (4) HSA soil borings (HSA-59 through HSA-62) to be completed as new monitoring wells to log and field screen soil for contamination and collect a soil sample from the midpoint of the well screen interval (Figure A-3). Four (4) soil samples will be collected, one from each well location, from the approximate middle of the well screen interval. Two shallow wells (HSA-59 and HSA-60) will be completed near the shoreline adjacent to existing deep monitoring wells MW-40 and MW-42, respectively. Two wells (HSA-61 and HSA-62) will be completed in the area upgradient of the pocket beach. The location of the wells upgradient of the pocket beach will likely be modified based on observations from the direct push borings to be completed upgradient of the proposed well locations. Soil samples collected from the borings to install the new monitoring wells will be submitted for a combination of the following laboratory analyses (Table A-1):
    - Metals including copper and iron using EPA Method 6010/6020;
    - Conventionals including total cyanide and total organic carbon (TOC) using methods EPA Method 9014 and SW 9060A, respectively;
    - Gasoline-, diesel- and oil- range petroleum hydrocarbons by NWTPH-Gx and NWTPH-Dx; and
    - Benzene and naphthalene using EPA Method 8260D.

The locations of soil borings shown on Figure A-3 are approximate and may be adjusted during investigation activities based on observations during field screening in adjacent borings or to avoid obstructions encountered during drilling.

Soil samples will be delivered to Analytical Resources Inc. (ARI) of Tukwila, Washington (an Ecology-accredited laboratory) for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-2). Laboratory QA/QC procedures will be verified following analysis in accordance with the Section 10.

2.1.2. Soil Sample Designation

The soil samples will be assigned a unique sample identifier. The sample boring designator will include the sampling method: hand auger (HA), Geoprobe (GP) or hollow stem auger (HSA), followed by the sample location number as presented in Table A-1 and shown on Figure A-3. The sample depth in feet bgs will be added following the sample location number.

For example, a Geoprobe soil sample collected from a depth of 4 to 8 feet bgs at direct-push boring location GP-1 would be designated as GP-1-4-8. The sample identification will be placed on the sample label, field report form, and chain-of-custody form.

2.2. Groundwater Sampling and Analysis

2.2.1. Groundwater Sample Locations

Groundwater samples will be collected for laboratory analysis from existing and new monitoring wells during two (2) Site-wide groundwater monitoring events and from direct push borings located below the slope area. The first Site-wide groundwater monitoring event will be conducted in the wet season (between December and March), the second Site-wide event will be conducted in the dry season (between July and September). The direct-push sampling will be completed during the wet season (between December and March), with a priority of completing the sampling during the wettest months (December and January) if possible. The locations of existing monitoring wells, the new wells, and the direct-push borings are identified on Figure A-4. The groundwater samples to be collected as part of each of the activities are identified in Table A-1. Groundwater sampling will include the following:

- Up to 14 grab samples from the direct push borings will be collected during a single event and submitted for laboratory analysis of:
    - Gasoline-, diesel, and oil-range petroleum hydrocarbons using NWTPH-Gx and NWTPH-Dx;
    - Benzene and naphthalene by EPA Method 8260D; and
    - Total and weak acid dissociable (WAD) Cyanide using EPA Method 9014 and SM4500, respectively.
- Two (2) groundwater sampling events will be completed to collect samples from 21 monitoring wells from across the Site for laboratory analysis of:
    - Gasoline-, diesel-, and oil--range petroleum hydrocarbons using NWTPH-Gx and NWTPH-Dx;
    - Benzene and naphthalene by EPA Method 8260D;
    - Total and WAD Cyanide using EPA Method 9014 and SM4500, respectively;
    - Metals including dissolved[2] iron, lead, and selenium, and total iron by EPA Method 6000/7000.
    - Nitrate and sulfate by EPA 353.2 and 375.2, respectively; and
    - TOC using Method SM5310B.

[2] Groundwater samples for dissolved metals will be field filtered.

Groundwater samples will be delivered to ARI of Tukwila, Washington (an Ecology-accredited laboratory) for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-3). Laboratory QA/QC procedures will be verified following analysis in accordance with the Section 10.

2.2.2. Groundwater Sample Designation

Groundwater samples collected as temporary well points from direct push borings will be assigned a unique sample identifier consistent with the soil boring name with "GW" and sample date. For example, a groundwater sample from boring GP-58 on September 9, 2020 would be identified as GP-58-GW-09092020.

Groundwater samples collected from monitoring wells will be assigned a unique sample identifier consisting of the well name and sample date. For example, a sample collected from monitoring well MW-07 on September 10, 2020 would be identified as MW-07-09102020. The sample names will be recorded in the field notes, on the sample label and on the chain-of-custody form.

2.3. Sediment and Porewater Sampling and Analysis

2.3.1. Sediment and Porewater Sample Locations

Sediment and porewater samples will be collected for laboratory analysis from the nearshore intertidal zone and sediment samples will be collected from the subtidal zone at the locations shown on Figures A-5 and A-6. The samples to be collected are identified in Table A-1.

2.3.1.1. Nearshore Intertidal Sediment and Porewater Sampling

At 12 nearshore intertidal sediment sample locations (PRDI-1 through PRDI-12) (Figure A-5), compliance zone, near surface, and shallow subsurface sediment samples will be collected with a hand auger or with hand tools from a shallow excavation. Sediment porewater samples will also be collected using a PushPoint™ (or similar) sampling device from each of these locations. Intertidal sediment and porewater sampling will include:

- At four nearshore intertidal sediment sample locations (PRDI-9 through PRDI-12) shown on Figure A-5, surface samples will be collected from the bioaccumulation compliance zone from 0 to 12 centimeters (cm) below mudline (bml) and direct contact compliance zone from 0 to 45 cm bml and analyzed for:
    - cPAHs by Method 8270D SIM.
- Near surface (0 to 15 cm) and shallow subsurface (15 to 60 cm) samples will be collected from locations PRDI-1 through PRDI-12 and analyzed for:
    - Gasoline-, diesel-, and oil-range petroleum hydrocarbons using NWTPH-Gx and NWTPH-Dx;
    - Benzene and naphthalene by EPA Method 8260D;
    - Cyanide by EPA Method 9014;
    - TOC by EPA Method 9060A; and
    - Grain size for shallow subsurface samples only using ASTM International (ASTM) D6913/7928.

- Sediment porewater samples will be collected from in-situ sediment at locations PRDI-1 through PRDI-12 and will be analyzed for:
  - Gasoline-, diesel-, and oil-range petroleum hydrocarbons using NWTPH-Gx and NWTPH-Dx;
  - Benzene and naphthalene by EPA Method 8260D; and
  - Total and WAD Cyanide using EPA Method 9014 and SM4500, respectively.

Porewater has not been collected at the nearshore intertidal area of the Site and the volume of porewater that is available to be extracted for each sample point is unknown. If the required porewater volume for the planned analyses is not obtained from the original sample location, additional location(s) will be attempted in the immediate vicinity (between 5 to 10 feet) from the original location. In the case that there still is not enough porewater volume, the Project Manager will be notified, and adjacent sample locations may be combined to allow for enough volume for the identified analyses. In this case the porewater results would represent a larger area of the nearshore intertidal for the purposes of design.

Nearshore intertidal sediment and sediment porewater samples will be delivered to ARI of Tukwila, Washington (an Ecology-accredited laboratory) for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-4 for sediment and Table A-3 for porewater). Laboratory QA/QC procedures will be verified following analysis in accordance with the Section 10.

2.3.1.2. Subtidal Sediment Sampling

Subtidal sediment sampling will consist of collecting surface samples using power-grab methods and sediment cores using vibracore methods from a marine research vessel at locations shown on Figure A-6. Subtidal sediment sampling will include:

- Seventeen (17) surface sediment locations (PRDI-13 through PRDI-29) will be collected from the subtidal zone using a power-grab at the locations shown in Figure A-6. Samples will be collected from the compliance zone of 0 to 12 cm bml and will be submitted for laboratory analysis of:
  - cPAHs by Method 8270D SIM; and
  - Grain size at selected locations (see Table A-1) using ASTM D6913/7928.
- Eight (8) sediment core locations (PRDI-30 through PRDI-37) will be completed to approximately 5 feet bml, the core will be recovered and core ends will be capped, and the cores will be transported to Coastal Geologic Services (CGS) to provide data for the purpose of assessing sedimentation rates.
  - Grain size analyses will be completed on selected intervals using ASTM D6913/7928 based on the lithology observed in the core.
  - Intervals may be selected and submitted for radiocarbon dating analysis using Accelerator Mass Spectroscopy and/or radioisotope analysis using Alpha Spectroscopy based on the lithology of the core to assess depositional history.
- At 3 of the 8 sediment core locations (PRDI-30, -34, and -35) a surface sample (0-12 cm) will be collected and submitted to a laboratory for analysis of:
  - cPAHs by Method 8270D SIM.
- At 5 of the 8 sediment core locations (PRDI-31, -32, -33, -36 and –37) an additional sediment core will be completed to approximately 3 to 5 feet bml and samples will be collected of near surface sediment at 15 cm intervals and submitted to a laboratory for analysis of:
  - cPAHs by Method 8270D SIM.

Subtidal sediment samples for cPAH and grain size analyses will be delivered to ARI of Tukwila, Washington (an Ecology-accredited laboratory) for analysis on a standard turn-around time in accordance with sample handling procedures (see Table A-4). Laboratory QA/QC procedures will be verified following analysis in accordance with the Section 10. Subtidal samples for radiocarbon dating analysis will be submitted to DirectAMS of Bothell, Washington. Subtidal samples for radioisotope analysis will be submitted to Chronos Scientific, Inc. of Ottowa, Ontario, Canada.

2.3.2. Sediment and Porewater Sample Designation

2.3.2.1. Nearshore Intertidal Sediment Sample Designations

Discrete sediment samples collected from the nearshore intertidal zone will be assigned unique sample identifiers consisting of the sample location number, sample type and depth interval in cm bml. The sample type will be one of the following:

- Surface Sample (SS) for surface samples representing the bioaccumulation compliance zone collected from 0 to 12 cm bml.
- Sediment Core (SC) for samples collected from a hand auger or excavation, if a hand auger is not effective, from 0 to 60 cm bml.

For example, a sample collected from PRDI-1 from 0 to 45 cm bml using a hand auger or excavation would be identified as PRDI-1-SC-0-45. Note that for the nearshore intertidal sample locations, surface (SS), sediment core (SC), and porewater (PW) designations will be used for samples at the same location.

Discrete sediment porewater samples collected from the nearshore intertidal zone of the Marine Unit will be designated with the sample location followed by "PW" and the sample collection date. For example, a sample collected from PRDI-PW-1 on September 1, 2020 would be identified as PRDI-1-PW-09012020.

2.3.2.2. Subtidal Sediment Sample Designations

Discrete sediment samples collected from the subtidal zone of the Marine Unit will be assigned unique sample identifiers consisting of the sample location number, sample collection method [surface sample (SS) or subsurface core (SC)] and depth in cm bml. The sample type will be one of the following:

- Surface Sample (SS) for surface samples collected from a Power Grab sampler representing the bioaccumulation compliance zone collected from 0 to 12 cm bml.
- Sediment Core (SC) for samples collected from a vibracore from 0 to 90 cm bml for evaluation of cPAH concentrations or from 0 to 5 ft bml for sediment cores capped and delivered to CGS.

For example, a sample collected from PRDI-13 from 0 to 12 cm bml using a Power Grab sampler would be identified PRDI-13-SS-0-12. Another example for a sample collected at PRDI-30 from 15 to 30 cm bml for analysis of cPAHs using a vibracore sampling device would be identified PRDI-30-SC-15-30.

The sample names will be recorded in the field notes, on the sample label and on the chain-of-custody form.

2.4. Site Survey

After field sampling activities are completed, a detailed topographic survey of the Upland Unit will be conducted by a licensed surveyor to support remedial design. A licensed surveyor will also measure the top of casing elevations for the newly installed monitoring wells in the Upland Unit. Other upland site features including but not limited to existing site buildings, surface conditions (i.e., grass, gravel, asphalt, etc.) and existing public utilities and associated structures (i.e., manholes, catch basins, etc.) will be documented in the topographic survey.

A licensed surveyor will also conduct a multibeam bathymetric survey of the Marine Unit. The bathymetry survey will support remedial design of the Marine Unit.

3.0 UPLAND AREA FIELD SAMPLING EQUIPMENT AND PROCEDURES

The following sections summarize sample collection procedures for the PRDI. Table A-1 and PRDI Work Plan provide additional rationale and details for the planned sampling objectives and analytical program.

3.1. Underground Utilities Clearance

Prior to beginning subsurface investigations in the Upland Unit, the exploration locations will be marked in the field using stakes, white marking paint or similar techniques. The following general procedures will be followed for utility clearances.

- Locations of proposed explorations will be visually observed to determine whether debris or other objects may need to be removed prior to drilling.
- Location coordinates of the proposed explorations will be determined using a portable global positioning system (GPS) unit.
- GeoEngineers, Inc. (GeoEngineers) will contact the Utilities Underground Location Center (1-800-424-5555) at least 48 hours prior to intrusive activities to arrange for location of underground utilities.
- GeoEngineers will coordinate with the City to obtain as built drawings of existing park utilities (if available) prior to intrusive subsurface activities.
- GeoEngineers will subcontract a commercial utility locating service to mark underground utilities in the vicinity of planned exploration locations prior to intrusive subsurface activities.

The exploration locations may be modified as necessary, to stay clear of utilities.

3.2. Soil Boring Methods

Drilling activities will conform to State and local regulations including Chapter 173-160 WAC, *Minimum Standards for Construction and Maintenance of Wells*. Drilling activities for the PRDI will be completed by direct-push drilling and hollow-stem auger drilling methods by a licensed drilling contractor.

Subsurface debris or structures may be encountered, resulting in drilling refusal. If refusal is encountered, the exploration will be relocated as close to the originally planned location as practical and based on field conditions and other considerations at the time of the work.

3.2.1. Direct-Push Borings

Soil borings will be advanced using direct-push methods to hydraulically drive a probe from the ground surface to required depths. The direct-push borings will be advanced to a target depth of approximately

15 feet bgs at locations GP-58 through GP-71. Soil cores will be collected continuously to the total depth of each boring. A continuous core will be collected by driving and retrieving a 5-foot long sample rod to the total depth of each boring. The probe rod will be lined with a disposable acetate sleeve that will be removed and opened to observe, log and field screen the core material after each 5-foot sample interval is driven. The cores will also be observed for the presence of saturated soil to identify the saturated soil thickness above the bedrock at each location. A portable GPS unit will be utilized to collect the coordinates of the soil boring location.

3.2.2. Hollow-stem Auger Borings

Soil borings for proposed wells MW-59 and MW-60 as shown on Figure A-3 (near MW-40 and MW-42, respectively) will be advanced to a depth of approximately 18 feet bgs using hollow-stem auger drilling methods. The monitoring well screen will be placed from approximately 6 feet to 16 feet bgs. One soil sample will be collected for chemical analysis from the approximate middle (approximately 10 to 12 feet bgs) of the monitoring well screened interval (Table A-1).

Soil borings for proposed wells MW-61 and MW-62 upgradient of the pocket beach are shown as approximate locations on Figure A-3. The soil borings will be completed to the depth of bedrock (expected to be approximately 10 to 15 feet bgs) and the well screen will be placed from bedrock to approximately 1 foot above the observed groundwater table. One soil sample will be collected from the approximate middle of the well screen interval. For example, if bedrock is encountered at 14 feet bgs and the groundwater table is at 6 feet bgs the monitoring well screen will be placed from 5 to 14 feet bgs and a sample will be collected at approximately 9 to 10 feet bgs.

Soil samples for the hollow-stem auger borings will be collected using an 18-inch long split-spoon sampler. Soil cores will be collected continuously for field screening and lithologic description at each new monitoring well location. Temporary monitoring wells will be installed at each hollow-stem auger boring as described in Section 3.4.

3.3. Soil Sampling

Soil samples will be collected from borings for lithologic logging and chemical analysis by removing representative material volumes from the sampling chamber. The samples to be submitted for chemical analysis will be placed into laboratory-supplied containers, lightly packed and capped with a lid. The sand-sized and finer fractions of the soil will be targeted for collection. Foreign material including debris and surface pavement that can be physically excluded from the in-situ matrix will not be sampled.

The soil samples will be selected in general accordance with Table A-1 and based on subsurface conditions and field observations at the time of the work. The number of samples selected for chemical analysis and sample depth intervals may be further adjusted based field conditions and observations.

Soil samples will be collected in labeled, pre-cleaned sample bottles provided by the analytical laboratory in accordance with Table A-2. The samples will be placed in containers with ice and delivered under chain-of-custody protocols to the analytical laboratory for analysis of constituents listed in Table A-1.

Reusable equipment used to obtain soil samples will be decontaminated prior to each use using an aqueous Alconox® or Liqui-Nox® solution and a distilled water rinse as described in Section 5.0.

3.4. Temporary Monitoring Well Installation

Temporary monitoring wells will be installed at sample locations GP-58 through GP-71 to collect discrete groundwater samples after soil is collected from each location to characterize the stratigraphy, document evidence of contamination, and measure the saturated thickness above bedrock. Groundwater samples will be collected adjacent to each soil boring using a groundwater sampler consisting of a 4-foot long, wire-wrapped, stainless-steel screen (0.010-inch slot size) with a retractable protective steel sheath. The groundwater sampler will be advanced with the direct-push (Geoprobe) drilling rig to the desired sample depth and the protective sheath will be retracted to expose the stainless-steel screen to the formation. The groundwater sample points will be completed within 5 feet of the direct push soil boring location.

Low-flow purging will be performed for approximately 10 minutes or until the purge water is clear using a peristaltic or bladder pump. During purging, water quality parameters (see below) will be measured using a flow-through cell and recorded on a field sample collection form. Groundwater samples will be collected directly into the appropriate sample containers using disposable polyethylene tubing and a peristaltic pump. Samples will be placed in a cooler immediately after collection for transport to the laboratory for analysis.

The following procedures will be used for collection of discrete groundwater samples using direct push methods:

1. The screen will be placed based on observations from the soil boring at the location. The top of the 4-foot long screen will be placed at the top of the water table using the direct push drill rig.
2. The protective steel sheath will be retracted to expose the temporary well screen.
3. The water level will be recorded as well as the total depth of the temporary well.
4. Groundwater samples will be collected with a peristaltic pump. The sample tubing will be inserted down into the temporary well so that it enters the screen interval and is set 1 to 2 inches above the bottom of the screen interval.
5. After the tubing is at the appropriate depth, groundwater will be extracted to purge the well. Groundwater will be extracted until the water is clear or for up to approximately 10 minutes at low flow groundwater sampling flowrates (approximately 250 to 500 milliliters (mL) per minute).
6. Water quality parameters (pH, temperature, dissolved oxygen, redox potential, conductivity and turbidity) will be collected and recorded while purging groundwater using a portable water quality meter in a flow through cell. The portable water quality meter will be calibrated in accordance with manufacturer specifications prior to use.
7. Groundwater samples will be collected into appropriate sample containers provided by the laboratory.
8. Following sample collection, decontaminate the well screen, sampling equipment and drilling equipment before advancing the equipment to the next sample location.
9. Document field activities and field measurements collected during groundwater sampling activities in the field logbook and groundwater sample field form.

If temporary monitoring wells do not produce an adequate volume of water to complete the analyses identified in Table A-1, the Project Manager will be notified and groundwater from multiple adjacent locations may be combined to collect sufficient volume for analysis and for the purposes of design.

3.5. New Monitoring Well Installation

New groundwater monitoring wells will be installed along the shoreline and upgradient of the pocket beach using hollow-stem auger drilling methods. The planned locations of the new wells are shown on Figure A-4. Monitoring well construction details will be recorded on field forms/logs. Well construction elements are discussed below.

Well Identification	Approximate Bottom Depth (ft bgs)	Approximate Screened Interval (ft bgs)	Description for Placement
MW-59 and MW-60	18	6 to 16	Wells to be screened across the groundwater table (approximately 8 feet bgs) using a 10-foot-long screen.
MW-61 and MW-62	14	5 to 14	Wells to be screened from the bedrock to approximately 1-foot above the estimated seasonal high groundwater elevation. Well locations may be modified based on visual observation of upgradient direct push borings.

3.5.1. Well Casing

The monitoring well will be constructed using 2-inch diameter, Schedule 40, threaded, polyvinyl chloride (PVC) casing that meets the following requirements: 1) casing will be new (unused); 2) glue will not be used to join casing sections; casing sections will be joined only by tightening the threaded sections; and 3) casing will be straight and plumb.

3.5.2. Well Screen

New monitoring wells MW-59 and MW-60 will be constructed with a screened interval of 10 feet in length set across the upper saturated zone and positioned from approximately 6 to 16 feet bgs. This screened interval is targeting the upper section of the shallow groundwater table to supplement the existing well pairs MW-40 and MW-42 that have wells screens completed to deeper depths (30 to 35 feet bgs). The well screen will consist of 2-inch diameter, Schedule 40, 0.010-inch or 0.020-inch machine-slotted, PVC well screens. A PVC end cap will be installed on the bottom of the well screen.

The new monitoring wells MW-61 and MW-62 will be constructed with a screened interval extending from bedrock (approximately 10 to 15 feet bgs) to 1 foot above the estimated seasonal high groundwater elevation, the depth of which will be dependent on the final location of the well. Similar to MW-59 and MW-60, the well screens for MW-61 and MW-62 will consist of 2-inch diameter, Schedule 40, 0.010-inch or 0.020-inch machine-slotted, PVC well screens with an end cap installed on the bottom of the well screen.

3.5.3. Filter Pack

The filter pack for the new wells will consist of silica sand with the appropriate grain size distribution to reduce the entry of fine-grained particulates from the surrounding formation into the wells (e.g., 10-20 or 20-40 sand). The filter pack will extend from the bottom of the well screen to at least 1 foot above the top of the well screen. The top of the sand pack will be sounded to verify its depth during placement.

3.5.4. Annular Seal

The annular seal will consist of a minimum 1-foot thick layer of hydrated bentonite pellets or chips installed between the filter pack and the concrete surface seal.

3.5.5. Surface Completion

The new monitoring wells will be completed with a flush-mount monument. The well casing will be cut approximately 3 inches bgs, and a locking J-plug (compression) or similar well cap will be installed to prevent surface water from entering the well. The well monument will be installed in a concrete surface seal. The well number will be marked on the well monument lid and/or the well cap. The new monitoring well will be secured with a corrosion-resistant lock as soon as possible after drilling.

3.6. New and Existing Monitoring Well Development

New monitoring wells will be developed no sooner than 24 hours after installation to allow the surrounding water-bearing zone to recover after well installation and allow the bentonite annular seal to cure. Monitoring wells to be sampled during the Site-wide groundwater monitoring event will be redeveloped before sampling. Groundwater sampling will be conducted no sooner than 48 hours after well development.

Before each well is developed, the depth to water in the well and the total well depth will be measured, and the well will be checked for the presence of light non-aqueous phase liquid (LNAPL). Based on the findings of the Remedial Investigation (RI) report, LNAPL is not expected to be encountered in the monitoring wells (Landau and GeoEngineers 2019). Monitoring wells with a measurable thickness of LNAPL, if encountered, will not be developed or sampled. The new and existing monitoring wells will be developed using a combination of surging and purging. The wells will be purged until at least five well casing volumes have been removed and turbidity has stabilized. The target turbidity is less than 10 nephelometric turbidity units (NTU) but may not be achieved in all wells. Water quality parameters (e.g., temperature, pH, conductivity, turbidity) will be measured and recorded on field logs during well purging.

3.7. Groundwater Sampling

A total of 21 wells are identified for the Site-wide groundwater monitoring events as listed in Table A-1 and shown on Figure A-4. Two rounds of groundwater sampling will be completed: one round in the dry season, between July and September, and one round in the wet season, between December and March. Samples collected from the monitoring wells will be analyzed for total petroleum hydrocarbon (TPH), cPAHs, volatile organic compounds (VOCs), ferrous iron, total and WAD cyanide, nitrate, sulfate, and TOC as noted in Table A-1. Prior to sampling, each of the existing monitoring wells will be inspected for signs of tampering or other damage. If tampering is suspected (i.e., casing is damaged, lock or cap is missing), this will be recorded in the field report and on the well sampling form and reported to the Project Manager.

Groundwater monitoring activities will be recorded in field reports, and well purging/sampling data will be recorded on groundwater sampling forms. The following sections describe the activities to be conducted during the groundwater monitoring event.

3.7.1. Well Purging Prior to Sampling

Monitoring wells will be purged prior to sampling using low-flow methods to evacuate standing water in the well that may not be representative of groundwater in the surrounding formation. Before the start of purging/sampling activities, plastic sheeting will be placed on the ground surrounding the well, if necessary, to provide a clean working area around the well and to reduce the possibility of soil contaminants contacting groundwater sampling equipment.

