Pre-Remedial Design Investigation Project Plan
Central Waterfront Cleanup Site
Bellingham, Washington

October 14, 2020

Prepared for

Port of Bellingham
Bellingham, Washington

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ALS	Analytical Laboratory Services, Inc.
AO	Agreed Order AO DE 3441
ARI	Analytical Resources, Inc.
ASB	Aerated Stabilization Basin
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CAP	Cleanup Action Plan
City	City of Bellingham, Washington
Ecology	Washington State Department of Ecology
EDR	Engineering Design Report
EPA	US Environmental Protection Agency
FID	flame ionization detector
ft	foot/feet
GMP	gas monitoring probe
GPS	Global Positioning System
HASP	health and safety plan
IDP	Inadvertent Discovery Plan
LAI	Landau Associates, Inc.
LANDGEM	Landfill Gas Emissions Model
LFG	landfill gas
LNAPL	light non-aqueous phase liquid
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
NAPL	non-aqueous phase liquid
PAH	polycyclic aromatic hydrocarbon
Port	Port of Bellingham
PRDI	Pre-Remedial Design Investigation
PSE	Puget Sound Energy
PVC	polyvinyl chloride
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RI/FS	Remedial Investigation/Feasibility Study
SAP	sampling and analysis plan
SSC	Sanitary Services Company
Site	Central Waterfront Cleanup Site
TPH	total petroleum hydrocarbons
TPH-D	diesel-range total petroleum hydrocarbons
TPH-G	gasoline-range total petroleum hydrocarbons
TPH-O	motor oil-range total petroleum hydrocarbons
VOC	volatile organic compound
Wilson	Wilson Engineering

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1.0 INTRODUCTION

The Washington State Department of Ecology (Ecology) approved a Remedial Investigation/Feasibility Study (RI/FS) of the Central Waterfront Cleanup Site (Site) located in Bellingham, Washington (Anchor QEA 2018). The RI/FS assessed a range of cleanup options for the Site. Subsequently, Ecology finalized a Cleanup Action Plan (CAP), which identifies the selected cleanup action for the Site (Ecology 2020). The Port of Bellingham (Port) is conducting a Pre-Remedial Design Investigation (PRDI) to support effective implementation of Ecology's approved cleanup action. This PRDI Project Plan (and subsequent addenda) has been prepared by Landau Associates, Inc. (LAI) to support a supplemental design-focused investigation at the Site with the objective of addressing data gaps necessary to inform the preparation of design documents.

1.1 Site Background

The Site is part of a historical and active waterfront industrial property that is bordered to the north by the I&J Waterway, the south by Whatcom Waterway, the east by Roeder Avenue, and the west by the Aerated Stabilization Basin (ASB) and Bellingham Bay (Figure 1-1). The Site comprises approximately 51 acres of upland area. The adjacent intertidal and sediment areas are generally not included within the Site boundary, except for Site-related metals in Whatcom Waterway sediments adjacent to the C Street Properties subarea. This sediment area was addressed as part of the Whatcom Waterway Phase 1 cleanup action in 2016.

The upland area has been impacted by historical landfilling and various industrial activities. Site contamination includes landfill refuse, total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), metals, and landfill gas (LFG).

The Site was previously subdivided into four separate cleanup sites based on historical operations and geographical areas. Figure 1-2 shows the locations of Site historical operations, including the former Chevron Terminal, Colony Wharf, the extent of the Roeder Avenue Landfill, and the former Olivine Uplands.

- The former Chevron Terminal area is located in the southwestern portion of the Site. It was operated as a bulk terminal from approximately 1913 until the late 1980s.
- The Colony Wharf area is located within the southeastern portion of the Site. It has been used for a variety of industrial activities since the early 1900s, including sale of building products (coal, lime, cement, plaster, brick, and tile); steel casting; foundry operations; truck garage; cement products manufacturing; boat repair and maintenance; machine shop and welding; fish and seafood distribution; and, electrical equipment manufacturing, sales, and repair (Ecology 2020).
- The Roeder Avenue Landfill was constructed in 1965 on the former Georgia-Pacific-owned property. Prior to the landfill, the area consisted of a shallow-water marine area used for log rafting. The landfill's construction included placement of a clay berm extending north-south

between Hilton Avenue and C Street, and a soil cover on top of the landfilled wood waste and municipal City of Bellingham (City) refuse.

- The former Olivine Uplands area is located within the northern portion of