Well purging will be accomplished using new dedicated tubing and a portable peristaltic pump, submersible pump, or bladder pump. The pump intake will be placed near the middle of the well screen interval, and the well will be purged at a target rate of 250 to 500 mL per minute. A flow-through cell and portable water quality meter(s) will be used to monitor water quality parameters during purging. The wells will be purged until water quality parameters have stabilized. Stabilization goals are as follows:

- Temperature ± 1°C
- pH ± 0.1 pH units
- Salinity and/or conductivity/specific conductance ± 3 percent
- Dissolved oxygen ± 0.3 milligrams per liter
- Redox potential (Eh) ± 10 millivolts (mV)
- Turbidity <10 NTU (if 10 NTU cannot be achieved, then ± 10 percent)

The portable water quality meter will be calibrated in accordance with manufacturer specifications prior to use.

3.7.2. Groundwater Sample Collection

Groundwater samples will be collected after water quality parameters have stabilized as discussed above. The samples will be collected using a peristaltic pump, submersible pump, or bladder pump and analyzed for the constituents listed in Table A-1. Groundwater samples will be collected in labeled, pre-cleaned sample bottles provided by the analytical laboratory. The sample containers will be retained on ice and delivered under chain of custody to the analytical laboratory. Required sample containers, preservation methods, volumes, and holding times are summarized in Table A-3.

Reusable sampling equipment will be decontaminated prior to commencing sampling activities and between each well following decontamination procedures described in Section 5.3.

4.0 MARINE UNIT FIELD SAMPLING EQUIPMENT AND PROCEDURES

The PRDI includes sediment sampling activities in the Marine Unit to support design of the sediment caps and to refine the area where natural recovery will be applied.

4.1.1. Nearshore Intertidal Sediment Sampling

Within the nearshore intertidal area, samples will be collected at 12 locations as shown in Figure A-5 to support the design of the nearshore intertidal sediment cap to be constructed as part of the cleanup action. The sediment samples to be collected and analyzed at each of the 12 locations includes:

- A sample from the near surface (0 to 15 cm bml) and shallow subsurface (15 to 60 cm bml) depth intervals.
- A sediment porewater sample from the shallow subsurface (15 to 60 cm bml zone) depth interval.

At four locations (PRDI-9 through -12) additional sediment samples will be collected and analyzed including:

- A surface sediment sample from the direct contact compliance zone (0 to 45 cm bml).
- A surface sediment sample from the bioaccumulation compliance zone (0 to 12 cm bml).

Hand auger and/or hand tool excavation methods will be used to collect sediment material for sampling and analysis. Armor rock and other larger rock (cobble and gravel) exist in the intertidal beach area of the proposed sample locations. Sample locations may be modified in the field to access areas that are feasible for collecting samples in accordance with standard procedures as described below. A portable GPS unit will be used to collect the coordinates of the nearshore intertidal sediment sampling locations.

4.1.1.1. Surface Direct Contact Compliance Zone Sediment Sampling

Surface samples will be collected utilizing a hand auger at the 4 sampling locations (PRDI-9 through PRDI-12). Surface samples will be collected to represent the direct contact compliance interval for the intertidal marine area that is from 0 to 45 cm (approximately 18 inches) below mudline. Sampling will be completed when the tidal elevation is below the sample location elevation. A decontaminated hand auger will used to collect the sample 0 to 45 cm. The nearshore intertidal area is comprised of armoring and rock of various sizes. Rock, or other debris if present, will be temporarily removed from the sample location, as necessary, to complete the hand auger borings if possible. If use of a hand auger is not feasible due to the presence of rocks at the proposed sample location, the sample location may be adjusted in the field and/or alternative methods such as using hand tools to dig an excavation to the target depth will be used. The sample location may be adjusted within an approximate 10-foot radius of the proposed location to complete the sampling. If an excavation is required due to refusal using the hand auger, samples will be collected from the sidewall(s) of the excavation to obtain samples representative of the target sample interval. If it is not feasible to collect a sample from the proposed location due to obstruction(s), the Project Manager shall be notified.

Sample material will be visually classified in accordance with ASTM D 2488 methods and the Unified Soil Classification System (ASTM D 2487) and recorded on a field log and the material will be photographed. In addition to the visual classification, sediment samples will be observed for biota, debris including wood debris, and potential presence of contamination including staining. If wood debris is present, the type or types of wood debris (i.e., saw dust, bark, chips, chunks, twigs, fibers, etc.), the estimated quantity (i.e., observed percent by volume) of each type of wood debris, and the depth interval where the wood is observed will be recorded on the field log.

First discrete samples for volatile analysis (gasoline total petroleum hydrocarbons [TPH-Gx] and VOCs) using EPA Method 5035 will be collected from in-situ sediment. Sediment from 0 to 45 cm for other analyses will be placed in a stainless-steel bowl and mixed thoroughly until uniform color and consistency are achieved. After mixing, the sample will be placed in appropriate containers for laboratory analysis as identified in Table A-4. Upon collection samples will be placed in coolers with ice throughout transport to testing laboratory.

4.1.1.2. Near Surface and Shallow Subsurface Sediment Sampling

Near surface (0 to 15 cm bml) and shallow subsurface (15 to 60 cm bml) samples will be collected utilizing a hand auger at the 12 sampling locations. Sampling will be completed when the surface water elevation is below the sample location elevation. A decontaminated hang auger will be used to collected sediment from 0 to 60 cm (approximately 2 feet) bml. Rock or other debris if present will be temporarily removed from the sample location, as necessary, to complete the hand auger borings if possible. If use of a hand auger is not feasible due to the presence of rocks at the proposed location, the sample location may be adjusted in the field and/or alternative methods such as using hand tools to dig an excavation to the target depth will be used. The sample location may be adjusted within approximate 10-foot radius of the proposed location to complete the sampling. If an excavation is required due to refusal using the hand auger, samples will be collected from the sidewall(s) of the excavation to obtain samples representative of the target sample interval. If it is not feasible to collect a sample from the proposed location due to obstruction(s), the Project Manager shall be notified.

Sample material will be visually classified, and photos will be taken in accordance with general sampling procedures. The sample intervals will be delineated and discrete samples for volatile analysis (TPH-Gx and VOCs) using EPA Method 5035 will be collected from in-situ sediment. Then sediment intervals will be separated and placed into separate stainless-steel bowls for homogenization and sampling in accordance with general sampling procedures. After mixing, the sample will be placed in appropriate containers for laboratory analysis as identified in Table A-4. Upon collection samples will be placed in coolers with ice throughout transport to testing laboratory.

4.1.1.3. Sediment Porewater Sampling

Sediment porewater samples will be collected from each of the 12 locations in the nearshore intertidal sediment area. Porewater samples will be collected using a PushPoint™ (or similar e.g., SedPoint™ mini piezometer sampling device manufactured by MHE Products. The PushPoint mini piezometer sampling device consists of a pointed stainless-steel tube with a screened zone at one end and a sampling port at the other. The screened zone on the pointed end of the sampler is approximately 2 to 4 inches in length consists of a series of very fine, machined slots to allow porewater to enter the sampler. A removable guard rod adds rigidity to the sampler during sediment insertion.

The sampling end of the porewater sampling device will be inserted into the sediment to the desired depth of approximately 50 cm bml (approximately 20 inches) to collect porewater that generally represents the shallow subsurface interval between 15 to 60 cm. Porewater will be extracted using a peristaltic pump.

The procedure for collecting porewater includes:

1. Insert guard-rod into PushPoint sampling devise [see Figure 1 below from EPA's Porewater Sampling Operating Procedure (EPA 2020)].

Figure 1. Pore Water Sampling Device

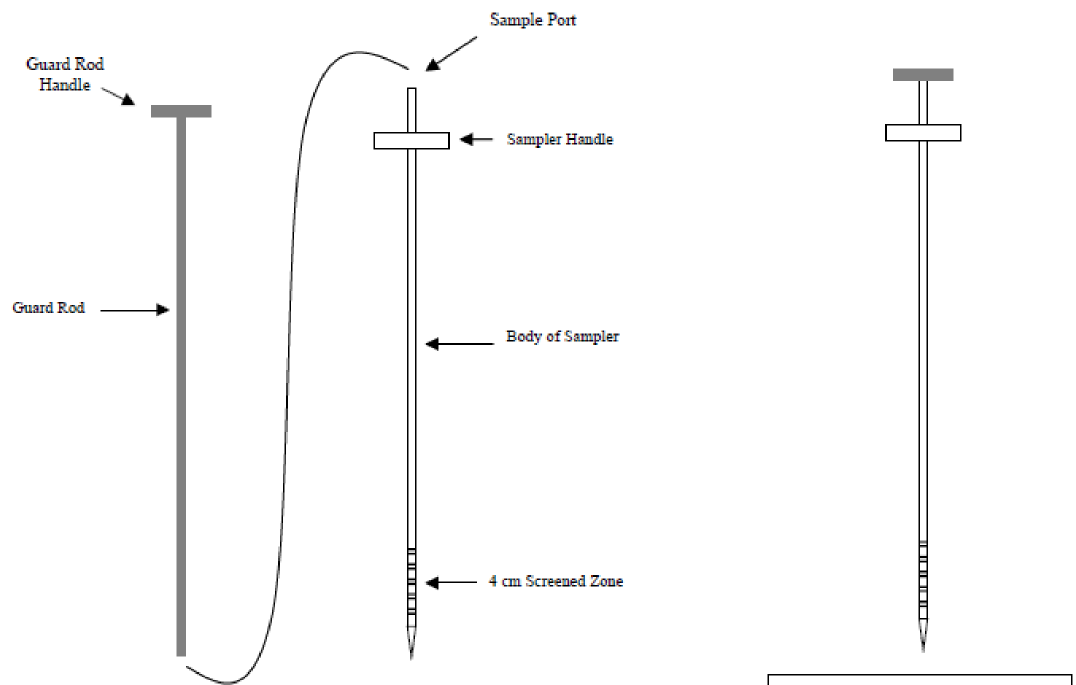

Figure 1A. Disassembled Device

Figure 1B. Assembled Device

Actual length and width of device will vary, depending on sampling needs and site conditions.
Note: cm = centimeter

2. Hold guard-rod/PushPoint handles so that two handles are squeezed towards each other to maintain the guard-rod fully inserted in the PushPoint body during the insertion process.
3. Push the PushPoint mini piezometer into the sediment to the desired depth (within the 15 to 60 cm bml interval) using a gentle twisting motion.
4. When the desired depth is reached (or refusal is encountered) remove the guard-rod from the PushPoint body without disturbing the position of the deployed sampler. Once the guard-rod has been removed from the PushPoint, it should not be reinserted into the device unless the bore of the PushPoint has been thoroughly decontaminated.
5. Attach a peristaltic pump to the PushPoint sample-port using Teflon tubing. Withdraw porewater at a low-flow sampling rate (50-200 mL per minute). The first 20-50 mL of groundwater will be turbid. This is the "development" water and should be discarded. If turbidity persists in the extracted porewater, the device may be re-placed in the sediment to attempt to collect a sample with limited suspended solids.
6. Once non-turbid porewater is being withdrawn, representative samples can be collected into laboratory provided jars (see Table A-3).

7. Porewater samples are to be collected for NWTPH-Gx, NWTPH-Dx, VOCs including benzene and naphthalene and total and WAD cyanide. A total of approximately 1,700 mL of porewater is needed to collect the appropriate volume for these analyses. If sufficient water is not available from the sample location, additional sample locations can be completed within 5 to 10 feet of the original location.
8. If additional porewater sample points in the vicinity of the original location do not produce enough porewater for the desired sample analyses the Project Manager will be notified and porewater from nearby sample locations may be combined to provide data for the purposes of cap design.

4.1.2. Nearshore Intertidal Seepage Velocity Measurements

A nearshore intertidal cap will be constructed is as part of the remedial action. To support design of the intertidal cap, cap modeling will be performed to estimate the cap thickness and cap material components. The model requires input parameters for groundwater transport to surface water. The seepage velocity of groundwater entering the surface water is a key parameter for sediment cap modelling.

As part of the PRDI, tracer testing will be completed at 4 locations (SV-1 through SV-4) to measure the seepage velocity in the nearshore intertidal area and provide empirical evidence for input into the intertidal cap design model. Tracer testing will be completed by injecting fluorescent dye into the sediment and timing the duration from injection to when the dye appears at the sediment surface. The tracer dye will be injected into the sediment using the PushPoint mini piezometer sampling device described in Section 4.1.1.3 for porewater sampling.

The tracer tests used to estimate seepages velocity will be completed at four proposed locations including two in the pocket beach area (SV-1 and SV-2) and two on the northern shoreline (SV-3 and SV-4) of the Marine Unit. Specific locations will be chosen based on surface conditions at the proposed locations that are relatively free of rock and debris if possible. Additionally, locations will be modified in the field if the PushPoint piezometer encounters refusal shallower than the target depth.

The following equipment will be needed to perform the tracer tests:

- PushPoint mini piezometer device (up to ½-inch diameter with approximately 2-inch screen interval) and associated tubing.
- Syringe and 4-way valve for injecting tracer dye;
- Tubing;
- Non-toxic fluorescent dye; and
- Camera and stopwatch to document the time for dye to appear in sediment at the surface of the shoreline.

The procedure for performing the tracer tests includes the following:

1. Insert the PushPoint mini piezometer using the procedures described in Section 4.1.1.3.
2. Position the midpoint of screened interval at approximately 38 cm bml which correlates to the approximate middle of the 15 to 60 cm sediment sample interval. Use a portable GPS unit to collect the coordinates of the tracer test location.

3. Extract enough porewater from the PushPoint piezometer to fill the syringe to approximately 0.5 to 1.0 mL.
4. Inject approximately 300 microliters (μL) of the non-toxic fluorescent dye into tubing.
5. Change 4-way valve to inject the previously extracted porewater (step 3 above) into tubing to clear the dye through the tubing and into the sediment porewater.
6. Record the time of injection.
7. Visually monitor and/or setup a time-lapse camera on a tripod to observe the sediment for expression of the florescent dye on the sediment surface. If using a camera be sure that the camera time setting is consistent with the time of injection recorded. Take photos and approximate measurements of the fluorescent dye that is found at the surface. Record field notes throughout the injection.
8. If the dye is expressed at the sediment surface a measurable distance away from the piezometer injection point, measure the distance and direction relative to the piezometer. Take photos with reference (tape measure in the photo) to document the distance/direction from the piezometer.
9. Record field procedures, observations, and notes throughout the tracer injection and monitoring activities.

The tracer tests will be completed during outgoing tides and when the surface water elevation is below the tracer test location. To the extent possible, the tracer test will be conducted on tides of 0 feet mean lower low water (MLLW) elevation or lower.

Prior to completing tracer testing at the four proposed test locations, a “pilot test” will be completed at two locations to field verify the test procedures (i.e., dye mixing, dye injection, photographic monitoring, etc.) and obtain the approximate duration from injection until the tracer appears in the surface sediment. This will allow for better planning for tides and sequencing of tracer tests that will be complete at the four test locations.

At a minimum of two of the four locations, duplicate tests will be completed approximately 5 to 10 feet apart to evaluate the reproducibility and variability of the tracer test for the site conditions. Therefore, a minimum of 6 total tracer tests will be completed for the PRDI.

Actual locations of all injection points will be collected using a hand-held Trimble GeoXT® GPS unit or similar equipment. Observations and measurements will be recorded in a field log and reported in the daily field report.

4.1.3. Subtidal Surface Sediment Sampling

Surface sediment samples will be collected from the subtidal zone using a Power Grab sampler operated off of subcontracted marine research vessel(s). Sampling equipment will be decontaminated and inspected before sampling.

At each sample station, discrete surface grab samples will be collected from the upper 12 cm from the sampler for processing on board the vessel. Upon retrieval of the sampler, the following surface sediment acceptance criteria will be evaluated:

- The sampler jaw is closed.

- The sampler is not overfilled so that the sediment surface is pressing against the top of the sampler.
- Minimal leakage has occurred, as evidenced by overlying water on the sediment surface.
- Minimal sample disturbance has occurred, as evidenced by limited turbidity in the water overlying the sample.
- A penetration of greater than 12 cm has been achieved. Greater than 12 cm shall be the target penetration depth to sample sediment that has not contacted the side or bottom of the sampler.

Sediment grab samples that do not meet the acceptance criteria (above) will be rejected. Sediment grab samples achieving the acceptance criteria will be retained for processing. If a grab sample is rejected, additional surface sediment grab samples will be collected (as needed) within 10 feet of the first location to fill appropriate containers for laboratory analysis. Each individual sampling attempt will be assigned a distinct identifier. For example, for two sampling attempts completed at sampling location PRDI-SS-13, the first location would be identified as PRDI-SS-13a and the second location would be identified as PRDI-SS-13b. Time of deployment, penetration depth, and coordinates for each sampling attempt will be documented. The Project Manager will be contacted if the acceptance criteria cannot be achieved after four deployments or where a sampling station needs to be moved more than 10 feet from the initial target location.

Samples meeting the acceptance criteria will be visually classified in accordance with ASTM D 2488 methods and the Unified Soil Classification System (ASTM D 2487) and recorded on a field log. In addition to the visual classification, sediment samples will be observed for biota, debris including wood debris, and presence of contamination including staining. If wood debris is present, the type or types of wood debris (i.e., saw dust, bark, chips, chunks, twigs, fibers, etc.), the estimated quantity (i.e., observed percent by volume) of each type of wood debris, and the depth interval where the wood is observed will be recorded on the field log.

Prior to processing, samples will be photographed. Included in the camera’s field of view will be a sheet of paper or whiteboard with the sample name written in large print using care not to touch the sediment with the paper/whiteboard or with hands contaminated with whiteboard ink. To avoid cross-contamination, a clean hands/dirty hands approach to use of whiteboard pens and erasers and lab pens will be utilized during all sample collection activities where subsequent chemical analyses will be carried out on the samples collected. Gloves that have been in contact with lab pens and whiteboard pens will not be used for sample handling.

After sediment sample acceptance criteria has been verified, the sample material will be photographed and examined for lithology and wood content. Then sediment from 0 to 12 cm will be placed in a stainless-steel bowl and mixed thoroughly until uniform color and consistency are achieved. After mixing, the sample will be placed in appropriate containers for laboratory analysis as described in Table A-4. Samples will then be placed in coolers with ice throughout transport to testing laboratory.

4.1.4. Subtidal Subsurface Sediment Sampling

Sediment cores will be collected to a depth of 5 feet from the subtidal zone using a vibracore sampler operated off of a subcontracted marine research vessel. If needed, the sediment cores will be collected using a vibracore sampler at high tide to access the proposed sample locations at shallow subtidal elevations closest to the shoreline. If a sediment core cannot be completed at a proposed sample location due to armoring, rock, wood or other debris the sample location will be moved within 10 feet of the first location. If the sediment core still cannot be completed, the location will be moved farther from the proposed location in coordination with the Project Manager.

Vibracoring technology is utilized to collect sediment cores by attaching a core tube to a source of mechanical vibration (power head). The vibration allows the core tube to be driven into sediment by the force of gravity, minimizing disturbance of the core. The core tube liner shall be 4 to 5 inches in nominal diameter and made of extruded polycarbonate. A core catcher shall be secured in the leading end of the core tube to reduce the loss of sample material as the tube is withdrawn following completion of the drive. Cores shall be driven to a depth of 5 feet or until practical refusal. Sample collection should be continuous; withdrawal and readvancement of the core tube shall be avoided.

Upon extraction of the core barrel, the liner will be capped, and the core will be evaluated by the following acceptance criteria:

- Overlying water is present, and the sediment surface is intact.
- Length of recovered core sample is a minimum of 75 percent of the sampler drive length.
- The core tube appears intact without obstructions or blockage.

If any of the sediment core acceptance criteria are not achieved, the sample will be rejected and the drive will be repeated at a suitable location approximately 10 to 15 feet (laterally) from the proposed drive location and at least 5 feet from any previous drive location. Rejected samples should be capped, stored, and recorded with the same procedure as approved samples. The GPS coordinates of each attempted core will be recorded. If the acceptance criteria are not satisfied after four attempts, the Project Manager will be notified.

Core will be completed at each sediment core sampling locations for the purposes of evaluation of erosions and/or accretion rates. A second core will be completed to a depth of 90 cm at five sediment core sampling locations for cPAH analysis as described below.

4.1.4.1. Sediment Core for Evaluation of Erosion and Accretion (Deposition) Rates

One core will be completed to 5 feet bml and will be capped for transport and delivery to CGS for inspection by a geotechnical engineer and principal engineering geologist who will perform preliminary visual classification of the sediment layers and stratigraphy and identify the depth intervals to be sampled for laboratory analyses. Visual observations and sample collection for grain size analysis and sediment dating (i.e., radiocarbon and/or radioisotope analysis) will be completed to assess depositional history. Laboratory analyses will be performed by a laboratory licensed and accredited in the State of Washington.

4.1.4.2. Sediment Core for cPAH Analysis

At five of the eight sediment core locations (PRDI-31, -32, -33, -36 and -37) a second core will be completed to a depth of approximately 5 feet bml. These cores will be transported to the upland area of the Site to be processed for sample collection for analysis of cPAHs.

The core will be opened, and photographs will be taken of each core. Core identification, and top and bottom elevations of the core will be documented in the photographs for reference. Sediment core material will be visually classified in general accordance with ASTM D 2487 and ASTM D 2488. Detailed descriptions of the core material and observed stratigraphy will be documented in exploration logs. Wood debris content will be determined by visually estimating amount of wood debris by volume through the sediment core. If wood debris is observed, the type of wood debris (i.e., wood chips, bark, sawdust, etc.) will be documented on the exploration log.

Following visual classification of the core material, discrete samples will be collected from increments of 15 cm bml, placed in a stainless-steel bowl and mixed thoroughly until uniform color and consistency are achieved. After mixing, the sample will be placed in an appropriate container for laboratory analysis as described as identified in Table A-4. Samples will be placed in coolers with ice throughout transport to testing laboratory.

5.0 GENERAL FIELD PROCEDURES

This section provides general field procedures and standard practices that apply to upland soil and groundwater sample collection and analysis as well as marine sediment and porewater sample collection and analysis.

5.1. Field Logging

The stratigraphy encountered in soil borings and sediment cores will be logged by the field geologist on field forms. Information on the boring/core logs will include the exploration location; general information about the drilling/coring equipment; sampling information such as sample intervals/depths, sample recoveries, stratigraphy, and field screening results. Stratigraphy encountered will generally be described in accordance with ASTM D 2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). In addition, identification of the Unified Soil Classification System (United State Geological Survey [USGS]) group symbol will be recorded on the field logs.

As applicable, additional information will be recorded on field logs during soil boring drilling including depth to groundwater/saturated soil, heaving conditions, changes in drilling rate, and other noteworthy observations or conditions such as the presence or absence of stratification, depth of apparent stratigraphic contacts and the type and occurrence of anthropogenic materials.

As applicable, additional information will be recorded on field logs during sediment coring and sampling including the presence or absence of stratification, depth of apparent stratigraphic contacts, the type and occurrence of anthropogenic materials, and qualitative description of biota and debris. The visual absence or presence of wood debris in the surface and subsurface sediment sample will be recorded on the field form. If wood debris is present, the type or types of wood debris (i.e., saw dust, bark, chips, chunks, twigs, fibers, etc.), the estimated quantity (i.e., observed percent by volume) of each type of wood debris, and the depth interval where the wood is observed will be recorded on the field form.

A photograph will be taken of the soil or sediment samples. Included in the camera's field of view will be a sheet of paper or whiteboard with the sample name written in large print. Care will be taken not to touch the sediment with the paper/whiteboard or with hands contaminated with whiteboard ink.

5.2. Field Screening

Field screening results will be recorded on the field logs. The following field screening methods will be used: 1) visual screening, 2) water sheen screening, and 3) headspace vapor screening.

5.2.1.1. Visual and Olfactory Screening

Soil and sediment will be observed for unusual color and stains and/or odor (e.g. hydrogen sulfide [rotten egg smell], petroleum hydrocarbons, etc.) indicative of possible contamination. Visual observation will also include presence of debris type, vegetation, and biological activity. If wood debris is present, the type or types of wood debris (i.e., bark, chips, chunks, twigs, fibers, etc.) and the estimated quantity (i.e., observed percent by volume) of each type of wood debris will be recorded.

5.2.1.2. Water Sheen Screening

This is a qualitative field screening method that can help identify the presence or absence of petroleum hydrocarbons. A portion of the soil sample will be placed in a pan containing distilled water. The water surface will be observed for signs of sheen. The following sheen classifications will be used:

Classification	Identifier	Description
No Sheen	(NS)	No visible sheen on the water surface
Slight Sheen	(SS)	Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly
Moderate Sheen	(MS)	Light to heavy sheen; may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas of no sheen on the water surface
Heavy Sheen	(HS)	Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen

5.2.1.3. Headspace Vapor Screening

This is a semi-quantitative field screening method that can help identify the presence or absence of volatile chemicals. As soon as possible after collecting a soil sample, a portion of the sample is placed in a resealable plastic bag. Ambient air is captured in the bag; the bag is sealed and then shaken gently to expose the soil to the air trapped in the bag. Vapors present within the sample bag headspace are measured by inserting the probe of a photoionization detector (PID) through a small opening in the bag. A PID measures the concentration of organic vapors ionizable by a 10.6 electron volt lamp (standard) in parts per million (ppm) and quantifies organic vapor concentrations in the range between 0.1 ppm and 2,000 ppm (isobutylene-equivalent) with an accuracy of 1 ppm between 0 ppm and 100 ppm. The maximum vapor concentration will be recorded on the field report for each sample. The PID will be calibrated to 100 ppm isobutylene.

5.3. Decontamination Procedures

To prevent cross-contamination of collected samples, reusable sampling equipment will be decontaminated prior to collecting each sample using the following procedures. Deviations from these procedures, if any, will be documented in field notes/logs.

5.3.1. Drilling Equipment

For large pieces of drilling equipment (such as augers, drill rods, drill bits, and those portions of the drill rig that may be positioned directly over a boring location), the following procedure will be used to decontaminate the equipment between borings and upon completion of drilling activities. The equipment will be pressure-washed and, if necessary, scrubbed to remove visible dirt, grime, grease, oil, loose paint, rust flakes, etc. The equipment will then be rinsed with potable water.

Sampling devices will be cleaned using an aqueous Alconox® or Liqui-Nox® solution and a distilled water rinse before each sample is collected.

5.3.2. Reusable Sampling Equipment

When possible, disposable sampling equipment will be used to minimize the need for decontaminating equipment. Prior to and between sample collection, reusable sampling equipment that contacts soil, groundwater, sediment porewater or sediment will be decontaminated. Reusable sampling equipment may include split-barrel soil samplers, stainless steel well screen intervals for direct push groundwater sampling, Power Grab sediment sampler, sediment porewater PushPoint probe, groundwater sampling pumps, interface probes, sounding tapes, trowels, spoons, and other hand tools or sampling/measuring devices.

For soil sampling equipment, excess soil will first be removed from the equipment. For sediment sampling equipment, excess sediment will be removed using seawater rinse over equipment to dislodge and remove excess sediment. The soil and/or sediment equipment will then be pressure-washed or washed using an aqueous Alconox® or Liqui-Nox® detergent solution and a brush. Detergent will be used to clean surfaces of sampling tools that directly contact samples (e.g., split-barrel core sampler, hand tools); equipment that does not directly contact samples (e.g., augers) will be pressure-washed and rinsed. Decontaminated equipment will be temporarily staged on clean plastic sheeting, wrapped or covered with aluminum foil, and/or stored in a clean, dry place.

Oil-water interface probes and electronic water level indicators/well sounders used for well gauging will be decontaminated before and after use at each well. Decontamination will be performed as follows:

1. Wipe off any visible LNAPL with disposable towels.
2. Clean measurement probe and tape with an aqueous Alconox® or Liqui-Nox® solution.
3. Rinse with distilled water.

If used, submersible (centrifugal) or bladder-type groundwater pumps will be decontaminated before and after each use by washing the exterior with an aqueous Alconox® or Liqui-Nox® solution and a brush. The interior of the pump may be cleaned by first pumping an aqueous Alconox® or Liqui-Nox® solution through the system, followed by distilled water.

5.3.3. Sample Containers

Pre-cleaned sample bottles and jars will be supplied by the subcontracted analytical laboratory. The sample containers will be protected from contact with dust, dirt, and other potential sources of cross-contamination. Sample containers will not be reused.

5.3.4. Used Decontamination Water

Used decontamination water will be stored on-property in labeled 55-gallon drums for subsequent characterization and off-property disposal at a permitted facility.

5.4. Field Documentation

Three primary types of field documentation will used for this project: field reports and field forms, sample container labels, and chain of custody (COC) forms. A description of each of these documentation methods is provided in the following sections.

5.4.1. Field Reports

Field reports are intended to provide a sufficient record of observations and data to enable participants to reconstruct events that occur during project field activities. They contain factual, detailed and objective information.

Field reports will be used to document the field and sampling activities performed at the project site for each day of field work. Field reports will include the date, time, description of field activities performed, names of personnel and site visitors, weather conditions, areas where photographs were taken (if applicable), and any other data pertinent to the project. Field reports will also contain sample collection and identification information, and if appropriate, a drawing of each area sampled, along with the locations (coordinates) where samples were collected. Sample data recorded in field reports will include the sample date, time, location, identification number, matrix, collection method, analyses to be performed, any comments and the sampler's name. Field reports will also document any safety issues; quality control samples collected (e.g., duplicate samples, trip blanks); calibration checks of field monitoring/measuring instruments (e.g., PID, water quality meter); field measurements; and investigation derived waste (IDW) disposition (e.g., number of drums generated and their contents and location).

Soil boring and sediment core information will be recorded on boring logs attached to the field report. Sediment sampling logs will be recorded for surface sediment samples recording the sediment type and field screening results and attached to the field report. A groundwater/well sampling record will be used for each well to record the information collected during water sampling.

Following review by the Project Manager, the original field records will be kept in the project file.

5.4.2. Sample Labels

Sample containers will be clearly labeled with waterproof black ink at the time of sampling. Sample labels will include the following information:

- Project/site name;
- Sampling date;
- Sampling time;
- Sample identification number;
- Preservation used, if any; and
- Initials of sampler.

The same information entered on the sample label will be recorded on the chain of custody form and in the field report.

5.4.3. Chain of Custody Forms

Samples will be retained in the field crew's custody until samples are delivered to the analytical laboratory. After samples have been collected and labeled, they will be maintained under chain of custody procedures. These procedures document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis will be recorded on a COC form.

The COC form documents sample names, dates, times, and analyses to be performed for each sample, as well as all transfers of sample custody from the field to the analytical laboratory. The COC form will be completed using waterproof ink. Any corrections will be made by drawing a line through and initialing and dating the change, then entering the correct information.

When transferring custody of samples, the individuals relinquishing and receiving them will sign, date, and note the time on the COC form. Sample coolers shipped by common carrier will have the COC form enclosed in a resealable plastic bag and placed in the sample cooler prior to sealing the cooler for shipping. Custody seals will be used on sample coolers that are shipped by common carrier or delivered by courier to the laboratory. The sample shipping receipt will be retained in the project files as part of the COC documentation. The shipping company will not sign the COC forms as a receiver; instead the laboratory will sign as a receiver when the samples are received. Internal laboratory records will document custody of the samples from the time they are received through final disposition.

5.5. Exploration Location and Surveying

5.5.1. Exploration Location by Field Crews

The horizontal coordinates of exploration soil, groundwater, sediment porewater and sediment locations collected in from the upland or low tide/dry conditions will be determined using a hand-held Trimble GeoXT® GPS unit or similar equipment. GeoEngineers field personnel will log the exploration location names and coordinates in the GPS unit for subsequent downloading to a computer. GPS data collected in the field will be processed in the office using measurements from the nearest reference station to each data collection point. For sediment sample locations collected in-water from a research vessel, the vessel will be equipped with GPS equipment and the vessel operator will provide GPS coordinates for each sediment sampling location.

5.5.2. Surveying by Professional Land Surveyor

As part of the PRDI, topographic and bathymetric surveys will be completed to provide a basis for completing design of the remedial actions. The upland topographic survey will be completed by a Washington-licensed professional land surveyor. The upland survey will also include site features including existing structures, utilities, monitoring wells and soil boring/sediment explorations that were completed as part of the PRDI. Elevations will be measured to the nearest 0.01 feet relative to the North American Vertical Datum of 1988 (NAVD88) vertical datum. Horizontal coordinates will be referenced to the Washington State Plane North coordinate system. The horizontal survey will have an accuracy of 0.10 feet.

The bathymetric survey will be completed by a Washington-licensed professional land surveyor using multibeam survey methods. The bathymetric survey will be completed from a research vessel to determine the elevation of the sea floor within the Marine Unit. Locations of any overwater structures will be surveyed and to the extent possible the depth of mudline beneath overwater structures. The multibeam bathymetric survey will be completed in general accordance with U.S. Army Corps of Engineers (USACE) Hydrographic Surveying Engineer Manual (USACE 2013). The bathymetric survey will be measured relative to the NAVD88 vertical datum and the horizontal coordinates will be referenced to the Washington State Plane North coordinate system.

The multibeam survey will be scheduled to be performed during a high tide, to the extent practical, to provide the greatest coverage along the shoreline. Topographic survey of the shoreline will be performed at low tide using upland surveying methods. The results of the multibeam and topographic surveys will be combined to provide a complete bathymetric survey of the Site.

5.6. Investigation Derived Waste

IDW will be placed in labeled storage containers and stored on Site in a designated containment area, which will be enclosed by fencing. Each waste container will be labeled, secured, stored, and disposed according to applicable local, State, and Federal regulations.

5.6.1. Soil

Soil cuttings from borings will be placed in 55-gallon drums marked with the contents, date, and contact information and placed in the containment area.

5.6.2. Groundwater and Decontamination Water

Well development and purge water removed from monitoring wells and decontamination water generated during sampling activities will be placed in 55-gallon drums marked with the contents, date, and contact information. The drums will be placed in the containment area.

5.6.3. Sediment

Excess sediment materials from surface grabs and cores will be placed back at the position of the subtidal sampling location as recorded by the GPS on the marine research vessel. intertidal sediment from hand augers will be placed in 55-gallon drums marked with the contents, date, and contact information. The drums will be placed in the containment area. Intertidal sediment from excavations will be placed back in the excavation in the general order in which it was removed.

5.6.4. Incidental Waste

Incidental waste generated during field activities includes items such as disposable personal protective clothing, gloves, and sampling supplies such as aluminum foil, paper towels, plastic bags/sheeting, and similar discarded materials. These materials will be placed in plastic garbage bags or other appropriate containers. At the completion of the field investigation, incidental waste will be removed from the staging area and disposed of as municipal waste at a local trash receptacle or county disposal facility.

6.0 HEALTH AND SAFETY

Field activities will be performed in accordance with the requirements of the Washington Industrial Safety and Health Act (WISHA; RCW 49.17) and the Federal Occupational Safety and Health Act (OSHA; 29 Code of Federal Regulations [CFR] 1910, 1926). These regulations include requirements that workers are to be protected from exposure to contaminants. A Site-specific health and safety plan (HASP) describing actions that will be taken to protect the health and safety of GeoEngineers personnel is presented in Appendix B. Companies providing services for this project on a subcontracted basis (if applicable) will be responsible for developing and implementing their own HASP.

7.0 QUALITY ASSURANCE (QA) PROCEDURES

7.1. Chemical Analyses and Methods

Samples of soil, groundwater, sediment, and porewater will be collected during field activities. Samples, analytes and analytical methods are listed in Table A-1.

7.2. Sample Preservation, Container, and Holding Times

Samples subject to laboratory analyses will be prepared, containerized, and preserved in the field according to the guidelines detailed in Tables A-2, A-3 and A-4 for soil, groundwater and porewater and sediment, respectively. Samples will be kept on ice in coolers while at the Site. The samples will be preserved and either hand-delivered by the GeoEngineers' field representative to the laboratory or to a laboratory courier. In cases where hand-delivery is not possible (inclement weather, after-hours sampling, etc.), the samples will be kept at 4°C until the next day or dropped off in the laboratory's after hour secure drop off. The samples will remain in a safe, refrigerated state upon delivery to the laboratory, and at the laboratory, until analyzed.

Holding times are defined as the time between sample collection and extraction, sample collection and analysis, or sample extraction and analysis. Some analytical methods specify a recommended holding time for analysis only. For many methods, recommended holding times may be extended by sample preservation techniques in the field. If a sample exceeds a recommended holding time, then the results may be biased low. For example, if the extraction holding time for volatile analysis of soil samples is exceeded, then the possibility exists that some of the organic constituents may have volatilized from the sample or degraded. Results for that analysis would be qualified as estimated to indicate that the reported results may be lower than actual site conditions. Recommended holding times are presented in Tables A-2, A-3 and A-4 for soil, groundwater and porewater, and sediment, respectively.

7.3. Data Quality Objectives

The environmental data quality assurance objective is to collect data of known, acceptable, and documentable quality. The QA objectives established for the project are:

- Implement the procedures outlined herein for field sampling, sample custody, equipment operation and calibration, laboratory analysis, and data reporting that will facilitate consistency and thoroughness of data generated.
- Achieve the acceptable level of confidence and quality required so that data generated are scientifically valid and of known and documented quality. This will be performed by establishing criteria for precision, accuracy, representativeness, completeness, and comparability, and by testing data against these criteria.

The QA/QC procedures are set up to provide high-quality data for use in this project. Specific data quality factors that may affect data usability include quantitative factors (bias, detection limits, precision, accuracy, and completeness) and qualitative factors (representativeness and comparability). The laboratory QA/QC requirements for soil (Table A-5), groundwater and porewater (Table A-6) and sediment (Table A-7) will be followed so that data of adequate quality is generated to support site characterization.

7.3.1. Analytical Detection Limits

Analytical methods have quantitative limitations at a given statistical level of confidence that are often expressed as the method detection limit (MDL). Although results reported near the MDL provide insight to Site conditions, quality assurance dictates that analytical methods achieve a consistently reliable level of detection known as the limits of quantification (LOQ) or practical quantitation limit (PQL), which is typically demonstrated with the lowest point of a linear calibration. The contract laboratory will provide numerical results for all analytes and report them as detected above the PQL or undetected at the PQL. It will be ensured with the laboratory to take extra care to keep PQLs below the cleanup or screening levels.

Laboratory PQLs for soil, groundwater and porewater, and sediment analyses are presented in Tables A-8, A-9, and A-10, respectively, and are considered target reporting limits (TRLs) because several factors may influence final reporting limits. First, moisture and other physical conditions affect detection limits. Second, analytical procedures may require sample dilutions or other practices to accurately quantify a particular analyte at concentrations above the range of the instrument. The effect is that other analytes could be reported as undetected but at a value higher than a specified TRL. Data users must be aware that high non-detect values, although correctly reported, can bias statistical summaries and careful interpretation is required to correctly characterize Site conditions.

7.3.2. Precision

Precision is the measure of mutual agreement among replicate or duplicate measurements of an analyte from the same sample and applies to laboratory duplicates, field duplicates and/or duplicates of spiked environmental samples. The closer the measured values are to each other, the more precise the measurement process. Precision error may affect data usefulness. Good precision is indicative of relative consistency and comparability between different samples. Precision will be expressed as the relative percent difference (RPD) for spike sample comparisons of various matrices and duplicate comparisons. This value is calculated by:

1

$$RPD\,(\%) = \frac{|D_1 - D_2|}{(D_1 + D_2)/2}\ X\ 100,$$

Where

D_1	=	Recovery for Matrix Spike (MS) or Duplicate 1
D_2	=	Recovery for Matrix Spike Duplicate (MSD) or Duplicate 2

The calculation applies to split samples, replicate analyses, duplicate spiked environmental samples (matrix spike duplicates), and laboratory control duplicates. The RPD will be calculated for samples and compared to the applicable criteria. Precision can also be expressed as the percent difference (%D) between replicate analyses. The RPD limits applicable for soil, groundwater and porewater, and sediment analyses are presented in Tables A-5, A-6, and A-7, respectively unless the primary and duplicate sample results are less than 5 times the method reporting limit (MRL), in which case RPD goals will not apply for data quality assessment purposes and the absolute difference will be used as a measurement of precision.

7.3.3. Accuracy

Accuracy is a measure of bias in the analytic process. The closer the measurement value is to the true value, the greater the accuracy. This measure is defined as the difference between the reported values versus the actual value and is often measured with the addition of a known compound to a sample. The amount of known compound reported in the sample, or percent recovery, assists in determining the performance of the analytical system in correctly quantifying the compounds of interest. Since most environmental data collected represent one point spatially and temporally rather than an average of values, accuracy plays a greater role than precision in assessing the results. In general, if the percent recovery is low, non-detect results may indicate that compounds of interest are not present when in fact these compounds are present. Detected compounds may be biased low or reported at a value less than actual environmental conditions. The reverse is true when recoveries are high. Non-detect values are considered accurate while detected results may be higher than the true value.

For this project, accuracy will be expressed as the percent recovery of a known surrogate spike, matrix spike, or laboratory control sample (blank spike), concentration:

$$Recovery\,(\%) = \frac{Spiked\ Result - Unspiked\ Result}{Known\ Spike\ Concentration}\ X\ 100$$

7.3.4. Representativeness

Representativeness expresses the degree to which data accurately and precisely represent the actual Site conditions. The determination of the representativeness of the data will be performed by completing the following:

- Comparing actual sampling procedures to those specified in this SAP.
- Invalidating non-representative data or identifying data to be classified as questionable or qualitative.

Only representative data will be used in subsequent data reduction, validation, and reporting activities.

7.3.5. Completeness

Completeness establishes whether a sufficient amount of valid measurements was obtained to meet project objectives. The number of samples and results expected establishes the comparative basis for completeness. Completeness goals are 90 percent useable data for samples/analyses planned. If the completeness goal is not achieved an evaluation will be made to determine if the data are adequate to meet study objectives.

$$Completeness = \frac{number\ of\ valid\ measurements}{total\ number\ of\ data\ points\ planned}\ x\ 100$$

7.3.6. Comparability

Comparability expresses the confidence with which one set of data can be compared to another. Although numeric goals do not exist for comparability, a statement on comparability will be prepared to determine overall usefulness of data sets, following the determination of both precision and accuracy.

7.3.7. Calibrations

Several types of instrument calibrations will be used by the laboratory, depending on the analytical method, to assess the linearity of the calibration curve and assure that the sample results reflect accurate and precise measurements. The main calibrations used are initial calibrations, daily calibrations, and continuing calibration verification. Calibration procedures will be performed in general accordance with the methods cited and laboratory standard operating procedures. Calibration documentation will be retained at the laboratory and readily available for a period of six months.

7.3.8. Holding Times

Holding times are defined as the time between sample collection and extraction, sample collection and analysis, or sample extraction and analysis. Some analytical methods specify a holding time for analysis only. For many methods, holding times may be extended by sample preservation techniques in the field. If a sample exceeds a holding time, then the results may be biased low. For example, if the extraction holding time for volatile analysis of soil sample is exceeded, then the possibility exists that some of the organic constituents may have volatilized from the sample or degraded. Results for that analysis would be qualified as estimated to indicate that the reported results may be lower than actual site conditions. Holding times are presented in Tables A-2 through A-4 for soil, groundwater and porewater, and sediment analyses, respectively.

8.0 QUALITY CONTROL (QC) SAMPLES AND PROCEDURES

QC samples will be analyzed to ensure the precision, accuracy, representativeness, comparability, and completeness of the data. Table A-11 summarizes the types and frequency of QC samples to be analyzed during the investigation, including both field QC and laboratory QC samples.

8.1. Field Quality Control Samples

Field QC samples serve as a control and check mechanism to monitor the consistency of sampling methods and potential influence of off-site factors on environmental samples. Examples of potential off-site factors include airborne VOCs and potable water used in drilling activities. As shown in Table A-11, field QC samples will include field duplicates. A description of this type of QC sample and other QC samples are provided in the following subsections.

8.1.1. Field Duplicates

Field duplicates serve as measures for precision. They are created by placing aliquots of a homogenized sample in separate containers and identifying one of the aliquots as the primary or parent sample and the other as the duplicate sample. Field duplicates measure the precision and consistency of laboratory analytical procedures and methods, as well as the consistency of the sample processing techniques used by field personnel and/or the relative homogeneity of sample matrices. The duplicate sample is submitted to gain precision information on sample homogeneity, handling, shipping, storage and preparation, and analysis. Field duplicates will be analyzed for the same parameters as the associated primary samples.

One field duplicate will be collected for every twenty (20) primary soil, groundwater, sediment, and porewater samples (i.e., a frequency of 5 percent for each matrix). The duplicate samples will be collected at the same locations and as close as possible to the same times as the associated primary samples.

8.1.2. Other QC Samples

According to the National Functional Guidelines for Organic Data Review (EPA 2017b), "The purpose of laboratory (or field) blank analysis is to assess the existence and magnitude of contamination resulting from laboratory (or field) activities. The criteria for evaluation of blanks apply to any blank associated with the samples…" Field blanks will be used at the discretion of the QA Leader if there is a reason to suspect contamination introduced by ambient conditions in the field. Field blanks are samples of distilled water poured directly into sample containers in the field. Field blanks are analyzed for the same parameters as the associated project samples.

Analytical results for QC blanks will be interpreted in general accordance with EPA's National Functional Guidelines for Inorganic (EPA 2017a) and Organic Data Review (EPA 2017b) and professional judgment.

8.2. Chemical Laboratory Quality Control

The analytical laboratories will follow standard analytical method procedures that include specified QC monitoring requirements. These requirements will vary by method, but generally include:

- Method blanks;
- Internal standards;
- Instrument calibrations;
- Matrix spikes/matrix spike duplicates (MS/MSDs);
- Laboratory control samples/laboratory control sample duplicates (LCS/LCSDs);
- Laboratory replicates or duplicates; and
- Surrogate spikes.

8.2.1. Laboratory Blanks

Laboratory procedures employ the use of several types of blanks but the most commonly used blanks for QA/QC assessments are method blanks. Method blanks are laboratory QC samples that consist of either a soil/sediment-like material that has undergone a contaminant destruction process, or a sample of reagent water. Method blanks are extracted and analyzed with each batch of environmental samples undergoing analysis. Method blanks are particularly useful during volatiles analysis since VOCs can be transported in the laboratory through the vapor phase. If a substance is found in the method blank, it indicates that one (or more) of the following occurred:

- Measurement apparatus or containers were not properly cleaned and contained contaminants.
- Reagents used in the analytical process were contaminated with a substance(s) of interest.
- Contaminated analytical equipment was not properly cleaned.
- Volatile substances in the air with high solubility or affinities toward the sample matrix contaminated the samples during preparation or analysis.

It is difficult to determine which of the above scenarios took place if method blank contamination occurs. However, it is assumed that the conditions that affected the blanks also likely affected the project samples. If method blank contamination occurs, validation guidelines assist in determining which substances detected in associated project samples are likely truly present in the samples and which ones are likely attributable to the analytical process.

8.2.2. Matrix Spike/Matrix Spike Duplicates

MS/MSDs are used to assess influences or interferences caused by the physical or chemical properties of the sample itself. For example, extreme pH can affect the results of semi-volatile organic compound (SVOC) analyses. Or, the presence of a particular analyte in a sample may interfere with accurate quantitation of another analyte. MS/MSD data are reviewed in combination with other QC monitoring data to evaluate matrix effects. In some cases, matrix effects cannot be determined due to dilution and/or high levels of related substances in the sample. An MS is created by spiking a known amount of one or more of the target analytes into a project sample, ideally at a concentration at least 5 to 10 times higher than the concentration in the unspiked sample. Percent recovery value is calculated by subtracting the unspiked sample result from the spiked sample result, dividing by the spike amount, and multiplying by 100.

The samples designated for MS/MSD analysis should be obtained from a sampling location that is suspected to not be highly contaminated. A sample from an area of low-level contamination is needed because the objective of MS/MSD analyses is to assess possible matrix interferences, which can best be achieved with low levels of contaminants. For the pre-remedial design investigation, additional sample volume will be collected for MS/MSD analysis for every twenty (20) primary soil, groundwater, sediment, and porewater samples, or as determined as necessary by the analytical laboratory.

8.2.3. Laboratory Control Spikes/ Laboratory Control Spike Duplicates

Also known as blank spikes, laboratory control spikes (LCS) and laboratory control spike duplicates (LCSDs) are similar to MS/MSD samples in that a known amount of one or more of the target analytes is spiked into a prepared medium and the percent recovery is calculated for the spiked substance(s). The primary difference between an MS and LCS is that the LCS spike medium is considered “clean” or contaminant-free. For example, reagent water is typically used for LCS water analyses. The purpose of an LCS is to help assess the overall accuracy and precision of the analytical process including sample preparation, instrument performance, and analyst performance. LCS data must be reviewed in context with other laboratory QC data to determine if corrective action is necessary for laboratory control limit exceedances.

8.2.4. Laboratory Replicates/Duplicates

Laboratories often utilize MS/MSDs, LCS/LCSDs, and/or laboratory replicates to assess precision. Replicates are a second analysis of a field-collected environmental sample. Replicates can be split at varying stages of the sample preparation and analysis process, but most commonly consist of a second analysis on the extracted media.

8.2.5. Surrogate Spikes

Surrogate spikes are used to verify the accuracy of the analytical instrument and extraction procedures used. Surrogates are substances similar to the target analytes. A known concentration of surrogate is added to each project sample and passed through the instrument, noting the surrogate recovery. Each surrogate used has an acceptable range of percent recovery. If a surrogate recovery is low, sample results may be biased low, and, depending on the percent recovery, a possibility of false negatives may exist. Conversely, when surrogate recoveries are above the specified range of acceptance, a possibility of false positives exists, although non-detected results are considered accurate.

8.3. Calibration Procedures

8.3.1. Field Instrumentation

Field instrument calibration and calibration checks facilitate accurate and reliable field measurements. The calibration of the instruments will be checked and adjusted as necessary in general accordance with manufacturers' recommendations. Methods and frequency of calibration checks and instrument maintenance will be based on the type of instrument, stability characteristics, required accuracy, intended use, and environmental conditions. The basic calibration check frequencies are described below.

8.3.2. Laboratory Instrumentation

Several types of instrument calibrations are used, depending on the method, to determine whether the methodology is 'in control' by verifying the linearity of the calibration curve and to assure that the sample results reflect accurate and precise measurements. This is done by verifying that the percent relative standard deviations (RSD) and/or the correlation coefficients are within the control limits specified in the validation documents. The main calibrations used are initial calibrations, daily calibrations, and continuing calibration verification.

For chemical analytical testing, calibration procedures and their appropriate chemical standards are to comply with the specific methods within EPA SW-846, Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, 3rd Edition, December 1996 and the laboratory's Standard Operating Procedures (SOP). Calibration documentation will be retained at the laboratory for a minimum period of 6 months.

9.0 LABORATORY DATA REPORTING AND DELIVERABLES

Laboratories will report data in formatted hardcopy and electronic form to the Project Manager and QA Leader. Upon completion of analyses, the laboratory will prepare electronic deliverables for data packages. The laboratory will provide electronic data deliverables (EDDs) within 2 business days after GeoEngineers' receipt of printed-copy analytical results, including the appropriate QC documentation. Analytical laboratory measurements will be recorded in standard formats that display, at a minimum, the client/field sample identification, the laboratory sample identification, reporting units, analytical methods, analytes tested, analytical results, extraction and analysis dates, quantitation limits, and data qualifiers. Each sample delivery group will be accompanied by sample receipt forms and a case narrative identifying data quality issues.

GeoEngineers will establish EDD requirements with the contract laboratories, as part of subcontracting.

10.0 DATA REDUCTION AND ASSESSMENT PROCEDURES

This section describes the process for generating and checking data, as well as the process for producing reports for field and analytical laboratory data.

10.1. Data Reduction

Data reduction involves the conversion or transcription of field and analytical data to a useable format. The laboratory personnel will reduce the analytical data for review by the QA Leader and Task Manager. This will involve both hard-copy forms and EDDs. Both forms of data will be compared with each other to verify that the data are reliable and error-free.

10.2. Review of Field Documentation and Laboratory Receipt Information

Documentation of field sampling data will be reviewed periodically for conformance with project QC requirements. At a minimum, field documentation will be checked for proper documentation of the following:

- Sample collection information (date, time, location, matrices, etc.);
- Field instruments used and calibration data;
- Sample collection protocol;
- Sample containers, preservation, and volume;
- Field QC samples collected at the frequency specified;
- Chain-of-custody protocols; and
- Sample shipment information.

Sample receipt forms provided by the laboratories will be reviewed for QC exceptions. The final laboratory data package will describe (in the case narrative) the effects that any identified QC exceptions have on data quality. The laboratories will review transcribed sample collection and receipt information for correctness prior to delivering the final data package.

10.3. Chemical Data Verification/Validation

Project decisions, conclusions, and recommendations will be based upon verified (validated) data. The purpose of data verification is to ensure that data used for subsequent evaluations and calculations are scientifically valid, of known and documented quality, and legally defensible. Field data verification will be used to eliminate data not collected or documented in accordance with the protocols specified in the SAP/QAPP. Laboratory data verification will be used to eliminate data not obtained using prescribed laboratory procedures.

The QA Leader will validate data collected during the PRDI to ensure that the data are valid and usable. Data will be validated in general conformance with Ecology's functional guidelines for data validation (Ecology 2016). At a minimum, the following items will be reviewed to verify the data as applicable:

- Documentation that a final review of the data was completed by the Laboratory QA Coordinator;
- Documentation of analytical and QC methodology;
- Documentation of sample preservation and transport;
- Sample receipt forms and case narratives; and
- The following QC parameters:
  - Holding times and sample preservation

- Method blanks
- MS/MSDs
- LCS/LCSDs or Ongoing Precision and Recovery (OPR) Samples
- Surrogate or Labeled Compound spikes
- Duplicates/replicates
- Initial Calibrations
- Continuing Calibrations
- Internal Standards

When sample analytical data are received from the analytical laboratory, they will undergo a QC review by the QA Leader. The accuracy and precision achieved will be compared to the laboratory's analytical control limits. Additional specifications and professional judgment by the QA Leader may be incorporated when appropriate data from specific matrices and field samples are available.

A data quality assessment will be prepared to document the overall quality of the data relative to the DQOs. The major components of the data quality assessment are as follows:

- **Data Validation Summary.** Summarizes the data validation results for all sample delivery groups by analytical method. The summary identifies any systematic problems, data generation trends, general conditions of the data, and reasons for any data qualification.
- **QC Sample Evaluation.** Evaluates the results of QC sample analyses, and presents conclusions based on these results regarding the validity of the project data.
- **Assessment of DQOs.** An assessment of the quality of data measured and generated in terms of accuracy, precision, and completeness relative to objectives established for the project.
- **Summary of Data Usability.** Summarizes the usability of data, based on the assessment performed in the three preceding steps.

The data quality assessment will help to achieve an acceptable level of confidence in the decisions that are to be made based upon the project data. The project analytical data will be submitted to Ecology's Environmental Information Management (EIM) system after the data quality assessment is completed.

10.4. Project Organization and Responsibilities

The key PRDI personnel and responsibilities are identified below. These key personnel are responsible for ensuring that the sampling and analysis activities are conducted in a manner sufficient to meet the PRDI objectives.

10.4.1. Principal-in-Charge

Iain Wingard is the Principal-in-Charge and has overall responsibility for seeing that the project is implemented in accordance with the PRDI and related requirements.

10.4.2. Project Manager

Neil Morton is the Project Manager for the PRDI and will coordinate and schedule field and laboratory testing activities, assign project team members, coordinate subcontractors, and track budgets and schedules. Neil will also verify that SAP and QAPP objectives are achieved or that potential modifications are documented if such changes are needed based on conditions at the time of the work. Additionally, he will provide technical oversight and coordinate production and review of PRDI deliverables.

10.4.3. Field Coordinator

The Field Coordinator is responsible for the daily management of activities in the field. Specific responsibilities include:

- Provide technical direction to the field staff.
- Develop schedules and allocate resources for field tasks.
- Coordinate data collection activities to be consistent with information requirements.
- Supervise the compilation of field data and laboratory analytical results.
- Review data for correct and complete reporting.
- Implement and oversee field sampling in accordance with the PRDI Project Plans, SAP, and QAPP.
- Supervise field personnel.
- Coordinate work with on-site subcontractors.
- Schedule sample shipments with the analytical laboratory.
- Monitor that appropriate sampling, testing, and measurement procedures are followed.
- Coordinate the transfer of field data, sample tracking forms, and log books to the Project Manager for data reduction and review.
- Identify whether deviations from the SAP and QAPP procedures are appropriate to achieve the investigation goals and discuss these changes with the Project Manager.

The Field Coordinator will be confirmed before beginning the field work.

10.4.4. Quality Assurance Leader

The Quality Assurance (QA) Leader is responsible for coordinating QA/QC for laboratory testing of field samples. Specific responsibilities include the following:

- Serve as the official contact for laboratory data QA questions and concerns.
- Confirm acceptability of the laboratory QA Plan.
- Respond to laboratory data QA needs, answer laboratory requests for guidance and assistance, and resolve issues.
- Monitor laboratory compliance with data quality requirements.
- Confirm that appropriate sampling, testing, and analysis procedures are followed and that proper QC checks are implemented.
- Review the implementation of the QAPP and the overall quality of the analytical data generated.
- Implement or direct corrective actions if necessary.

- Review project policies, procedures, and guidelines and review the project activities to verify that the QA program is being properly implemented.
- Provide oversight of the data development and review process and of subcontracting laboratories.
- Develop work scopes for the subcontracting laboratories that incorporate QAPP requirements.
- Conduct or delegate data review activities.
- Enter data into Ecology's EIM system.

Mark Lybeer, GeoEngineers' in-house chemist, will serve as the QA Leader.

10.4.5. Laboratory Management

The subcontracted laboratory(ies) conducting analytical testing for this project are required to confirm with the QA Leader that laboratory procedures are consistent with the project QA objectives. The Laboratory QA Coordinator administers the Laboratory QA Plan and is responsible for QC. Specific responsibilities of the Laboratory QA Coordinator include:

- Verify implementation of the Laboratory QA Plan.
- Serve as the laboratory point of contact.
- Activate corrective action as necessary when analytical control limits are exceeded.
- Issue the final laboratory QA/QC report.
- Comply with QAPP and contractual requirements for laboratory services.
- Participate in QA audits and compliance inspections if determined by GeoEngineers to be needed.

ARI (Tukwila, Washington) will be the Ecology-certified analytical laboratory for the PRDI for the analysis of all analytes with the exception of radionuclide dating which will be subcontracted out to DirectAMS (Bothell, Washington) for radiocarbon analysis and Chronos Scientific, Inc. (Ottawa, Ontario, Canada) for radioisotope analysis. Amanda Volgardsen or designate will be ARI's Laboratory QA Coordinator.

11.0 LIMITATIONS

This SAP/QAPP has been prepared for the exclusive use of the PSE and the City of Bellingham, their authorized agents and regulatory agencies in their evaluation of the South State Street Site. No other party may rely on the product of our services unless we agree in advance and in writing to such reliance.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted environmental science practices in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

12.0 REFERENCES

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TABLES

Table A-1

Proposed Sample Locations, Objectives and List of Analyses

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site
Bellingham, Washington

Sample			Proposed Location[1]			List of Analyses																		
			Coordinates[2]							Metals[4]					Conventionals									
Identification	Collection Method	Number of Sample for Analysis	Northing	Easting	Sample Depth Interval[3]	TPH-Gx and -Dx	Benzene (EPA 8260D)	Napthalene (EPA 8260D)	cPAHs (EPA 8270D-SIM)	Total Copper (EPA 6010/6020)	Dissolved Lead (EPA 6010/6020)	Dissolved Selenium (EPA 6010/6020)	Dissolved Iron (EPA 6010/6020)	Total Iron (EPA 6010/6020)	Total Cyanide for Soil (EPA 9014)	Total Cyanide (EPA 9014) and WAD Cyanide (SM4500) for Water	Nitrate (EPA 353.2)	Sulfate (EPA 375.2)	TOC in solids (SW 9060A)	TOC in water (SM5310B)	Grain Size (ASTM D6913/7928)	Laboratory Archive	Submit to Coastal Geologic Services[5]	Objectives[6]
Upland Groundwater Samples																								
MW-07	Low Flow	2	636452.3805	1238276.483	--	X	X	X			X	X	X	X		X	X	X		X				The most recent Site-wide characterization of groundwater at the Site was completed in 2016. Two Site-wide groundwater monitoring events will be completed to evaluate current conditions and spatial and temporal contaminant concentration trends. One groundwater monitoring event will occur during the dry season (July to September) and one event will occur during the wet season (Decemer to March).
MW-19	Low Flow	2	636337.7521	1238153.274	--	X	X	X			X	X	X	X		X	X	X		X				
MW-24	Low Flow	2	636289.3257	1238101.865	--	X	X	X			X	X	X	X		X	X	X		X				
MW-28	Low Flow	2	636460.7002	1238191.675	--	X	X	X			X	X	X	X		X	X	X		X				
MW-29	Low Flow	2	636407.5579	1238139.57	--	X	X	X			X	X	X	X		X	X	X		X				
MW-31	Low Flow	2	636331.2228	1237992.867	--	X	X	X			X	X	X	X		X	X	X		X				
MW-34	Low Flow	2	636464.1132	1238060.75	--	X	X	X			X	X	X	X		X	X	X		X				
MW-36	Low Flow	2	636523.0613	1238001.187	--	X	X	X			X	X	X	X		X	X	X		X				
MW-38	Low Flow	2	636410.9585	1237910.261	--	X	X	X			X	X	X	X		X	X	X		X				
MW-40	Low Flow	2	636491.7684	1237816.765	--	X	X	X			X	X	X	X		X	X	X		X				
MW-42	Low Flow	2	636582.3691	1237940.218	--	X	X	X			X	X	X	X		X	X	X		X				
MW-44	Low Flow	2	636416.1711	1238247.061	--	X	X	X			X	X	X	X		X	X	X		X				
MW-45	Low Flow	2	636398.398	1238066.545	--	X	X	X			X	X	X	X		X	X	X		X				
MW-46	Low Flow	2	636498.7	1238138.17	--	X	X	X			X	X	X	X		X	X	X		X				
MW-53	Low Flow	2	636272.68	1237958.98	--	X	X	X			X	X	X	X		X	X	X		X				
MW-54	Low Flow	2	636342.5	1237871.9	--	X	X	X			X	X	X	X		X	X	X		X				
MW-55	Low Flow	2	636416.5	1237787.33	--	X	X	X			X	X	X	X		X	X	X		X				
MW-59	Low Flow	2	636621.7624	1238241.588	~6 to 16ft[8]	X	X	X			X	X	X	X		X	X	X		X				
MW-60	Low Flow	2	636529.0248	1238054.638	~6 to 16ft[8]	X	X	X			X	X	X	X		X	X	X		X				
MW-61	Low Flow	2	636445.4694	1238099.971	~5 to 14ft[8]	X	X	X			X	X	X	X		X	X	X		X				
MW-62	Low Flow	2	636453.2187	1238156.363	~5 to 14ft[8]	X	X	X			X	X	X	X		X	X	X		X				
Marine Nearshore Intertidal Sediment Samples																								
PRDI-9-SS/SC	Hand Auger/Excavation	1	636623.034	1237954.748	0 to 12cm				X															Nearshore sediment sampling within direct contact point of compliance (45 cm bml) and bioaccumulation point of compliance (12 cm bml) to support cap design.
	Hand Auger/Excavation	1			0 to 45cm				X															
PRDI-10-SS/SC	Hand Auger/Excavation	1	636624.8752	1237893.981	0 to 12cm				X															
	Hand Auger/Excavation	1			0 to 45cm				X															
PRDI-11-SS/SC	Hand Auger/Excavation	1	636570.8602	1237822.779	0 to 12cm				X															
	Hand Auger/Excavation	1			0 to 45cm				X															
PRDI-12-SS/SC	Hand Auger/Excavation	1	636497.2032	1237752.805	0 to 12cm				X															
	Hand Auger/Excavation	1			0 to 45cm				X															

Sample			Proposed Location[1]			List of Analyses																		
Identification	Collection Method	Number of Sample for Analysis	Coordinates[2]		Sample Depth Interval[3]					Metals[4]					Conventionals								Submit to Coastal Geologic Services[5]	Objectives[6]
			Northing	Easting		TPH-Gx and -Dx	Benzene (EPA 8260D)	Napthalene (EPA 8260D)	cPAHs (EPA 8270D-SIM)	Total Copper (EPA 6010/6020)	Dissolved Lead (EPA 6010/6020)	Dissolved Selenium (EPA 6010/6020)	Dissolved Iron (EPA 6010/6020)	Total Iron (EPA 6010/6020)	Total Cyanide for Soil (EPA 9014)	Total Cyanide (EPA 9014) and WAD Cyanide (SM4500) for Water	Nitrate (EPA 353.2)	Sulfate (EPA 375.2)	TOC in solids (SW 9060A)	TOC in water (SM5310B)	Grain Size (ASTM D6913/7928)	Laboratory Archive		
Marine Nearshore Intertidal Near Surface and Shallow Subsurface Sediment Samples																								
PRDI-1-SC	Hand Auger/Excavation	1	636652.4939	1238247.019	0 to 15cm	X	X	X							X				X					Nearshore intertidal sediment sampling of near surface (0-15cm) and shallow subsurface (15-60cm) intervals to support cap design.
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-2-SC	Hand Auger/Excavation	1	636603.2397	1238201.168	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-3-SC	Hand Auger/Excavation	1	636528.3147	1238133.622	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-4-SC	Hand Auger/Excavation	1	636561.2631	1238122.379	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-5-SC	Hand Auger/Excavation	1	636517.297	1238081.479	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-6-SC	Hand Auger/Excavation	1	636555.1755	1238086.52	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-7-SC	Hand Auger/Excavation	1	636553.663	1238035.509	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-8-SC	Hand Auger/Excavation	1	636580.0672	1238001.397	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-9-SC	Hand Auger/Excavation	1	636623.034	1237954.748	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-10-SC	Hand Auger/Excavation	1	636624.8752	1237893.981	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-11-SC	Hand Auger/Excavation	1	636570.8602	1237822.779	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		X			
PRDI-12-SC	Hand Auger/Excavation	1	636497.2032	1237752.805	0 to 15cm	X	X	X							X				X					
	Hand Auger/Excavation	1			15 to 60cm	X	X	X							X				X		x			
Marine Nearshore Intertidal Sediment Porewater Samples																								
PRDI-1-PW	Porewater Extraction	1	636652.4939	1238247.019	15-60cm	X	X	X								X								Nearshore intertidal porewater concentrations in groundwater to support cap modeling and design. Collect porewater at the approximate midpoint of the 15 to 60 cm interval to correlate to the sediment sample at this location.
PRDI-2-PW	Porewater Extraction	1	636603.2397	1238201.168	15-60cm	X	X	X								X								
PRDI-3-PW	Porewater Extraction	1	636528.3147	1238133.622	15-60cm	X	X	X								X								
PRDI-4-PW	Porewater Extraction	1	636561.2631	1238122.379	15-60cm	X	X	X								X								
PRDI-5-PW	Porewater Extraction	1	636517.297	1238081.479	15-60cm	X	X	X								X								
PRDI-6-PW	Porewater Extraction	1	636555.1755	1238086.52	15-60cm	X	X	X								X								
PRDI-7-PW	Porewater Extraction	1	636553.663	1238035.509	15-60cm	X	X	X								X								
PRDI-8-PW	Porewater Extraction	1	636580.0672	1238001.397	15-60cm	X	X	X								X								
PRDI-9-PW	Porewater Extraction	1	636623.034	1237954.748	15-60cm	X	X	X								X								
PRDI-10-PW	Porewater Extraction	1	636624.8752	1237893.981	15-60cm	X	X	X								X								
PRDI-11-PW	Porewater Extraction	1	636570.8602	1237822.779	15-60cm	X	X	X								X								
PRDI-12-PW	Porewater Extraction	1	636497.2032	1237752.805	15-60cm	X	X	X								X								

Sample			Proposed Location[1]			List of Analyses																		
			Coordinates[2]							Metals[4]					Conventionals									
Identification	Collection Method	Number of Sample for Analysis	Northing	Easting	Sample Depth Interval[3]	TPH-Gx and -Dx	Benzene (EPA 8260D)	Napthalene (EPA 8260D)	cPAHs (EPA 8270D-SIM)	Total Copper (EPA 6010/6020)	Dissolved Lead (EPA 6010/6020)	Dissolved Selenium (EPA 6010/6020)	Dissolved Iron (EPA 6010/6020)	Total Iron (EPA 6010/6020)	Total Cyanide for Soil (EPA 9014)	Total Cyanide (EPA 9014) and WAD Cyanide (SM4500) for Water	Nitrate (EPA 353.2)	Sulfate (EPA 375.2)	TOC in solids (SW 9060A)	TOC in water (SM5310B)	Grain Size (ASTM D6913/7928)	Laboratory Archive	Submit to Coastal Geologic Services[5]	Objectives[6]
Marine Subtidal Surface Sediment Samples																								
PRDI-13-SS	Surface Power Grab	1	637351.0653	1238570.21	0 to 12cm				X															Collect suface sediment samples in the shallow subtidal zone to refine the limits of where conventional and thin layer capping, ENR, and MNR will be applied.
PRDI-14-SS	Surface Power Grab	1	637180.1831	1238451.202	0 to 12cm				X												X			
PRDI-15-SS	Surface Power Grab	1	637149.6684	1238535.118	0 to 12cm				X												X			
PRDI-16-SS	Surface Power Grab	1	637122.968	1238586.23	0 to 12cm				X												X			
PRDI-17-SS	Surface Power Grab	1	636822.3984	1238264.3	0 to 12cm				X												X			
PRDI-18-SS	Surface Power Grab	1	636669.8249	1237971.359	0 to 12cm				X												X			
PRDI-19-SS	Surface Power Grab	1	636765.9461	1237978.988	0 to 12cm				X												X			
PRDI-20-SS	Surface Power Grab	1	636649.2275	1237697.49	0 to 12cm				X												X			
PRDI-21-SS	Surface Power Grab	1	636466.1393	1237457.949	0 to 12cm				X												X			
PRDI-22-SS	Surface Power Grab	1	636485.2669	1237399.873	0 to 12cm				X												X			
PRDI-23-SS	Surface Power Grab	1	636572.9409	1237250.449	0 to 12cm				X												X			
PRDI-24-SS	Surface Power Grab	1	636860.5417	1237672.315	0 to 12cm				X															
PRDI-25-SS	Surface Power Grab	1	636902.4993	1237903.464	0 to 12cm				X												X			
PRDI-26-SS	Surface Power Grab	1	637073.5688	1237732.549	0 to 12cm				X												X			
PRDI-27-SS	Surface Power Grab	1	637129.071	1237962.204	0 to 12cm				X															
PRDI-28-SS	Surface Power Grab	1	637323.6021	1238060.614	0 to 12cm				X															
PRDI-29-SS	Surface Power Grab	1	637267.9129	1238201.745	0 to 12cm				X												X			
Marine Subtidal Surface and Subsurface Sediment Samples																								
PRDI-30-SS	Surface Power Grab	1	636777.0117	1238311.353	0 to 12cm				X															Collect surface grab and sediment cores within subtidal area to perform age dating estimates and determine deposition or erosion rates. Collect and analyze cPAH data in sediment to evaluate empirical evidence of ongoing natural recovery.
PRDI-30-SC	Sediment Core	1			~0 to 5ft																X		X	
PRDI-31-SC	Sediment Core	1	636873.5105	1238205.559	~0 to 5ft																X		X	
		1			0 to 15cm				X															
		1			15 to 30cm				X															
		1			45 to 60cm																	X		
		1			60 to 75cm																	X		
		1			75 to 90cm																	X		
PRDI-32-SC	Sediment Core	1	637036.1312	1238057.263	~0 to 5ft																X		X	
		1			0 to 15cm				X															
		1			15 to 30cm				X															
		1			45 to 60cm																	X		
		1			60 to 75cm																	X		
		1			75 to 90cm																	X		
PRDI-33-SC	Sediment Core	1	637220.6151	1237856.929	~0 to 5ft																X		X	
		1			0 to 15cm				X															
		1			15 to 30cm				X															
		1			45 to 60cm																	X		
		1			60 to 75cm																	X		
		1			75 to 90cm																	X		
PRDI-34-SS	Surface Power Grab	1	636606.5068	1237776.828	0 to 12cm				X															
PRDI-34-SC	Sediment Core	1			~0 to 5ft																X		X	
PRDI-35-SS	Surface Power Grab	1	636698.814	1237640.275	0 to 12cm				X															
PRDI-35-SC	Sediment Core	1			~0 to 5ft																X		X	

Sample			Proposed Location[1]			List of Analyses																		
			Coordinates[2]							Metals[4]					Conventionals									
Identification	Collection Method	Number of Sample for Analysis	Northing	Easting	Sample Depth Interval[3]	TPH-Gx and -Dx	Benzene (EPA 8260D)	Napthalene (EPA 8260D)	cPAHs (EPA 8270D-SIM)	Total Copper (EPA 6010/6020)	Dissolved Lead (EPA 6010/6020)	Dissolved Selenium (EPA 6010/6020)	Dissolved Iron (EPA 6010/6020)	Total Iron (EPA 6010/6020)	Total Cyanide for Soil (EPA 9014)	Total Cyanide (EPA 9014) and WAD Cyanide (SM4500) for Water	Nitrate (EPA 353.2)	Sulfate (EPA 375.2)	TOC in solids (SW 9060A)	TOC in water (SM5310B)	Grain Size (ASTM D6913/7928)	Laboratory Archive	Submit to Coastal Geologic Services[5]	Objectives[6]
PRDI-36-SC	Sediment Core	1	636726.2772	1237592.977	~0 to 5ft																X		X	
		1			0 to 15cm				X															
		1			15 to 30cm				X															
		1			45 to 60cm																	X		
		1			60 to 75cm																	X		
		1			75 to 90cm																	X		
PRDI-37-SC	Sediment Core	1	636815.1747	1237468.823	~0 to 5ft																X		X	
		1			0 to 15cm				X															
		1			15 to 30cm				X															
		1			45 to 60cm																	X		
		1			60 to 75cm																	X		
		1			75 to 90cm																	X		

Notes:

[1] Approximate locations are shown on Figures A-3 through A-6.

[2] Coordinates are presented in North American Datum (NAD) of 1983, Washington State Plane North.

[3] Depth is presented in feet (ft) below ground surface (bgs) for soil samples and ft or centimeter (cm) below mudline (bml) for sediment samples.

[4] Groundwater samples for dissolved metals will be field filtered.

[5] Intact sediment cores will be transported to Coastal Geologic Services Bellingham office to evaluate sediment and determination of deposition/erosion potential.

[6] See PRDI Work Plan for further detail of sampling and analysis data objectives.

[7] Continuous soil cores are to be collected for visual observation of soil stratigraphy and presence of contamination. No samples are proposed to be collected for analysis.

[8] Soil samples to collected from approximate middle of the monitoring well screen interval. Monitoring construction and well screen placement will be based on field conditions.

ASTM = ASTM International

EPA = U.S. Environmental Protection Agency

ENR = Enhanced Natural Recovery

MNR = Monitored Natural Recovery

TPH = Total Petroleum Hydrocarbons

TOC = Total Organic Carbon

WAD = Weak Acid Dissociable

Table A-2

Soil Analytical Methods, Sample Size, Containers, Preservation and Holding Times

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site
Bellingham, Washington

Parameter	Method	Minimum Sample Size (dry weight)	Container Size and Type	Sample Preservation Technique	Holding Time for Indicated Preservation Technique
TOC	SW 9060A	2 g	4-oz WM Jar	Cool, ≤ 6°C	14 days
Gasoline-Range Hydrocarbons	NWTPH-Gx	5 g per vial	Two 40 mL VOA	Methanol, Cool, ≤ 6°C	14 days
Diesel- and Heavy Oil-Range Hydrocarbons	NWTPH-Dx	15 g	8-oz WM-Glass	Cool, ≤ 6°C	14 days until extraction 40 days after extraction
VOCs (Benzene and Naphthalene)	EPA 8260D	5 g per vial	Three-40 mL VOA	NaHSO4, Cool, ≤ 6°C	14 days
		5 g per vial	Two-40 mL VOA	Methanol, Cool, ≤ 6°C	
		10 g	2-oz WM Glass	None	
cPAHs	EPA 8270D - SIM	100 g	8-oz WM Jar	Cool, ≤ 6°C	14 days until extraction 40 days after extraction
Total Cyanide	EPA 9014	100 g	4-oz WM Jar	Cool, ≤ 6°C	14 days
Total Metals (Copper, Iron)	EPA 6010/6020	20 g	4-oz WM Glass	Cool, ≤ 6°C	6 months
				Freeze, -18°C Only Sediments	2 years

Notes:

°C = degrees centigrade
cPAHs = Cacinogenic Polycyclic Aromatic Hydrocarbons
EPA = U.S. Environmental Protection Agency
g = gram
mL = millileter
oz =ounce
SIM = Selective Ion Monitoring
TOC = Total Organic Carbon
VOC = Volatile Organic Compound
VOA = volatile organic analysis
WAD = Weak Acid Dissociable
WM = wide mouth

Table A-3

Groundwater and Porewater Analytical Methods, Sample Size, Containers, Preservation and Holding Times

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site

Bellingham, Washington

Parameter	Method	Container Size and Type	Sample Preservation Technique	Holding Time for Indicated Preservation Technique
TOC	SM5310B	250 mL Amber Glass (narrow mouth)	Cool, ≤6°C, with H_2SO_4	28 days
Total and WAD Cyanide	EPA 9014, SM4500	500 mL HDPE	Cool, ≤6°C, with NaOH	48 hour if unpreserved 14 days with NaOH
Sulfate	EPA 375.2	500 mL HDPE	Cool, ≤ 6°C	28 days
Nitrate	EPA 353.2	500 mL HDPE	Cool, ≤ 6°C	2 days
Gasoline-Range Hydrocarbons	NWTPH-Gx	Two 40 mL VOAs	Cool, ≤ 6°C, with HCl	7 days if unpreserved 14 days
Diesel- and Heavy Oil-Range Hydrocarbons	NWTPH-Dx	Two 500 mL Amber	Cool, ≤ 6°C, with HCl	7 days if unpreserved 14 days
Total Metals (Iron)	EPA 6010/6020	500 mL HDPE	Cool, ≤ 6°C, with HNO3	6 months
Dissolved Metals (Iron, Lead and Selenium)	EPA 6010/6020	500 mL HDPE	Cool, ≤ 6°C, with Lab filter and preserve with HNO3 or Field filtered, Cool, ≤ 6°C, with HNO3	6 months
cPAHs	SW8270D-SIM	Two 1 L Amber	Cool, ≤ 6°C	7 days until extraction
VOCs (Benzene and Naphthalene)	SW8260D	Three 40 mL VOAs	Cool, ≤ 6°C, with HCl	7 days if unpreserved 14 days

Notes:

°C = degrees centigrade

cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons

EPA = Environmental Protection Agency

HDPE = High-density polyethylene

mL = milliliter

SIM = Selective Ion Monitoring

TOC = Total Organic Carbon

VOA = volatile organic analysis

VOCs = volatile organic compounds

WAD = Weak Acid Dissociable

Table A-4

Sediment Analytical Methods, Sample Size, Containers, Preservation and Holding Times

Soil, Groundwater, and Sediment SAP/QAPP, South State Street Site
Bellingham, Washington

Parameter	Method	Minimum Sample Size (dry weight)	Container Size and Type	Sample Preservation Technique	Holding Time for Indicated Preservation Technique
Grain Size	ASTM D6913 (sieve), ASTM D7928 (hydrometer)	16 oz	16-oz WM-HDPE	NA	NA
TOC	EPA 9060A	100 g	4-oz WM jar	Cool, ≤ 6°C	28 days
Gasoline-Range Hydrocarbons	NWTPH-Gx	5 g per vial	Two 40 mL VOA	Methanol, Cool, ≤ 6°C	14 days
Diesel- and Heavy Oil-Range Hydrocarbons	NWTPH-Dx	15 g	8-oz WM-Glass	Cool, ≤ 6°C	14 days until extraction 40 days after extraction
Total Cyanide	EPA 9014	100 g	4-oz WM jar	Cool, ≤ 6°C	14 days
VOCs (Benzene and Naphthalene)	VOCs by EPA 8260D	5 g per vial	Three-40 mL VOA	NaHSO4, Cool, ≤ 6°C	14 days
		5 g per vial	Two-40 mL VOA	Methanol, Cool, ≤ 6°C	
		10 g	2-oz WM Glass	None	
cPAHs	SW8270D-SIM	200 g	8-oz WM jar	Cool, ≤ 6°C	14 days

Notes:

ASTM = ASTM International
°C = degrees centigrade
cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons
EPA = U.S. Environmental Protection Agency
g = gram
HDPE = High-density polyethylene
mL = milliliter
NA = Not applicable
oz =ounce
SIM = Selective Ion Monitoring
TOC = Total Organic Carbon
VOA = volatile organic analysis
VOCs = Volatile Organic Compounds
WM = wide mouth

Table A-5

Soil Laboratory Quality Assurance/Quality Control Requirements

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site
Bellingham, Washington

Analyte Group		Laboratory Control Sample (LCS) %R Limits (%)	Matrix Spike (MS) %R Limits (%)	MS Duplicate Samples or Lab Duplicate RPD Limits[1] (%)	Surrogate Standard (SS) or Labeled Compounds %R Limits (%)
Conventionals		80-120	75-125	≤20	NA
Gasoline-Range Hydrocarbons		70-121	28-162	≤30	80-120
Diesel- and Heavy Oil-Range Hydrocarbons		50-150	NA	≤30	50-150
Metals[2]		80-120	75-125	≤20	NA
VOCs	Benzene	80-120	same as LCS	≤30	1,2-Dichloroethane-D4 (80-149) Toluene-D8 (77 - 120) 4-Bromofluorobenzene (80 - 120) 1,2-Dichlorobenzene-D4 (80 - 120)
	Naphthalene	29-125	same as LCS	≤30	
cPAHs	Benzo(a)anthracene	42 - 120	same as LCS	≤30	2-Methylnaphthalene-d10 (32 -120) Dibenzo[a,h]anthracene-d14 (21 - 133) Fluoranthene-d10 (36 - 134)
	Benzo(a)pyrene	36 - 120	same as LCS	≤30	
	Benzo(b)fluoranthene	46 - 120	same as LCS	≤30	
	Benzo(k)fluoranthene	46 - 120	same as LCS	≤30	
	Chrysene	48 - 120	same as LCS	≤30	
	Dibenzo(a,h)anthracene	38 - 120	same as LCS	≤30	
	Indeno(1,2,3-cd)pyrene	40 - 120	same as LCS	≤30	

Notes:

[1]RPD control limits are only applicable if the primary and duplicate sample concentrations are greater than 5 times the method reporting limit (MRL). For results less than 5 times the MRL, the difference between the primary and duplicate samples must be less than 2 times the MRL for soils/sediments.

[2]Metals to be analyzed include copper and iron.

cPAHs = carcinogenic polycyclic aromatic hydrocarbons

NA = Not applicable

RPD = Relative percent difference

%R = Percent Recovery

VOCs = Volatile Organic Compounds

Table A-6

Groundwater and Porewater Laboratory Quality Assurance/Quality Control Requirements

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site
Bellingham, Washington

Analyte Group		Laboratory Control Sample (LCS) %R Limits (%)	Matrix Spike (MS) %R Limits (%)	MS Duplicate (MSD) Samples or Lab Duplicate %RPD Limits[1] (%)	Surrogate Standard (SS) or Labeled Compounds %R Limits (%)
Conventionals		80 - 120	75 - 125	≤20	NA
Gasoline-Range Hydrocarbons		72 - 128	72 - 128	≤30	80-120
Diesel- and Heavy Oil-Range Hydrocarbons		56-120	56 - 120	≤30	50-150
Metals[2]		80 - 120	75 - 125	≤20	NA
VOCs	Benzene	80-120	same as LCS	≤30	1,2-Dichloroethane-D4 (80-129) Toluene-D8 (80 - 120) 4-Bromofluorobenzene (80 - 120) 1,2-Dichlorobenzene-D4 (80 - 120)
	Naphthalene	50-134	same as LCS	≤30	

Notes:

[1] RPD control limits are only applicable if the primary and duplicate sample concentrations are greater than 5 times the method reporting limit (MRL). For results less than 5 times the MRL, the difference between the primary and duplicate samples must be less than 2 times the MRL for soils/sediments.

[2] Metals to be analyzed include total iron, lead and selenium and total iron.

NA = Not applicable

%R = Percent Recovery

RPD = Relative percent difference

VOCs = Volatile Organic Compounds

Table A-7

Sediment Laboratory Quality Assurance/Quality Control Requirements

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site
Bellingham, Washington

Analyte Group		Laboratory Control Sample (LCS) %R Limits (%)	Matrix Spike (MS) %R Limits (%)	MS Duplicate (MSD) Samples or Lab Duplicate %RPD Limits[1] (%)	Surrogate Standard (SS) or Labeled Compounds %R Limits (%)
Conventionals		80 - 120	75 - 125	≤20	NA
Gasoline-Range Hydrocarbons		70-121	28-162	≤30	80-120
Diesel- and Heavy Oil-Range Hydrocarbons		50-150	NA	≤30	50-150
VOCs	Benzene	80-120	same as LCS	≤30	1,2-Dichloroethane-D4 (80-149) Toluene-D8 (77 - 120) 4-Bromofluorobenzene (80 - 120) 1,2-Dichlorobenzene-D4 (80 - 120)
	Naphthalene	29-125	same as LCS	≤30	
cPAHs	Benzo(a)anthracene	42 - 120	same as LCS	≤30	2-Methylnaphthalene-d10 (32 -120) Dibenzo[a,h]anthracene-d14 (21 - 133) Fluoranthene-d10 (36 - 134)
	Benzo(a)pyrene	36 - 120	same as LCS	≤30	
	Benzo(b)fluoranthene	46 - 120	same as LCS	≤30	
	Benzo(k)fluoranthene	46 - 120	same as LCS	≤30	
	Chrysene	48 - 120	same as LCS	≤30	
	Dibenzo(a,h)anthracene	38 - 120	same as LCS	≤30	
	Indeno(1,2,3-cd)pyrene	40 - 120	same as LCS	≤30	

Notes:

[1] RPD control limits are only applicable if the primary and duplicate sample concentrations are greater than 5 times the method reporting limit (MRL). For results less than 5 times the MRL, the difference between the primary and duplicate samples must be less than 2 times the MRL for soils/sediments.

cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons

NA = Not applicable

%R = Percent Recovery

RPD = Relative percent difference

VOCs = Volatile Organic Compounds

Table A-8

Soil Cleanup Levels (CULs) and Practical Quantitation Limits (PQLs)

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site

Bellingham, Washington

Analysis	CAS Number	Units	Soil Cleanup Levels		Practical Quantification Limit (PQL)
			Vadose	Saturated	
Conventionals (%)					
Total Organic Carbon (TOC)	--	%	--	--	0.02
Cyanide	57-12-5	mg/kg	--	--	5
Nitrate	14797-55-8	mg/kg	--	--	0.1
Sulfate	14996-02-2	mg/kg	--	--	20
Total Petroleum Hydrocarbons					
Gasoline-Range Hydrocarbons	-	mg/kg	--	--	5
Diesel-Range Hydrocarbons	-	mg/kg	--	--	50
Heavy Oil-Range Hydrocarbons	-	mg/kg	--	--	100
Metals					
Iron	7439-89-6	mg/kg	--	--	5
Copper	7440-50-8	mg/kg	--	--	0.2
Lead	7439-92-1	mg/kg	250	250	0.2
Selenium	7782-49-2	mg/kg	7	0.5	0.2
Carcinogenic PAHs[1] (cPAHs)					
Benzo(a)anthracene	56-55-3	µg/kg	--	--	0.5
Benzo(a)pyrene	50-32-8	µg/kg	--	--	0.5
Benzo(b)fluoranthene	205-99-2	µg/kg	--	--	0.5
Benzo(k)fluoranthene	207-08-9	µg/kg	--	--	0.5
Chrysene	218-01-9	µg/kg	--	--	0.5
Dibenzo(a,h)anthracene	53-70-3	µg/kg	--	--	0.5
Indeno(1,2,3-cd)pyrene	193-39-5	µg/kg	--	--	0.5
Total cPAHs TEQ	--	µg/kg	6.6	6.6	--
Volatile Organic Compounds (VOCs)					
Benzene	71-43-2	mg/kg	0.009	0.005	0.001
Naphthalene	91-20-3	mg/kg	2.3	0.12	0.005

Notes:

[1]The chemical analytical results of individual compounds will be used to calculate TEQ in accordance with Environmental Protection Agency's toxicity equivalency factor (TEF) methodology. For non-detect results, one-half the practical quantitation limit (PQL) result will be used in the TEQ calculations. The calculated TEQ will be screened against the applicable screening level.

CAS = Chemical Abstract Services

mg/kg = milligrams/kilogram

µg/kg = micrograms/kilogram

TEQ = toxic equivalency quotient

"--" = Not Available

Table A-9

Groundwater and Porewater Cleanup Levels (CULs) and Practical Quantitation Limits (PQLs)

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site

Bellingham, Washington

Analysis	CAS Number	Units	Groundwater Cleanup Level	Practical Quantification Limit (PQL)
Conventionals				
Nitrates	14797-55-8	µg/L	--	0.1
Sulfate	14996-02-2	µg/L	--	2.0
Total Cyanide	57-12-5	µg/L	5	0.005
WAD Cyanide	57-12-6	µg/L	5	0.005
Total Organic Carbon (TOC)	--	µg/L	--	0.5
Total Petroleum Hydrocarbons				
Gasoline-Range Hydrocarbons	--	µg/L	--	100
Diesel-Range Hydrocarbons	--	mg/L	--	0.10
Heavy Oil-Range Hydrocarbons	--	mg/L	--	0.20
Metals				
Iron	15438-31-0	µg/L	--	20.0
Copper	7440-50-8	µg/L	--	0.5
Lead	7439-92-1	µg/L	--	0.5
Selenium	7782-49-2	µg/L	71	0.5
Carcinogenic PAHs[1] (cPAHs)				
Benzo(a)anthracene	56-55-3	µg/L	--	0.01
Benzo(a)pyrene	50-32-8	µg/L	--	0.01
Benzo(b)fluoranthene	205-99-2	µg/L	--	0.01
Benzo(k)fluoranthene	207-08-9	µg/L	--	0.01
Chrysene	218-01-9	µg/L	--	0.01
Dibenzo(a,h)anthracene	53-70-3	µg/L	--	0.01
Indeno(1,2,3-cd)pyrene	193-39-5	µg/L	--	0.01
Total cPAHs TEQ	--	µg/L	0.02	
Volatile Organic Compounds (VOCs)				
Benzene	71-43-2	µg/L	1.6	0.2
Naphthalene	91-20-3	µg/L	83	0.5

Notes:

[1]The chemical analytical results of individual compounds will be used to calculate toxic equivalency quotient (TEQ) in accordance with Environmental Protection Agency's toxicity equivalency factor (TEF) methodology. For non-detect results, one-half the practical quantitation limit (PQL) result will be used in the TEQ calculations. The calculated TEQ will be screened against the applicable screening level.

CAS = Chemical Abstract Services

mg/L = milligrams/liter

µg/L = micrograms/liter

TEQ = toxic equivalency quotient

WAD = Weak Acid Dissociable

"--" = Not Available

Table A-10

Sediment Cleanup Levels (CULs) and Practical Quantitation Limits (PQLs)

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site
Bellingham, Washington

Analysis	CAS Number	Units	Sediment Cleanup Level	Practical Quantification Limit (PQL)
Conventionals				
Total Organic Carbon (TOC)	--	%	--	0.02
Cyanide	57-12-5	mg/kg	--	5.0
Total Petroleum Hydrocarbons				
Gasoline-Range Hydrocarbons	-	mg/kg	-	5
Diesel-Range Hydrocarbons	-	mg/kg	-	50
Heavy Oil-Range Hydrocarbons	-	mg/kg	-	100
Metals				
Copper	7440-50-8	mg/kg	--	0.2
Iron	7439-89-6	mg/kg	--	5.0
Carcinogenic PAHs (cPAHs)[1]				
Benzo(a)anthracene	56-55-3	µg/kg	--	0.5
Benzo(a)pyrene	50-32-8	µg/kg	--	0.5
Benzo(b)fluoranthene	205-99-2	µg/kg	--	0.5
Benzo(k)fluoranthene	207-08-9	µg/kg	--	0.5
Chrysene	218-01-9	µg/kg	--	0.5
Dibenzo(a,h)anthracene	53-70-3	µg/kg	--	0.5
Indeno(1,2,3-cd)pyrene	193-39-5	µg/kg	--	0.5
Total cPAHs - TEQ[2]	--	µg/kg	83	
Volatile Organic Compounds (VOCs)				
Benzene	71-43-2	mg/kg	--	0.2
Naphthalene	91-20-3	mg/kg	--	0.5

Notes:

[1] To achieve PQLs lower than the applicable screening levels, these chemicals are run by SIM method.

[2] Toxic equivalency quotients (TEQs) will be calculated using Environmental Protection Agency's (EPA's) toxic equivalency factors (TEF) methodology. For non-detect results, one-half the PQL result will be used in the TEQ calculations.

CAS = Chemical Abstract Services

mg/kg = milligrams/kilogram

µg/kg = micrograms/kilogram

SIM = Selective Ion Monitoring

Table A-11

Quality Control Samples Type and Frequency

Preliminary Remedial Design Investivation SAP/QAPP, South State Street Site

Bellingham, Washington

Parameter	Field QC Samples		Laboratory QC Samples[1]			
	Field Duplicates	Trip Blanks	Method Blanks	LCS or OPR	MS/MSD	Lab Duplicates
Soil						
Conventionals	1 per round of investigation	NA	NA	NA	1 set/batch	1 set/batch
Gasoline-Range Hydrocarbons	1 per 20 primary soil samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
Diesel- and Oil-Range Hydrocarbons	1 per 20 primary soil samples	NA	1/batch	1/batch	1 set/batch	NA
VOCs (Benzene and Naphthalene)	1 per 20 primary soil samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
Metals (Copper, Iron)	1 per 20 primary soil samples	NA	1/batch	1/batch	1 set/batch	1 set/batch
cPAHs	1 per 20 primary soil samples	NA	1/batch	1/batch	1 set/batch	NA
Groundwater and Porewater						
Conventionals	1 per round of investigation	NA	1/batch	1/batch	1 set/batch	1 set/batch
Gasoline-Range Hydrocarbons	1 per 20 primary groundwater/ porewater samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
Diesel- and Oil-Range Hydrocarbons	1 per 20 primary groundwater/ porewater samples	NA	1/batch	1/batch	1 set/batch	NA
VOCs (Benzene and Naphthalene)	1 per 20 primary groundwater/ porewater samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
Metals (Dissolved Lead, Iron and Selenium and Total Iron)	1 per 20 primary groundwater/ porewater samples	NA	1/batch	1/batch	1 set/batch	1 set/batch
Sediment						
Conventionals	1 per round of investigation	NA	1/batch	1/batch	NA	1 set/batch
Gasoline-Range Hydrocarbons	1 per 20 primary sediment samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
Diesel- and Oil-Range Hydrocarbons	1 per 20 primary sediment samples	NA	1/batch	1/batch	1 set/batch	NA
VOCs (Benzene and Naphthalene)	1 per 20 primary sediment samples	Minimum 1 within each cooler	1/batch	1/batch	1 set/batch	NA
cPAHs	None	NA	1/batch	1/batch	N/A	NA

Notes:

[1]An analytical batch is defined as a group of samples taken through a preparation procedure and sharing a method blank, LCS, and MS/MSD (or MS and lab duplicate). No more than 20 field samples are contained in one batch.

cPAHs = carcinogenic polycylic aromatic hydrocarbons

LCS = laboratory control sample

MS = matrix spike

MSD = matrix spike duplicate

NA = Not applicable

OPR = ongoing precision and recovery

QC = quality control

VOCs = volatile organic compounds

FIGURES

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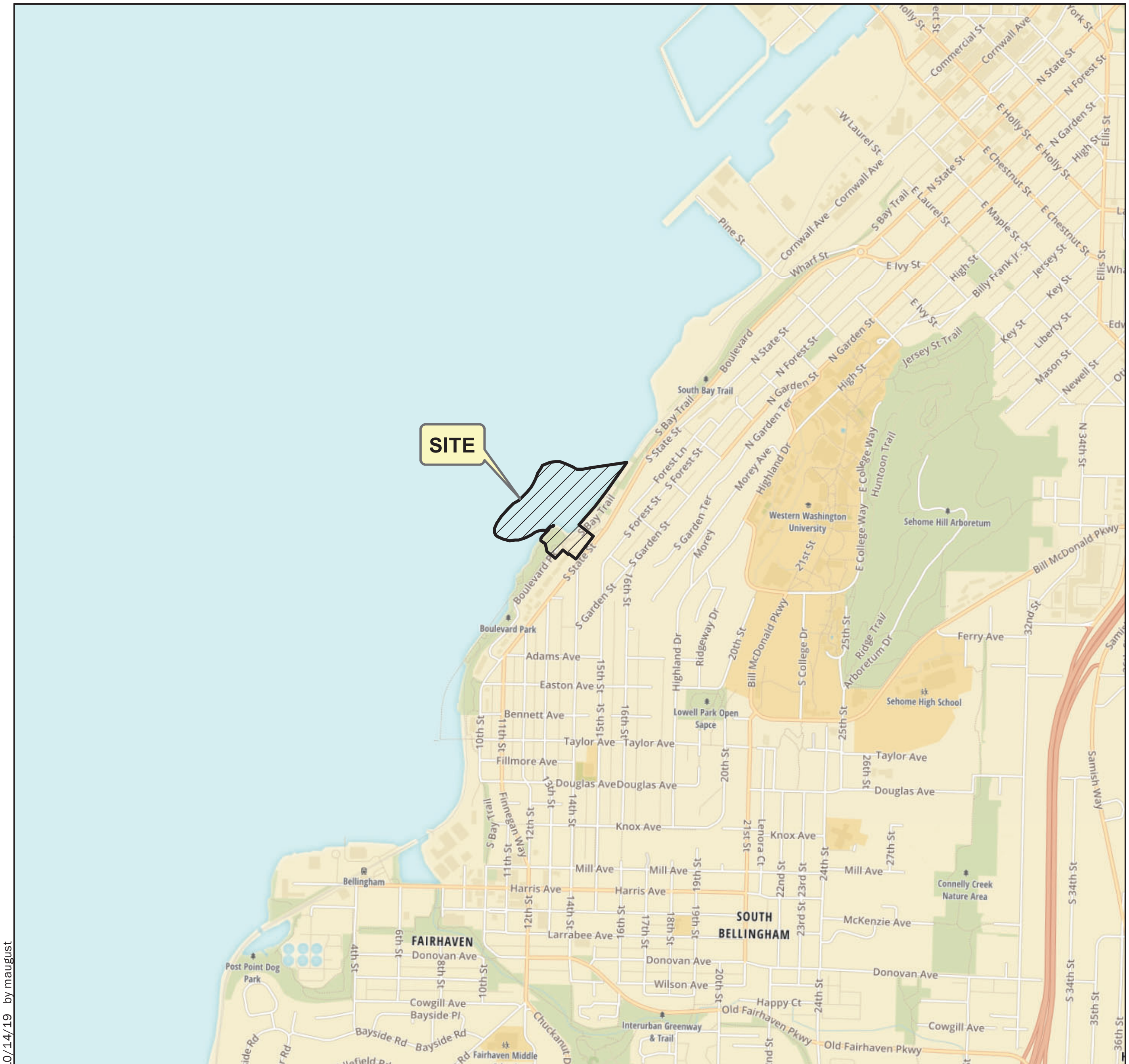
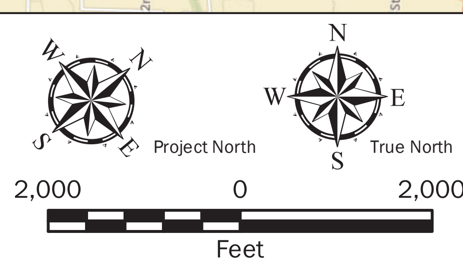


Legend

South State Street MGP Site



Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2017

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Vicinity Map

South State Street MGP Site
Bellingham, Washington

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Figure A-1

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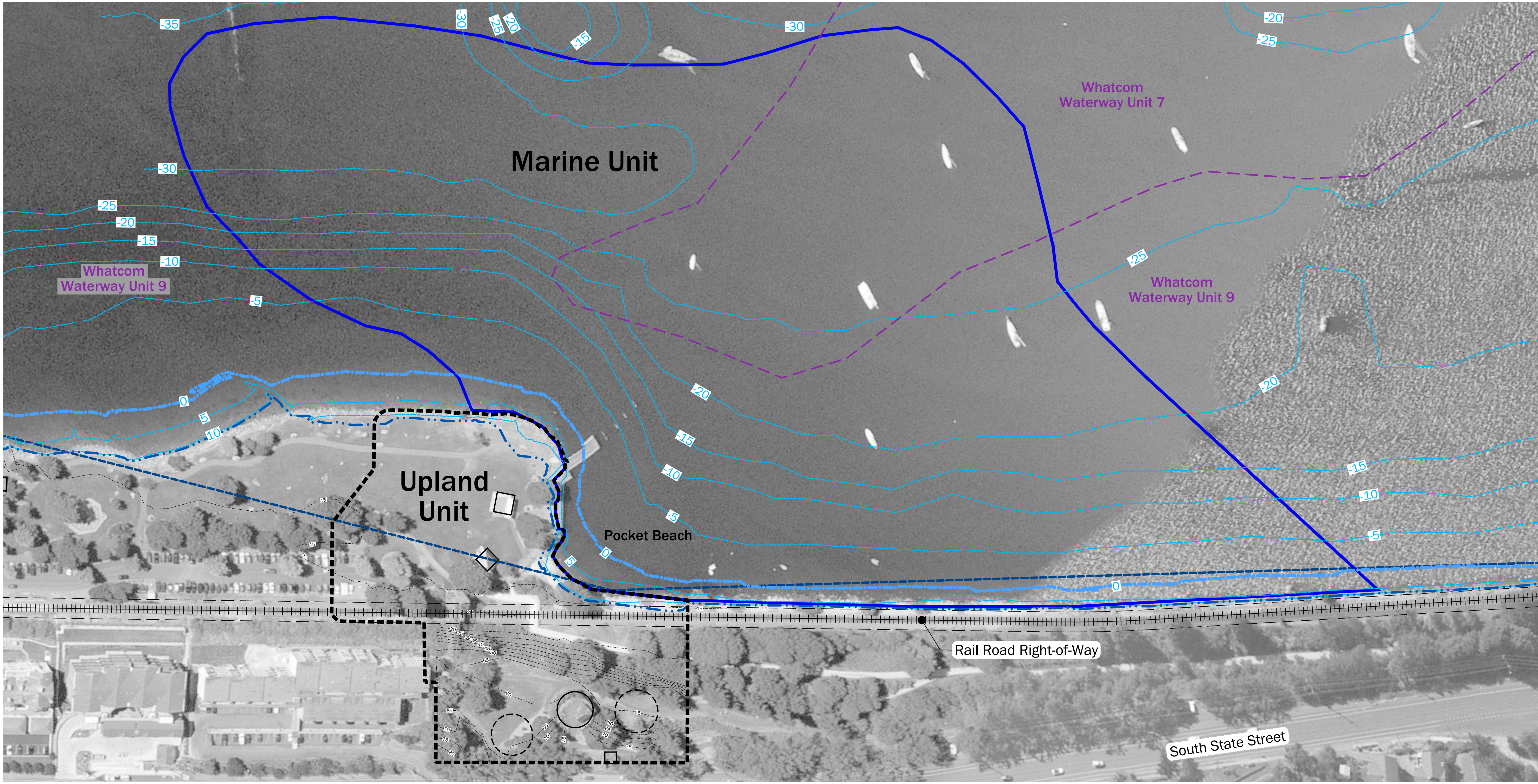

Notes:

1. The locations of all features shown are approximate.
2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.

Projection: NAD83 WA State Planes, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Legend

- Marine Unit Boundary
- Upland Unit Boundary
- Inner Harbor Line
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- -15 Bathymetry Contours (5ft Interval - MLLW)
- 15 Topographic Contours (5ft Interval - MLLW)

Project North

True North

150 0 150

Feet

South State Street and Whatcom Waterway Site Units

SSS MGP Site
Bellingham, Washington

GeoEngineers

Figure A-2

P:\0\0186890\CAD\02\CAP\018689002_F02_Site Units.dwg TAB:11x17 Landscape Date Exported: 08/11/20 - 9:52 by tmichaud

Path: P:\0\0186890\GIS\MXDs\018689000_F07_PRDI_SoilLocations.mxd Map Revised: 13 August 2020 maugust

Site Features

- Railroad
- Topographic Contours (5ft Interval MLLW)
- Bathymetry Contours (5ft Interval MLLW)
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el 10.47' MLLW)
- Inner Harbor Line
- Site Structure
- Former Gas Holder
- Slope Area
- Upland Unit Boundary

Sample Location Type

- Proposed Shallow (2-foot) Soil Sample Location - Hand Auger Boring
- Proposed Soil Sample Location - Direct-Push Boring
- Proposed Soil Sample Location - Hollow Stem Auger Boring
- Existing RI Soil Sample Location - Borehole
- Existing RI Soil Sample Location - Hand Augered

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.
Projection: NAD83 WA State Plane, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Notes:
1. The locations of all features shown are approximate.
2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Project North   True North

60   0   60
Feet

Soil Sample Locations

SSS MGP Site
Bellingham, Washington

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Figure A-3

Site Features

- Railroad
- Topographic Contours (5ft Interval MLLW)
- Bathymetry Contours (5ft Interval MLLW)
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- Inner Harbor Line
- Site Structures
- Former Gas Holder
- Slope Area
- Upland Unit Boundary

Sample Location Type

- Proposed Direct-Push Groundwater Sample Location
- Proposed New Monitoring Well
- Existing Monitoring Well
- Surface Water Outfall

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.
Projection: NAD83 WA State Plane, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Notes:
1. The locations of all features shown are approximate.
2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Project North   True North

60 0 60
Feet

Groundwater Sample Locations

SSS MGP Site
Bellingham, Washington

GeoEngineers

Figure A-4

Notes:
1. The locations of all features shown are approximate.
2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.
Projection: NAD83 WA State Plane, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Legend

- Marine Unit Boundary
- Upland Unit Boundary
- Site Structure
- Surveyed Extent of Eelgrass (Grette and Associates, 2008a and 2009)
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- Topographic Contours (5ft Interval MLLW)
- Bathymetric Contour (5ft Interval MLLW)
- Proposed Sediment Location - Sediment Core and Porewater Samples
- Proposed Sediment Location - Surface Sediment, Sediment Core, and Porewater Samples
- Proposed Seepage Velocity Measurement Location
- RI Subsurface Sediment Sample Location

Project North   True North

50   0   50
Feet

Intertidal Sediment Sample Locations

SSS MGP Site
Bellingham, Washington

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Figure A-5

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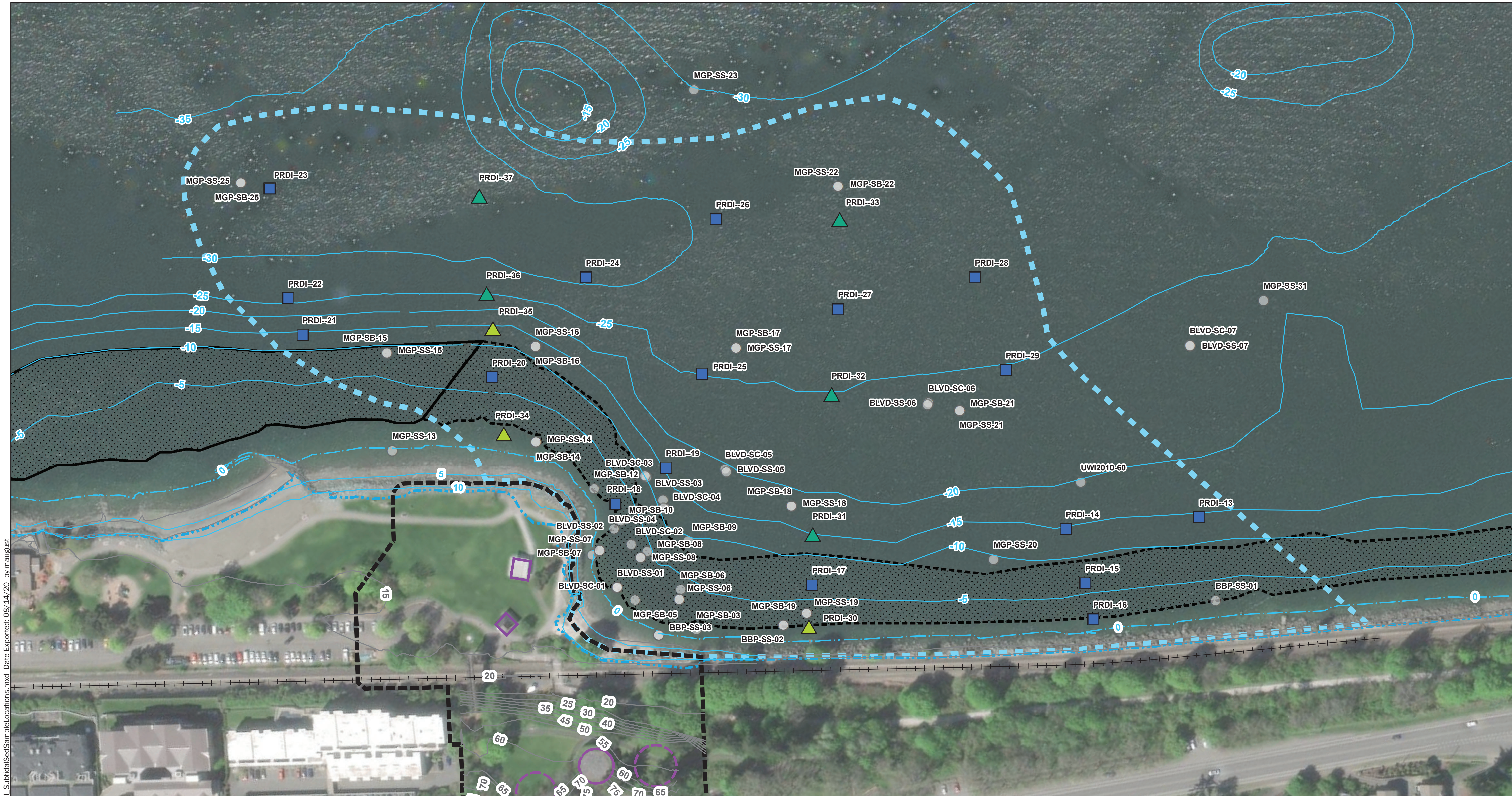

Notes:
1. The locations of all features shown are approximate.
2. Mean High Tide defines the boundary between the Upland Unit and Marine Unit.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Base data from AECOM. Survey data from Larry Steele and Assoc., 2012.
Projection: NAD83 WA State Plane, N Zone, US Foot
Vertical Datum: Mean Lower Low Water (MLLW)

Legend

- Marine Unit Boundary
- Upland Unit Boundary
- Site Structure
- Former Gas Holder
- Estimated Extent of Eelgrass (Grette and Associates, 2008b)
- Surveyed Extent of Eelgrass (Grette and Associates, 2008a and 2009)
- Mean Lower Low Water (el. 0' MLLW)
- Ordinary High Water (el. 10.47' MLLW)
- Topographic Contours (5ft Interval MLLW)
- Bathymetric Contour (5ft Interval MLLW)
- Proposed Subtidal Sediment Sample Location - Core Samples, Two Cores
- Proposed Subtidal Sediment Sample Location - Surface Power Grab Sample
- Proposed Sediment Sample Location - Core and Surface Grab Sample
- Existing RI Surface Sediment Sample Location
- Existing RI Subsurface Sediment Sample Location

Project North True North

150 0 150
Feet

Subtidal Sediment Sample Locations

SSS MGP Site
Bellingham, Washington

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Figure A-6

P:\0\0186890\GIS\MXDs\018689000_F10_PRDI_SubtidalSedSampleLocations.mxd Date Exported: 08/14/20 by maugust

APPENDIX B
Health and Safety Plan

Appendix B
Pre-Remedial Design Investigation Work Plan Health and Safety Plan

South State Street MGP Site
Bellingham, Washington

for
Puget Sound Energy

October 30, 2020

GEOENGINEERS

2101 4th Avenue, Suite 950
Seattle, Washington 98121
206.728.2674

Table of Contents

GEOENGINEERS, INC.
HEALTH AND SAFETY PLAN
SOUTH STATE STREET – PRDI WORK PLAN
PUGET SOUND ENERGY
FILE NO. 0186-890-02

This HASP is to be used in conjunction with GeoEngineers, Inc. (GeoEngineers) Safety Programs. Together, the written safety programs and this HASP constitute the site safety plan for this site. This plan is to be used by GeoEngineers personnel on this site and must be available on-site. If the work entails potential exposures to other substances or unusual situations, additional safety and health information will be included, and the plan will need to be approved by the GeoEngineers Health and Safety Manager. All plans are to be used in conjunction with current standards and policies outlined in the GeoEngineers Health and Safety Program Manual.

Liability Clause: If requested by subcontractors, this site safety plan may be provided for informational purposes only. In this case, Form 3 shall be signed by the subcontractor. Please be advised that this Site Safety Plan is intended for use by GeoEngineers Employees only. Nothing herein shall be construed as granting rights to GeoEngineers' subcontractors or any other contractors working on this site to use or legally rely on this Site Safety Plan. GeoEngineers specifically disclaims any responsibility for the health and safety of any person not employed by them.

1.0 GENERAL PROJECT INFORMATION

Project Name:	South State Street - PRDI Work Plan
Project Number:	00186-890-02
Type of Project:	PRDI Work Plan – Health and Safety Plan
Site Address	Boulevard Park, Bellingham, Washington
Start/Completion:	2020/2021
Subcontractors:	Drillers, Private Utility Locators, Surveyors and Vessel Operators

1.1. Project Responsibilities

Chain of Command	Title	Name	Telephone Numbers
1	Project Manager (PM)	Neil Morton	206.239.3238
2	HAZWOPER Supervisor	Iain Wingard	253.722.2417
3	Field Engineer/Geologist	TBD	
4	Site Safety Officer (SSO)*	TBD	
5	Client Assigned Site Supervisor	TBD	
6	Health and Safety Manager (HSM)	Mary Lou Sullivan	360.633.9821
7	Current Owner	Puget Sound Energy	
8	Subcontractors	TBD	

* **Site Safety and Health Supervisor** – The individual present at a hazardous waste site responsible to the employer and who has the authority and knowledge necessary to establish the site-specific health and safety plan and verify compliance with applicable safety and health requirements.

1.2. List of Field Personnel and Training

Anticipated field personnel include the following:

- Nate Solomon
- Claudia De La Via
- Brian Anderson
- Katy Atakturk
- Chelsey Gohr
- Brian Tracy

Field personnel will have appropriate training and up to date certifications.

2.0 WORK PLAN

GeoEngineers will conduct field activities to investigate contaminated soil, groundwater, sediment and porewater at the South State Street Site (Site). The purpose of the Pre-Remedial Design Investigation (PRDI) Work Plan is to address upland and marine contamination. As part of the PRDI Work Plan, our scope includes:

- Upland soil and groundwater investigation through drilling, hand auger samples and monitoring well installation and sampling.
- Marine sediment and porewater investigation of the intertidal and subtidal zones.
- Conduct detailed topographic survey of the property to support future design and construction work.

2.1. Site Description

A PRDI is planned at the South State Street Former Manufactured Gas Plant (MGP) Site (Site) in Bellingham, Washington to obtain additional data to support design of the cleanup action. The Site is generally located at Boulevard Park, south of the downtown business district. The Site is divided into an upland unit and marine unit, separated by the ordinary high-water mark (OHWM).

2.2. Site History

The Site has been used as a public park since 1980. The park was constructed by placing fill on tidelands formerly occupied by a historic sawmill (lower park) and upland formerly occupied by the MGP facility. Fill in the lower park includes wood waste associated with former lumber mill and log-rafting operations, and materials from local demolition and construction projects. Pilings associated with the former lumber mill wharf likely remain beneath the lower park. The base of one of the former gas holders remains above-ground in the upper park.

2.3. List of Field Activities

Check the activities to be completed during the project:

X	Site reconnaissance	X	Field Screening of Soil Samples
X	Exploratory Borings		Vapor Measurements
	Construction Monitoring	X	Groundwater Sampling
X	Surveying	X	Groundwater Depth and Free Product Measurement
	Test Pit Exploration		Product Sample Collection
X	Monitoring Well Installation		Soil Stockpile Testing
X	Monitoring Well Development		Remedial Excavation
X	Soil Sample Collection		Underground Storage Tank (UST) Removal Monitoring
	Remediation System Monitoring	X	Sediment and Porewater Sampling

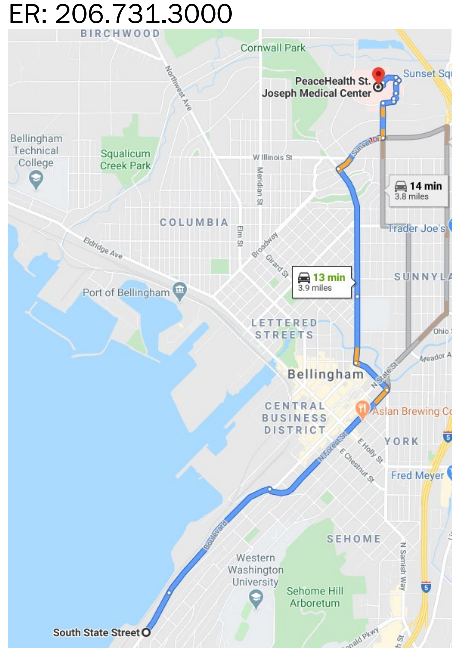
3.0 EMERGENCY INFORMATION

Hospital Name and Address:
St. Joseph Hospital
2901 Squalicum Parkway
Bellingham, WA 98225-1898
Phone: (360) 734-5400

Phone Numbers (Hospital ER): ER: 206.731.3000

Route to Hospital:
Distance: 3.94.2 miles
Time: 13 minutes

1. Head northeast on S State St toward S Bay Trail
2. (0.2) mi Continue straight onto Boulevard
3. (0.8) mi at the traffic circle, take the 2nd exit onto N Forest St
4. (0.8 mi) Turn left onto York St
5. (0.2) mi Turn right onto Cornwall Ave
6. (0.3) mi Continue straight to stay on Cornwall Ave
7. (0.7) mi Turn right onto Sunset Dr



Ambulance:	9-1-1
Poison Control:	(800) 732-6985
Police:	9-1-1
Fire:	9-1-1
Location of Nearest Telephone:	Cell phones are carried by field personnel.
Nearest Fire Extinguisher:	Located in the GeoEngineers vehicle on-site.
Nearest First-Aid Kit:	Located in the GeoEngineers vehicle on-site.

3.1. Standard Emergency Procedures

Get help

- Send another worker to phone 9-1-1 (if necessary)
- As soon as feasible, notify GeoEngineers' Project Manager

Reduce risk to injured person

- Turn off equipment
- Move person from injury location (if in life-threatening situation only)
- Keep person warm or cool as necessary
- Perform CPR (if necessary)

Transport injured person to medical treatment facility (if necessary)

- By ambulance (if necessary) or GeoEngineers vehicle
- Stay with person at medical facility
- Keep GeoEngineers manager apprised of situation and notify Human Resources Manager of situation

4.0 HAZARD ANALYSIS

- Note: A hazard assessment will be completed at every site prior to beginning field activities. Updates will be included in the daily log. This list is a summary of hazards listed on the form.

4.1. Physical Hazards

X	Drill rigs
	Backhoe
	Trackhoe
	Crane
	Front End Loader
	Excavations/trenching (1:1 slopes for Type B soil)
	Shored/braced excavation if greater than 4 feet of depth
X	Overhead hazards/power lines
X	Tripping/puncture hazards: working close to eroded 4- to 6-foot-tall bluff along shoreline. In places the edge of the bluff is obscured by vegetation so care should be taken to ensure sure footing.
X	Unusual traffic hazard – Street traffic: Transients frequent the site and GeoEngineers personnel should leave the Site and call police at any indication of a threat.
X	Unusual traffic hazard – Railroad traffic: Sampling locations are near BNSF railroad and some sampling locations will require coordination with rail company to ensure safe sampling.
X	Heat/Cold, Humidity
X	Utilities/utility locate
X	Overwater work on a vessel
X	Tide fluctuations in portion of Site affected by tides

- High-visibility vests will be worn by on-site personnel to ensure they can be seen by vehicle and equipment operators.
- Field personnel will be aware at all times of the location and motion of heavy equipment in the area of work to ensure a safe distance between personnel and the equipment. Personnel will be visible to the operator at all times and will remain out of the swing and/or direction of the equipment apparatus. Personnel will approach operating heavy equipment only when they are certain the operator has indicated that it is safe to do so through hand signal or other acceptable means.
- Heavy equipment and/or vehicles used on this Site will not work within 20 feet of overhead utility lines without first ensuring that the lines are not energized. This distance may be reduced to 10 feet based on acceptable electrical engineering controls or the use of a safety watch.
- Safety glasses will be worn during sampling to protect against splashing or other potential eye injuries.
- Caution will be taken near the drill rig to avoid moving parts of the drill rig, as well as falling or flying objects.
- Field personnel will minimize time spent near drill rig; will not wear loose clothing; will use safety glasses, hard hat, and steel-toed boots.
- Personnel will avoid tripping hazards, steep slopes, pits and other hazardous encumbrances. If it becomes necessary to work within 6 feet of the edge of a pit, slope or other potentially hazardous area, appropriate fall protection measures will be implemented by the Site Safety and Health Supervisor in accordance with Occupational Safety and Health Administration (OSHA)/Division of Occupational Safety and Health (DOSH) regulations and the GeoEngineers Health and Safety Program.
- Personnel shall understand the times and magnitude of tides when working in the intertidal areas.
- Cold stress control measures will be implemented according to the GeoEngineers Health and Safety Program to prevent frost nip (superficial freezing of the skin), frost bite (deep tissue freezing), or hypothermia (lowering of the core body temperature). Heated break areas and warm beverages shall be available during periods of cold weather.
- Heat stress control measures required for this site will be implemented according to GeoEngineers Health and Safety Program with water provided on-site.
- Excessive levels of noise (exceeding 85 decibels [dBA]) are anticipated during drilling. Personnel potentially exposed will wear ear plugs or muffs with a noise reduction rating (NRR) of at least 25 dB whenever it becomes difficult to carry on a conversation 3 feet away from a co-worker or whenever noise levels become bothersome. (Increasing the distance from the source will decrease the noise level noticeably.)
- Approved floatation devices will be donned while aboard a vessel. Personnel will become familiar with safety aboard vessel at captain's direction.

4.2. Engineering Controls

______	Trench shoring (1:1 slope for Type B Soils)
X	Locating work spaces upwind/wind direction monitoring
X	Other soil covers (as needed)
X	Dust Control (as needed)

4.3. Chemical Hazards

CHEMICAL HAZARDS (POTENTIALLY PRESENT AT SITE)

Substance	Pathways
Total Petroleum Hydrocarbons (gasoline-, diesel-, and heavy oil-range hydrocarbons)	Free product/Water/Soil
Cyanide	Water/Soil/Sediment
Carcinogenic Polycyclic aromatic hydrocarbons (cPAHs)	Water/Soil/Sediment
Metals (lead and selenium)	Water/Soil/Sediment
Volatile Organic Compounds (VOCs) Benzene and Naphthalene	Water/Soil/Sediment

SPECIFIC CHEMICAL HAZARDS AND EXPOSURES (POTENTIALLY PRESENT AT SITE)

Compound/ Description	Exposure Limits/IDLH	Exposure Routes	Symptoms/Health Effects
Gasoline-range hydrocarbons — liquid with a characteristic odor	300 mg/m^3 TWA	Ingestion, inhalation, skin absorption, skin and eye contact	Irritated eyes, skin, and mucous membrane; fatigue; blurred vision; dizziness; convulsions; headache; dermatitis; possible liver, kidney damage
Cyanide	PEL 5 mg/m^3 TWA REL 5 mg/m^3, 10-min. ceiling IDLH 25 µg/m^3	Ingestion, inhalation, skin absorption, skin and eye contact	Asphaxia; lassitude (weakness, exhaustion), headache, confusion; nausea, vomiting; increased rate and depth of respiration or respiration slow and gasping; thyroid, blood changes
Diesel-range hydrocarbons — liquid with a characteristic odor	None established by OSHA, but ACGIH has adopted 100 mg/m^3 for a TWA (as total hydrocarbons)	Ingestion, inhalation, skin absorption, skin and eye contact	Irritated eyes, skin, and mucous membrane; fatigue; blurred vision; dizziness; slurred speech; confusion; convulsions; headache; dermatitis
Heavy oil-range hydrocarbons — liquid with a characteristic odor	None established by OSHA. 350 mg/m^3 TWA	Ingestion, inhalation, skin absorption, skin and eye contact	Irritated eyes; dizziness; vomiting; convulsions; headache; may cause cancer.

Compound/ Description	Exposure Limits/IDLH	Exposure Routes	Symptoms/Health Effects
Benzene	PEL 1 ppm TWA TLV 0.5 ppm TWA REL 0.1 ppm TWA	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritated eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude; dermatitis; bone marrow depression; confirmed human carcinogen
Polycyclic aromatic hydrocarbons (PAHs)	PEL 0.2 mg/m^3 TLV 0.2 mg/m^3 REL 0.1 mg/m^3 IDLH 80 mg/m^3	Inhalation, ingestion, skin and/or eye contact	Dermatitis, bronchitis, potential carcinogen
Metals (Lead as a chemical)	PEL 50 µg/m^3 TWA REL 50 µg/m^3 TWA TLV 50 µg/m^3	Inhalation, ingestion, skin and eye contact.	Fatigue; headaches; loss of appetite; memory loss; weakness; pain or tingling in limbs
Metals (Selenium as a chemical)	PEL 0.2 mg/m^3 TWA REL 0.2 mg/m^3 TWA IDLH 1 mg/m^3	Inhalation, ingestion, skin and eye contact.	Irritation eyes, skin, nose throat; visual disturbance; headache; chills, fever; dyspnea (breathing difficulty), bronchitis; metallic taste, garlic breath, gastrointestinal disturbance; dermatitis; eye, skin burns

Notes:

ACGIH = American Conference of Governmental Industrial Hygienists
IDLH = immediately dangerous to life or health
µg/m^3 = micrograms per cubic meter
mg/m^3 = milligrams per cubic meter
OSHA = Occupational Safety and Health Administration
PEL = permissible exposure limit
ppm = parts per million
REL = recommended exposure limit
STEL = short-term exposure limit (15 min)
TLV = threshold limit value (over 10 hrs.)
TWA = time-weighted average (Over 8 hrs.)

4.3.1. Gasoline-range Petroleum Hydrocarbons

Gasoline is a complex manufactured mixture that does not exist naturally in the environment. It is a colorless, pale brown, or pink volatile liquid and is very flammable. The odor threshold of gasoline is approximately 0.25 parts per million (ppm) in the air. Gasoline may be present in the air, groundwater, soil, sediment and porewater. Gasoline is also a skin irritant. Breathing in high levels of gasoline for short periods of time or swallowing large amounts of gasoline may also cause harmful effects on the nervous system. Less serious nervous system effects include dizziness and headaches, while more serious effects include coma and the inability to breathe. Effects on the nervous system have also occurred in people exposed to gasoline vapors for long periods of time in their jobs. OSHA has set a legal limit of 300 ppm for workroom air during an 8-hour workday of a 40-hour workweek.

4.3.2. Diesel Oil

Diesel fuels are similar to fuel oils used for heating (fuel oils no. 1, no. 2 and no. 4). All fuel oils consist of complex mixtures of aliphatic and aromatic hydrocarbons. Diesel fuels predominantly contain a mixture of C10 through C19 hydrocarbons, which include approximately 64 percent aliphatic hydrocarbons, 1 to 2 percent olefinic hydrocarbons and 35 percent aromatic hydrocarbons. Workers may be exposed to fuel oils through their skin without adequate protection, such as gloves, boots, coveralls or other protective clothing. Breathing diesel fuel vapors for a long time may damage your kidneys, increase your blood pressure, or lower your blood's ability to clot. Constant skin contact (for example, washing) with diesel fuel may also damage your kidneys. The International Agency for Research on Cancer (IARC) has determined that residual (heavy) fuel oils and marine diesel fuel are possibly carcinogenic to humans (Group 2B classification).

4.3.3. Benzene

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities. Benzene is also a natural part of gasoline. The odor threshold for benzene in air is approximately 60 ppm and is recognizable as benzene at 100 ppm. Benzene may be present in the air, groundwater, soil sediment, and porewater. OSHA maximum allowable exposure limit of benzene in air during an 8-hour workday of a 40-hour workweek is 1 ppm. Benzene is a known carcinogen; therefore, National Institute for Occupational Safety and Health (NIOSH) recommends that all workers wear respirators when they are likely to be exposed to benzene at levels exceeding the recommended (8-hour) exposure limit of 0.1 ppm.

4.3.4. Polycyclic Aromatic Hydrocarbons (PAHs), Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)

Exposure to cPAHs can occur via inhalation of vapors, ingestion, and skin and eye contact. Skin contact can result in reddening or corrosion. Ingestion can cause nausea, vomiting, blood pressure fall, abdominal pain, convulsions and coma. Damage to the central nervous system can also occur. The U.S. Department of Health and Human Services (1989) has classified 15 PAHs compounds as having sufficient evidence for carcinogenicity, while the U.S. Environmental Protection Agency (EPA) (1990) has classified at least five of the identified PAHs as human carcinogens. There is no currently assigned permissible exposure limit time weighted average (PEL-TWA) for cPAHs, but the closely related material coal tar is listed as coal tar pitch volatiles with a PEL-TWA of 0.2 milligrams per cubic meter (mg/m^3). PAHs and cPAHs as soil contaminants can be irritating to eyes and mucous membranes. PAHs are also formed during combustion and are linked to lung cancers with exposure to combustion byproducts. Lymphatic cancers are reported in the literature with PAHs in the presence of carbon black.

4.3.5. Lead

Lead is a common contaminant in source material for manufactured gas plants. Exposure to lead can occur from breathing contaminated air in or near workplaces that process lead or lead materials, as well as from incidentally ingesting dust or paint chips in houses with lead-based paint. Lead can cause effects on the blood, as well as the nervous, immune, renal and cardiovascular systems. Early childhood and prenatal exposures are associated with slowed cognitive development, learning deficits and other effects. Exposure to high amounts of lead can cause gastrointestinal symptoms, severely damage the brain and kidneys, and may cause reproductive effects. Large doses of some lead compounds have caused cancer in lab animals (EPA Technology Transfer Network, Lead Compounds).

4.3.6. Cyanide

Cyanide is used in a number of industries and is found at low levels in air from car exhaust. Cyanide is extremely toxic to humans. Chronic (long-term) inhalation exposure of humans to cyanide results primarily in effects on the central nervous system (CNS). Other effects in humans include cardiovascular and respiratory effects, an enlarged thyroid gland, and irritation to the eyes and skin. No data are available on the carcinogenic effects of cyanide in humans via inhalation. Animal studies have suggested that oral exposure to cassava (a cyanide-containing vegetable) may be associated with malformations in the fetus and low fetal body weights. EPA has classified cyanide as a Group D, not classifiable as to human carcinogenicity (EPA Health Effects Notebook for Hazardous Air Pollutants).

4.3.7. Selenium

Selenium exposure is teratogenic and can result in fetal death as tested in mice. Chronic toxicity is characterized by hair loss, white horizontal streaking on fingernails, paronchyia, fatigue, irritability, hyperreflexia, nausea, vomiting, garlic odor on breath, and metallic taste [FDA Label]. Serum selenium correlates weakly with symtoms. Blood chemistry as well as liver and kidney function are normally unaffected. Acute toxicity presents as stupor, respiratory depression, and hypotension. ST elevations and t-wave changes characteristic of myocardial infarction may be observed (PubChem).

4.4. Biological Hazards and Procedures

Y/N	Hazard	Procedures
Y	Covid-19 virus	See attached JHA for details
Y	Poison Ivy or other vegetation	
Y	Insects or snakes	Work gloves and long sleeve shirt
Y	Used hypodermic needs or other infectious hazards	Do not pick up or contact
Y	Others: Blackberry bushes	Hard hat, gloves and long sleeve shirt

4.5. Additional Hazards

Update in Daily Report. Include evaluation of:

- *Physical Hazards* (equipment hazards, tripping hazards and others)
- *Chemical Hazards* (odors, spills, free product, airborne particulates and others present)
- *Biological Hazards* (stray dogs, discarded needles, pollen, bees/wasps and others present)

5.0 AIR MONITORING PLAN

Work upwind if at all possible.

Check instrumentation to be used:

__X__ Photoionization Detector (PID)

_____ Other (i.e., detector tubes): ____________________

Check monitoring frequency/locations and type (specify: work space, borehole, breathing zone):

_____ 15 minutes - Continuous during soil disturbance activities or handling samples

_____ 15 minutes

_____ 30 minutes

__X__ Initially to detect hot spots and hourly thereafter (in breathing zone during investigation activities)

Additional personal air monitoring for specific chemical exposure:

5.1. Dust

Dust is not expected since the uplands is covered with grass, paving, or buildings. However, if activities generate visible dust, the Site Safety and Health Supervisor will be notified immediately to assess the need for air monitoring and lab analysis for inhalable and respirable particulates.

5.2. Action Levels

- The workspace will be monitored using a photoionization detector (PID) and lower-explosive-limit meter (LEL). These instruments must be properly maintained, calibrated and charged (refer to the instrument manuals for details). Zero this meter in the same relative humidity as the area in which it will be used and allow at least a 10-minute warm-up prior to zeroing. Do not zero in a contaminated area. The PID can be tuned to read chemicals specifically if there are not multiple contaminants on-site. It can be tuned to detect one chemical with the response factor entered into the equipment, but the PID picks up all volatile organic compounds (VOCs) present. The ionization potential (IP) of the chemical has to be less than the PID lamp (11.7 / 10.6eV), and the PID does not detect methane. The LEL meter will detect if explosive gasses such as methane are present at concentrations approaching the LEL.
- An initial vapor measurement survey of the site should be conducted to detect “hot spots” every 15 minutes during initial excavation and boring of the soil. If ppm is below 5 ppm during this time the vapor measurement survey of the workspace can be conducted at least hourly or more often if persistent petroleum-related odors are detected. If vapor concentrations exceed 5 ppm above background continuously for a 15-minute period as measured in the breathing zone, upgrade to Level C personal protective equipment (PPE) or move to a non-contaminated area.
- Note: Standard industrial hygiene/safety procedure is to require that action be taken to reduce worker exposure to organic vapors when vapor concentrations exceed one-half the threshold limit value (TLV). Because of the variety of chemicals, the PID will not indicate exposure to a specific PEL and is therefore not a preferred tool for determining worker exposure to chemicals. If odors are detected, then employees shall upgrade to respirators with Organic Vapor cartridges and will contact the Health and Safety Program Manager for other sampling options.

ACTION LEVEL TABLE FOR CHEMICAL MONITORING

Contaminant	Activity	Monitoring Device	Frequency of Monitoring Breathing Zone	Action Level	Action
Organic Vapors	Environmental Investigations	PID	Start of shift; every 60 minutes and in event of odors	Background to 5 ppm in breathing zone	Use Level D or Modified Level D PPE
Organic Vapors	Environmental Investigations	PID	Start of shift; every 60 minutes and in event of odors	5 to 25 ppm in breathing zone	Upgrade to Level C PPE

Contaminant	Activity	Monitoring Device	Frequency of Monitoring Breathing Zone	Action Level	Action
Organic Vapors	Environmental Investigations	PID	Start of shift; every 60 minutes and in event of odors	> 25 ppm in breathing zone	Stop work and evacuate the area. Contact Health and Safety Manager for guidance.
Benzene	Environmental Investigations	PID	Start of shift; hourly if necessary	Background to 0.5 ppm in breathing zone	Use Level D PPE
Benzene	Environmental Investigations	PID	3 minutes sustained	0.5 ppm – 2.5 ppm in breathing zone	Use Level C PPE
Benzene	Environmental Investigations	PID	3 minutes sustained	> 2.5 ppm in breathing zone	Stop work and evacuate the Site. Contact Health and Safety Manager for guidance.
Combustible Atmosphere	Environmental Investigations	PID or 4-gas meter	Start of shift; every 60 minutes and in event of odors	>10% LEL or >1,000 ppm	Stop work and evacuate the Site. Contact Health and Safety Manager for guidance.

6.0 SITE CONTROL PLAN

This section provides a Control Plan to minimize employee exposure to hazardous substances. In addition, this section addresses methods to delineate work zones and exclude non-site personnel, including pedestrians and park users.

6.1. Traffic or Vehicle Access Control Plans

Roads or parking areas are not present in the portions of the Site where the investigations will take place. No unauthorized vehicles will be allowed in the work area. Contractor vehicle access to the Site will be controlled by the contractor with the help of road work signs and cones.

6.2. Site Work Zones

As part of site control measures to protect the public and restrict access to drilling and hand auger operations and contaminated media, exclusion zones will be established within a minimum of 10 feet around each boring or well during drilling/sampling. Only persons with the appropriate training will enter this perimeter while work is being conducted there.

A contamination reduction zone will be established just outside the exclusion zone for the decontamination of sampling equipment. Care will be taken to prevent the spread of contamination. Equipment and personnel decontamination are discussed in the following sections, and the following types of equipment will be available to perform these activities:

- Scrub brushes;
- Spray rinse applicator;
- Plastic garbage bags; and
- Container of Alconox/water solution and Alconox powder.

Method of delineation / excluding non-site personnel (including pedestrians/park users)

X	Fence (secure IDW area only)
X	Survey Tape
X	Traffic Cones
	Other.

6.3. Buddy System

Personnel on-site should use the buddy system (pairs), particularly whenever communication is restricted. If only one GeoEngineers employee is on-site, a buddy system can be arranged with subcontractor/ contractor personnel.

6.4. Site Communication Plan

Positive communications (within sight and hearing distance or via radio) should be maintained between pairs on-site, with the pair remaining in proximity to assist each other in case of emergencies. The team should prearrange hand signals or other emergency signals for communication when voice communication becomes impaired (including cases of lack of radios or radio breakdown). In these instances, you should consider suspending work until communication can be restored; if not, the following are some examples for communication:

1. Hand gripping throat: Out of air, can't breathe.
2. Gripping partner's wrist or placing both hands around waist: Leave area immediately, no debate.
3. Hands on top of head: Need assistance.
4. Thumbs up: Okay, I'm all right: or I understand.
5. Thumbs down: No, negative.

6.5. Decontamination Procedures

Decontamination, at a minimum, should include removing and disposing of PPE when exiting the exclusion zone and washing your hands. Decontamination may also consist of removing outer protective gloves and washing soiled boots and gloves using bucket and brush provided on-site in the contamination reduction zone. If needed, inner gloves will then be removed, and respirator, hands and face will be washed in either a portable wash station or a bathroom facility at the site. Employees will perform decontamination procedures and wash before eating, drinking, or leaving the site.

6.6. Waste Disposal or Storage

Incidental waste including used PPE is to be placed in a plastic bag for disposal. Investigation derived waste (IDW) will be place in 35/55-gallon drums and stored on site in a secure location pending characterization and disposal.

7.0 PERSONAL PROTECTIVE EQUIPMENT

PPE will consist of standard Level D equipment.

- Level D PPE unless a higher level of protection is required will be worn at all times on the site. Potentially exposed personnel will wash gloves, hands, face and other pertinent items to prevent hand-to-mouth contact. This will be done prior to hand-to-mouth activities including eating, smoking, etc.
- Adequate personnel and equipment decontamination will be used to decrease potential ingestion and inhalation.

Air monitoring will be conducted to determine the level of respiratory protection.

- Half-face combination organic vapor/high efficiency particulate air (HEPA) or P100 cartridge respirators will be available on-site to be used as necessary. P100 cartridges are to be used only if PID measurements are below the site action limit. P100 cartridges are used for protection against dust, metals and asbestos, while the combination organic vapor/HEPA cartridges are protective against both dust and vapor. Ensure that the PID or TLV will detect the chemicals of concern on-site.

Check applicable personal protection gear to be used:

X Hardhat (if overhead hazards, or client requests)
X Steel-toed boots (if crushing hazards are a potential or if client requests)
X Safety glasses (if dust, particles, or other hazards are present or client requests)
X Hearing protection (if it is difficult to carry on a conversation 3 feet away)
___ Chemical resistant boots or boot covers
X Life Jackets (for work near/over water)

Gloves (specify):

X Nitrile
X Latex
___ Liners
___ Leather

Protective clothing:

___ Tyvek (if dry conditions are encountered, Tyvek is sufficient)
___ Saranex (personnel shall use Saranex if liquids are handled or splash may be an issue)
___ Cotton
X Rain gear (as needed)
X Layered warm clothing (as needed)

Inhalation hazard protection:

__X__ Level D

__X__ Level C (respirators with organic vapor/HEPA or P100 filters) – only if needed as indicated by air monitoring)

7.1. Personal Protective Equipment Inspections

PPE clothing ensembles designated for use during site activities shall be selected to provide protection against known or anticipated hazards. However, no protective garment, glove or boot is entirely chemical-resistant, nor does any PPE provide protection against all types of hazards. To obtain optimum performance from PPE, site personnel shall be trained in the proper use and inspection of PPE. This training shall include the following:

- Inspect PPE before and during use for imperfect seams, non-uniform coatings, tears, poorly functioning closures or other defects. If the integrity of the PPE is compromised in any manner, proceed to the contamination reduction zone and replace the PPE.
- Inspect PPE during use for visible signs of chemical permeation such as swelling, discoloration, stiffness, brittleness, cracks, tears or other signs of punctures. If the integrity of the PPE is compromised in any manner, proceed to the contamination reduction zone and replace the PPE.
- Disposable PPE should not be reused after breaks unless it has been properly decontaminated.

7.2. Respirator Selection, Use and Maintenance

If respirators are required, site personnel shall be trained before use on the proper use, maintenance and limitations of respirators. Additionally, they must be medically qualified to wear a respiratory protection in accordance with 29 CFR 1910.134. Site personnel who will use a tight-fitting respirator must have passed a qualitative or quantitative fit test conducted in accordance with an OSHA-accepted fit test protocol. Fit testing must be repeated annually or whenever a new type of respirator is used. Respirators will be stored in a protective container.

7.2.1. Respirator Cartridges

If site personnel are required to wear air-purifying respirators, the appropriate cartridges shall be selected to protect personnel from known or anticipated site contaminants. The respirator/cartridge combination shall be certified and approved by the NIOSH. A cartridge change-out schedule shall be developed based on known site contaminants, anticipated contaminant concentrations and data supplied by the cartridge manufacturer related to the absorption capacity of the cartridge for specific contaminants. Site personnel shall be made aware of the cartridge change-out schedule prior to the initiation of site activities. Site personnel shall also be instructed to change respirator cartridges if they detect increased resistance during inhalation or detect vapor breakthrough by smell, taste or feel, although breakthrough is not an acceptable method of determining the change-out schedule.

7.2.2. Respirator Inspection and Cleaning

The Site Safety and Health Supervisor shall periodically (weekly) inspect respirators at the project site. Site personnel shall inspect respirators prior to each use in accordance with the manufacturer's instructions. In addition, site personnel wearing a tight-fitting respirator shall perform a positive and negative pressure user seal check each time the respirator is donned, to ensure proper fit and function. User seal checks shall be performed in accordance with the GeoEngineers respiratory protection program or the respirator manufacturer's instructions.

7.2.3. Facial Hair and Corrective Lenses

Site personnel with facial hair that interferes with the sealing surface of a respirator shall not be permitted to wear respiratory protection or work in areas where respiratory protection is required. Normal eyeglasses cannot be worn under full-face respirators because the temple bars interfere with the sealing surface of the respirator. Site personnel requiring corrective lenses will be provided with spectacle inserts designed for use with full-face respirators. Contact lenses should not be worn with respiratory protection.

8.0 BOAT, OVER WATER AND NEAR WATER SAFETY PROGRAM

Use of a boat for work requires safe boating practices, good equipment, and training. These procedures are not meant to replace the safety manuals that are provided by the U.S. Coast Guard. Instead they should highlight some of the areas of concern and address specific GeoEngineers, Inc. work procedures. While working near water over waist deep or while on a boat, use a Coast Guard approved flotation device. Remember that being submersed in water increases the chance of hypothermia. Have a dry set of clothes and work with a buddy if you are working around water. If an employee is required to work in the water, they will wear appropriate gear including a wet suit or dry suit if necessary, for safe accomplishment of the task.

The U.S. Coast Guard's Federal Requirements state, "All recreational boats must carry one wearable personal floatation device (PFD) (Type I, II, II, or Type V) for each person aboard… [and that] any boat 16 feet and longer (except canoes and kayaks) must also carry one throwable Type IV PFD."

GeoEngineers' Insurance for working over water is covered under the United States Longshore and Harbor Workers Compensation Act (USL&H) policy (worker's comp over water) and is not specific to the individuals participating. For work in arctic waters an additional site safety plan will be created to address the additional hazards of working in extremely cold waters.

For work on barges or boats or areas near water that have an OSHA standard height and strength guardrail, PFDs are not required while working behind the guardrail. The access to the barge or near water area also requires that the gangway be protected by guardrails. If employees are not wearing PFDs, there cannot be a risk of falling in the water. Fall protection rules can be utilized on projects where employees are not within 6 feet of a leading edge and there is no risk of falling in the water.

8.1. Regulatory References

When working near water, over water or on a barge, OSHA has authority. The U.S. Coast Guard has authority 12 miles offshore and until international waters.

Life Jackets ~ Employees wear Coast Guard Approved vests that meet the water conditions (see Section 9.4.2.5). Employees can wear the self-inflating vests.

This safety program is based on the following state and federal regulations:

- OSHA 1926.106 Working over or near water; 1926.605 Marine operations and equipment; Access to vessels 1915.74 and Access to barges and river towboats 1918.26 (Idaho, Missouri)
- WAC 296-800-160 Personal Protective Equipment for PFD (Washington)
- OR-OSHA 1926 (Oregon)
- AAC Title 8 (Alaska)
- HIOSH Title 12 (Hawaii)
- Cal/OSHA Title 8 (California)

8.2. Procedures for Using Boats

Two people will be involved with the use of the boat. The boat operator should always plan a course of travel that is the safest and minimizes the distance to the shore. As a general courtesy, the boat should be cleaned up by the user after each day. Note that for this project the research vessel used for sediment sampling will be subcontracted and the subcontractor shall operate the boat and sampling device(s).

8.2.1. Maneuvering a Boat

- To move boat from dock, move stern away then bow (but not into waves or wind)
- Try not to depend on fendering, slow down
- Communicate with other person in boat when:
    - increase or decrease speed
    - dramatically change direction
    - approach pilings so hands can come inside boat

8.2.2. Right-of-Way

- Watch out for ferry traffic-- large vessels have right of way and cannot stop
    - Don't cut them off, they move much faster than they appear to. If the boat breaks down in a ferry lane, use radio, flares, and wave and make sure they see you until help arrives.
- Larger vessel has right of way over smaller.
- With boats of similar size, sailboat has right of way.
- When lights are visible, green has the right of way over red.

8.2.3. Load Limits

Cargo should be evenly distributed and there should be a safe amount of freeboard which depends on water conditions. When loading up the boat for travel that goes beyond the protection of the pier, the employee should drive to the end of the pier and check wave conditions before entering.

8.2.4. Engine Use

When using an outboard motor, the boat operator will use the tether kill switch. This will hook to the employee's wrist and turn off the engine if the employee were to be launched into the water.

8.2.5. Personal Floatation Device (PFD)

Type 1 PFDs will be worn in the boats at all times. PFD will be the correct size for the wearer and will be securely fastened. The PFD should be inspected for damage prior to each use.

In water with PFD -- to reduce water from lowering body temperature:

- One person: cross arms pull knees up
- Two persons: huddle together

Chance of swimming 100 yards is not very good, so the best strategy is to stay with the boat. The boat should always be closer to shore than this distance during transport and the employee would be close enough to swim to shore.

8.2.6. Throwing Lines

- Make first two coils larger
- Kneel in boat
- Shoulder pointed to victim
- Throw over their head

8.2.7. Water on Board

- A 5-gallon bucket will always be available on the boat to bale water that comes inside the boat.

8.2.8. Towing

- Take time to set up
- Look at lines
- Stay in step with waves
- For logs, may want to tow from bow. use timber hitch, shackle to weigh down
- Don’t overstress lines
- Don’t shock load lines
- Sea anchor – can use to slow down tow, make more controllable. For some situations, a sea anchor is not necessary and could make things worse.

8.2.9. Safety and Signals

- Horn blasts: 5 short signals danger
- Lights: Employees will not be traveling between terminals in the dark. If it becomes dark while working, the operator will moor the boat at that terminal for the night. A flashlight will be available in the waterproof box stored in the workboat.

8.3. Barge or Platform Procedures

Any work within 6 feet of a leading edge will require a life jacket if water is below the leading edge. Railings must be present if a leading edge is above a hard surface. Refer to GeoEngineers' Fall Protection Program for additional details.

Employees shall not be permitted to walk along the sides of covered lighters or barges with coamings more than 5 feet high, unless there is a 3-foot clear walkway, or a grab rail, or a taut hand line is provided. (Coaming is any vertical surface on a ship designed to deflect or prevent entry of water. It usually refers to raised section of deck plating around an opening, such as a hatch. Coamings also provide a frame onto which to fit a hatch cover.)

Employees shall not be permitted to walk over deck loads from rail to coaming unless there is a safe passage. If it is necessary to stand at the outboard or inboard edge of the deck load where less than 24 inches of bulwark, rail, coaming, or other protection exists, all employees shall be provided with a suitable means of protection against falling from the deck load.

The employer shall ensure that there is in the vicinity of each barge in use at least one U.S. Coast Guard-approved 30-inch life ring with not less than 90 feet of line attached, and at least one portable or permanent ladder which will reach the top of the apron to the surface of the water. If the above equipment is not available at the pier, the employer shall furnish it during the time that he is working the barge.

Whenever practicable, a gangway of not less than 20 inches walking surface of adequate strength, maintained in safe repair and safely secured shall be used. If a gangway is not practicable, a substantial straight ladder, extending at least 36 inches above the upper landing surface and adequately secured against shifting or slipping shall be provided. When conditions are such that neither a gangway nor a straight ladder can be used, a Jacob's ladder meeting the requirements of paragraphs (d)(1) and (2) of this section may be used.

8.3.1. Cranes/Hoists/Cables

Employees need to use caution when working in areas where cranes, hoists and cables are in use. Refer to the GeoEngineers' Drilling and Rigging Safety Program.

8.4. Working Near Water Procedures

GeoEngineers' employees working over or near water, where the danger of drowning exists, shall be provided with U.S. Coast Guard-approved life jacket or buoyant work vests.

Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects which would alter their strength or buoyancy. Defective units shall not be used.

Ring buoys with at least 90 feet of line shall be provided and readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.

At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.

8.5. Emergency Procedures

The following topics are items that are important for handling an emergency. The boat operator should know these procedures and follow them at all times.

8.5.1. Communication

The Marine Radio will be with the boat operator at all times. Before entering the boat, the operator will call in to the Dispatcher and notify them of the location and destination of the boat. Each time an employee enters or exits the boat, this will be recorded by the Dispatcher. This contact should occur at departure and arrival for long transits.

8.5.2. Engine Problems

In the event of engine problems, contact the Dispatcher and notify them of the situation immediately. Depending on the situation, a rescue could be dispatched by the Coast Guard, another employee or a contractor. If a repair is made in the interim while waiting for the tow, call the Dispatcher again and notify them of the situation.

Spare plugs will be in the waterproof kit for offshore engine problems only. The boat operator will be required to take a spare tank and line for fuel, thus eliminating the need for spare line.

8.5.3. Distress Flares

Are located in the waterproof boxes that the boat operator needs to ensure are on the boat before each travel session. Boat operators should also make sure that they are familiar with the operation of these flares.

8.5.4. Person Overboard/Rescue

Boat operators should be familiar with in water rescue techniques. The Coast Guard recommends that people not try to swim long distances to shore but wait for a rescue. This is because of hypothermia. Please see the section on "Personal Floatation Devices." Access back into the boat will be from the stern. The engine will be turned off while the employee re-enters the boat.

8.5.5. Fire

Each workboat will be equipped with a 5 lb. ABC fire extinguisher located near the bow. The fire extinguisher should be checked each time the boat is used to ensure that it is ready to operate.

8.5.6. Work Related Injuries

Work related injuries that are not threatening to the safety of the persons on board should be reported to the Supervisor as soon as possible. Any work-related injury that impairs operation of the boat should be called in to the GeoEngineers' office immediately. The office will call for the Coast Guard and or the Fire Department in the event of a serious injury.

8.6. Weather/Tides

If the visibility is very low due to fog, the operator will not take the boat out.

8.6.1. Fog

In fog employees will stay within sight of the shoreline and/or head in and tie up. Whereas the Maritime Training Center (MTC) class instructed employees to drop anchor and use horn alert those nearby, employees are not likely to be caught unexpected in dense fog and should not go out if visibility is not sufficient for travel. Remember, ferry boats can't pick you up on radar and can't stop quickly.

8.6.2. Rough Water

- Look for protection from oncoming wind/waves. Can be the leeward side of a boat, dock, or pier
- Head into swells, throttle up when approaching, throttle down when dropping down
- Check wave conditions before taking the boat out
- Head in at 45-degree angle at times, depending on wave size

8.6.3. Tides

Tidal changes in the Puget Sound and northern areas can be significant. Employees should always be aware of the tide changes and plan their work accordingly. There have been several instances where work under the docks became dangerous due to changing tides and lack of planning.

8.7. List of Supplies

In addition to the list of supplies generated in the training at the MTC, the U.S. Coast Guard identified the following items to be critical for safe boating.

<u>Items to be stored with the boat at all times:</u>

- Oars and oarlocks
- Anchor
- Bucket for baling water
- Fire Extinguisher
- One spare fuel tank and line

<u>Items that will be brought onto the boat when in use</u>:

- Marine radio
- Watertight box with first aid kit, flashlight, flares
- Personal Floatation Device(s)
- Carry a knife with serrated edge
- Tide book
- Spare plugs and wrench

8.8. Personal Floatation Device Specifications

PFD use applies to terminals and piers and employees working near other bodies of water. It also applies to all activities conducted by GeoEngineers employees at these facilities, including construction, maintenance, inspections, tours, and operations. Type 1 PFDs will be worn in the boats at all times. PFD will be the correct size for the wearer and will be securely fastened. The PFD should be inspected for damage prior to each use. Boats longer than 16 feet must carry at least one Type I, II, III, or V PFD for each person on board.

In addition, at least one Type IV (throwable device) must be carried. This is important, you may not use a Type IV "flotation cushion" as your sole PFD in your small rowboat or sailing dingy. Note: If a Type V device is used to count toward requirements, it must be worn. Federal regulations require PFDs on canoes and kayaks of any size; they are not required on racing shells, rowing skulls, or racing kayaks. State laws may vary.

PFDs are required for:

- Any employee in a boat/skiff/barge,
- Any employee is working on top of, or beyond the bull rail (a railing for docking the boat), or
- Employees working near water where the danger of drowning exists.

PFDs are not specifically required when:

- Employees are working behind standard height and strength guardrails.
- Employees are working inside operating cabs or stations that eliminate the possibility of accidentally falling into the water.
- Employees are wearing an approved safety harness with a lifeline attached that prevents the possibility of accidentally falling into the water.
- Working behind a guardrail of standard height and strength or other stable restraint.
- A single person is working more than 6 feet from the edge.
- Working over shallow water (less than chest deep) where floatation would not be achieved (other protective measures required).

Provide your employees with PFDs approved by the U.S. Coast Guard for use on commercial or merchant vessels. The following are appropriate or allowable United States Coast Guard-approved PFDs:

Type of PFD	General Description
Type I	Off-Shore Life Jacket-effective for all waters or where rescue may be delayed.
Type II	Near-Shore Buoyant Vest- intended for calm, inland water or where there is a good chance of quick rescue.
Type III	Flotation aid- good for calm, inland water, or where there is a good chance of rescue.
Type V	Flotation aids such as boardsailing vests, deck suits, work vests and inflatable PFDs marked for commercial use.

8.8.1. Off-Shore Life Jacket (Type I PFD)

Best for open, rough, or remote water, where rescue may be slow coming.

- Advantages
    - Floats person the best.

- Turns most unconscious wearers face-up in water.
- Highly visible color.

■ Disadvantages

- Bulky.

8.8.2. Near-Shore Buoyant Vest (Type II PFD)

Good for calm, inland water, or where there is good chance for fast rescue.

■ Advantages

- Turns some unconscious wearers face-up in water.
- Less bulky, more comfortable than Off-Shore Life Jacket (Type I PFD).
- Compromise between Type I PFD performance and wearer comfort.

■ Disadvantages

- May be uncomfortable wearing for extended periods.
- Will not turn as many people face-up as a Type I PFD will.
- In rough water, a wearer's face may often be covered by waves.
- Not for extended survival in rough water.

8.8.3. Flotation Aid (Type III PFD)

Good for calm, inland water, or where there is good chance of fast rescue.

■ Advantages

- Generally, the most comfortable type for continuous wear.
- Freedom of movement for water skiing, small boat sailing, fishing, etc.
- Available in many styles, including vests and flotation coats.

■ Disadvantages

- Not for rough water.
- Wearer may have to tilt head back to avoid face-down position in water.

Inflatable PFDs come in Types I, II, and III. Although the different “Types” of inflatable PFDs are intended for use in the same areas as inherently buoyant types of PFDs, the characteristics of inflatable PFDs are different. Inflatable PFDs are not inherently buoyant and will not float without inflation. For Types I, II, and III inflatables, the lower the Type number, the better the PFDs performance (e.g., Type I is better than Type II).

Although inflatable PFDs are considered one of the most comfortable PFDs to wear when it is hot, inflatable PFDs require regular maintenance and are not recommended for children or individuals who can’t swim. Inflatable PFDs are not for use where water impact is expected as when waterskiing, riding personal watercraft, or whitewater paddling.

8.9. Training

8.9.1. Personnel Using Boats

Each state is specific boat training requirements. In addition, the U.S. Coast Guard can also be contacted for local training opportunities. All GeoEngineers employees operating a boat should have documented training.

The topics are copied from the Basic Use section of these Policy and Procedure Training materials provided by MTC are available from the Health and Safety Program Manager to use as a guide for additional training.

- Boat safety
- Boat operations, maneuvering (hands on)
- Towing
- Communications
- Emergency situations
- Rescue (hands on)
- Use of ropes (hands on)

8.9.2. Personnel Working Over or Near Water

GeoEngineers employees working over or near water should be trained in the contents of the Boat, Over Water and Near Water Safety Program. At the start of each project in which working over or near water presents a danger of drowning employees should have a tailgate safety meeting and discuss the following:

- The danger of drowning where it exists.
- Use of U.S. Coast Guard-approved life jacket or buoyant work vests.
- Life jacket or buoyant work vests inspections.
- Location of ring buoys for emergency rescue operations.
- Location of a lifesaving skiff for rescue if needed.

9.0 ADDITIONAL ELEMENTS

9.1. Cold Stress Prevention

Working in cold environments presents many hazards to site personnel and can result in frost nip (superficial freezing of the skin), frost bite (deep tissue freezing), or hypothermia (lowering of the core body temperature).

The combination of wind and cold temperatures increases the degree of cold stress experienced by site personnel. Site personnel shall be trained on the signs and symptoms of cold-related illnesses, how the human body adapts to cold environments, and how to prevent the onset of cold-related illnesses. Heated break areas and warm beverages shall be provided during periods of cold weather.

9.2. Heat Stress Prevention

State and federal OSHA regulations provide specific requirements for handling employee exposure to heat stress. GeoEngineers' program complies with these requirements and will be implemented in all areas where heat stress is identified as a potential health issue.

General requirements for preventing heat stress apply to outdoor work environments from May 1 through September 30, annually, only when employees are exposed to outdoor heat at or above an applicable temperature listed in the table below. To determine which temperature applies to each worksite, select the temperature associated with the general type of clothing or personal protective equipment (PPE) each employee is required to wear.

HEAT STRESS

Type of Clothing	Outdoor Temperature Action Levels (Degrees Fahrenheit)
Nonbreathing clothes including vapor barrier clothing or PPE such as chemical resistant suits	52°
Double-layer woven clothes including coveralls, jackets and sweatshirts	77°
All other clothing	89°

9.2.1. Minimize Exposure to Extreme Temperatures

Where acceptable temperature cannot be maintained, all outdoor work should be scheduled so as to minimize exposure to extreme temperatures.

9.2.2. Monitoring

Temperature and conditions in the work area should be monitored by supervisory personnel.

9.2.3. Appropriate Dress

Employees are required to dress appropriately for the relevant working conditions, including normal weather extremes. Limiting the time of exposure and wearing protective clothing will reduce the dangers of exposure to heat. Clothing should:

- Be constructed of an absorbent, close-weave material that doesn't allow penetration of sunlight; and
- Be worn in light layers that can be adjusted for comfort.

9.2.4. Preventive Measures for Working Outdoors

The following measures are to be implemented to protect employees working outdoors:

- Use of a range of sunscreens (with high protection factor) that are persistent on the skin irrespective of humidity and perspiration.
- Encouragement of the application of a sunscreen 15 minutes prior to exposure.
- Encouragement of regular re-application of sunscreen throughout the day.

- Use of safety sunglasses (where lighting is not an issue).

9.2.5. Appropriate Dress

Employees shall retire to shaded or cooled areas for rest breaks when possible.

9.2.6. Rest Breaks

When cool down is required, employees shall take rest breaks in a shaded or cooled area.

9.2.7. Drinking Water

Ensure an adequate supply of cool drinking water for the employees to replace water lost through perspiration. It is essential that water intake be approximately equal to the amount of sweat produced to avoid dehydration. Most workers exposed to hot conditions drink fewer fluids than needed because of an insufficient thirst drive. A worker, therefore, should not depend on thirst to signal when and how much to drink.

- Fluids shall be replaced approximately every 20 minutes in amounts of at least one gallon per day.
- Water shall be kept cool throughout the operation.
- Electrolyte replacement shall be in the form of a commercial electrolyte replacement drink (that is, Gatorade or equivalent).
- Avoid alcohol and caffeine (including coffee and tea), which contribute to dehydration.

9.2.8. Air Conditioning

Minimize humidity in the work environment to improve sweat evaporation from the surface of the skin. This can be accomplished by air conditioning or dehumidification. Cooling by the evaporation of sweat lets the body reduce its temperature; evaporation proceeds more quickly, and the cooling effect is more pronounced within increasing air speed and low relative humidity. When possible, vehicle and work areas should be equipped with air conditioning.

9.2.9. Reduce Physical Demands

Increase work during high temperatures can add stress to the body. Reduce physical demands of work task when possible through mechanical means such as hoists, hand trucks, lift-tables etc.

9.2.10. Steps to Prevent Heat Stress

Steps to help prevent heat stress include:

- Consider a worker's physical condition when determining fitness to work in hot environments. Obesity, lack of conditioning, pregnancy and inadequate rest can increase susceptibility to heat stress.
- Certain medical conditions (such as heart conditions) or treatments (such as low-sodium diets and some medications) increase the risk from heat exposure.
- Seek medical advice when symptoms of heat stress appear.
- Schedule strenuous physical activity at the beginning and end of the day, when external temperatures may be cooler.

- Provide portable water sprayers so that employees can cool down skin surfaces.
- Provide whole-body cooling devices such as ice vests with frozen packs or recirculation systems.

10.0 MISCELLANEOUS

10.1. Emergency Response

Indicate what site-specific procedures you will implement.

- Personnel on-site should use the "buddy system" (pairs).
- Visual contact should be maintained between "pairs" on-site, with the team remaining in proximity to assist each other in case of emergencies.
- If any member of the field crew experiences any adverse exposure symptoms while on-site, the entire field crew should immediately halt work and act according to the instructions provided by the Site Safety and Health Supervisor.
- The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated should result in the evacuation of the field team, contact of the PM, and reevaluation of the hazard and the level of protection required.
- If an accident occurs, the Site Safety and Health Supervisor and the injured person are to complete, within 24 hours, an Accident Report for submittal to the PM, the Health and Safety Program Manager and Human Resources. The PM should ensure that follow-up action is taken to correct the situation that caused the accident or exposure.

10.2. Personnel Medical Surveillance

GeoEngineers employees are not in a medical surveillance program because they do not fall into the category of "Employees Covered" in OSHA 1910.120(f)(2), which states a medical surveillance program is required for the following employees:

1. All employees who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year;
2. All employees who wear a respirator for 30 days or more a year or as required by state and federal regulations;
3. All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation; and
4. Members of HAZMAT teams.

10.3. Spill Containment Plans (Drum and Container Handling)

If fluid from the wells is spelled onto the ground the area should be identified and noted in the field report, If significant volume of fluid is spilled absorbent (such as cat litter) should be applied to the spill area and the project manager contacted. Spent absorbent material will need to be stored within the designated containment area, which will be enclosed by fencing.

10.4. Sampling, Managing and Handling Drums and Containers

Drums and containers used during the cleanup shall meet the appropriate Department of Transportation (DOT), OSHA and EPA regulations for the waste that they contain. Site operations shall be organized to minimize the amount of drum or container movement. When practicable, drums and containers shall be inspected, and their integrity shall be ensured before they are moved. Unlabeled drums and containers shall be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled. Before drums or containers are moved, all employees involved in the transfer operation shall be warned of the potential hazards associated with the contents.

Drums or containers and suitable quantities of proper absorbent shall be kept available and used where spills, leaks or rupture may occur. Where major spills may occur, a spill containment program shall be implemented to contain and isolate the entire volume of the hazardous substance being transferred. Fire extinguishing equipment shall be on hand and ready for use to control incipient fires.

10.5. Sanitation

Public washrooms are present at the south end of Boulevard Park. If necessary, portable toilets will be provided during work activities. Water should be available in the decontamination area for washing.

10.6. Lighting

Investigation activities are expected to be conducted during daylight hours. However, in the event that work must occur early or late in the day to time the activities at low tide, the contractor will be required to provide adequate artificial lighting to safely perform investigation activities.

11.0 DOCUMENTATION TO BE COMPLETED FOR HAZWOPER PROJECTS

The following forms are required for Hazardous Waste Operations and Emergency Response (HAZWOPER) projects:

- Field Log
- Health and Safety Plan acknowledgment by GeoEngineers employees (Form 2)
- Contractors Health and Safety Plan Disclaimer (Form 3)
- Conditional forms available at GeoEngineers office: Accident Report

NOTE: The Field Report is to contain the following information:

- Updates on hazard assessments, field decisions, conversations with subcontractors, client or other parties, etc.;
- Air monitoring/calibration results, including personnel, locations monitored, activity at the time of monitoring, etc.;
- Actions taken;
- Action level for upgrading PPE and rationale; and
- Meteorological conditions (temperature, wind direction, wind speed, humidity, rain, snow, etc.).

12.0 APPROVALS

1.	Plan Prepared	Neil Morton Neil Morton Preparer	October 30, 2020 Date
2.	Plan Approval	Iain H. Wingard Iain Wingard Project Manager	October 30, 2020 Date
3.	Health & Safety Officer	Mary Lou Sullivan Mary Lou Sullivan Health & Safety Program Manager	NOV 2 2020 Date

HASP FORM 1
HEALTH AND SAFETY BRIEFING
SOUTH STATE STREET - PRDI WORK PLAN
FILE NO. 0186-890-02

Inform employees, contractors and subcontractors or their representatives about:

- The nature, level, and degree of exposure to hazardous substances they're likely to encounter;
- Emergency response procedures; and
- Any identified potential fire, explosion, or other health or safety hazards, and associated safe work practices.

Date	Topics	Attendee	Company Name	Employee Initials

HASP FORM 2
SITE SAFETY PLAN – GEOENGINEERS' EMPLOYEE ACKNOWLEDGMENT
SOUTH STATE STREET - PRDI WORK PLAN
FILE NO. 0186-890-02

(All GeoEngineers' Site workers shall complete this form, which should remain attached to the Safety Plan and filed with other project documentation).

I hereby verify that a copy of the current Safety Plan has been provided by GeoEngineers, Inc., for my review and personal use. I have read the document completely and acknowledge an understanding of the safety procedures and protocol for my responsibilities on Site. I agree to comply with all required, specified safety regulations and procedures.

Print Name	**Signature**	**Date**

HASP FORM 3
SUBCONTRACTOR AND SITE VISITOR SITE SAFETY FORM
SOUTH STATE STREET - PRDI WORK PLAN
FILE NO. 0186-890-02

I verify that a copy of the current Site Safety Plan has been provided by GeoEngineers, Inc. to inform me of the hazardous substances on Site and to provide safety procedures and protocols that will be used by GeoEngineers' staff at the Site. By signing below, I agree that the safety of my employees is the responsibility of the undersigned company.

Print Name	**Signature**	**Firm**	**Date**

Project Name: PRDI Work Plan HASP **File No:** 186-890-02	**Date:** October 30, 2020	**Site Location:** Boulevard Park and South State Street Bellingham, Washington

Application:

This COVID-19 supplementary JHA is designed to meet the requirements of GeoEngineers' Field Safety During COVID-19 protocols and the COVID-19 Response Plan as well as the recommendations provided by the Centers for Disease Control and Prevention (CDC) and other applicable state or federal agencies.

PPE/Supplies/Actions Equipment: (select those applicable to this jobsite)

PPE	Supplies	Tools	Actions
☒ Eye Protection	☐ Hand Washing Soap	☒ Cell Phone/Satellite	☒ Maximize Social Distance (≥6ft)
☒ Gloves	☐ Hand Washing Water Supply	☐ Scanning Thermometer	☒ Meeting Location Planning
☒ Cloth Face Covering	☒ Hand Sanitizer	☐ Water Basin	☐ Hand Washing
☐ N95 Mask	☒ Sanitizing Wipes	☐	☒ High Touch Surface Sanitation
☐ Disposable Coveralls	☐	☐	☐
☐	☐	☐	☐
☐	☐	☐	☐

Job Steps	Potential Hazard	Critical Actions to Mitigate Hazard
Mobilization to worksite	Transmission of COVID-19 Virus	■ Check temperature at home prior to mobilizing to worksite. ■ Pack hand sanitizer and wipes for use during all modes of business travel. ■ Assign hand sanitizer to vehicle when able. ■ Sanitize "high touch" areas: keys, steering wheels, dash controls, door handles, mirror adjustments, shifter, blinkers, head rests, etc. ■ Re-Fueling: Use sampling gloves or wash hands after using the pump at a gas station. When possible, do this before you get back into the vehicle. ■ Intra-Site Transportation: Maintain social distancing on transport skiffs or multi-passenger ATVs. Request multiple trips if overcrowded. Keep your field PPE on during travel.
Pre-work Safety Meetings	Transmission of COVID-19 Virus	■ Review site maps, photos and routes prior to site arrival to anticipate present staffing or public density areas. ■ Conduct a tailgate safety meeting in location that can accommodate ≥6' social distancing. ■ Keep group sizes as small as possible (≤ 10 people or smaller depending on individual state guidance). ■ Meeting attendance should be verbally announced and recorded by a single representative to avoid contact with shared supplies/equipment/computers/work surfaces. ■ Use verbal greetings. Do not shake hands, hug, fist bump, or high five. ■ Wear face coverings if social distances cannot be maintained. ■ Use own supply of pens, notebooks and similar field supplies.

Site Operations	Transmission of COVID-19 Virus	■ Maximize social distances to the greatest extent feasible. ■ If tasks or locations require sharing workspaces in proximity to others with <6' separation, wear a face covering. ■ Sanitize shared tools or equipment ■ Use own vehicle as site office rather than shared spaces. ■ Wash ungloved hands after contacting shared surfaces. ■ Sanitize personal items regularly (cell phone, water bottle, clipboards, notebooks). ■ Set up exclusion zones surrounding public interface areas if < 6' separation. ■ Wear face covering if traveling off site for lunch/coffee/supplies and recommended social distances cannot be maintained. ■ Leave job site if experiencing onset of COVID-19 symptoms.
Positive or Assumed Positive COVID-19 Result at Job Site	Transmission of COVID-19 Virus	■ Contact your manager as soon as information is received of a positive or assumed positive result on the jobsite. ■ Determine if you have had close and prolonged personal proximity to the individual. ■ Based on proximity, you may be asked to remove yourself from the worksite. ■ Your manager will provide guidance for how to proceed safely following worksite withdrawal.
Additional Comments:		

DAILY JHA RECORD OF SAFETY MEETINGS

Name of Attendees **Date**

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Signature of Individual Verifying the Above **Date**

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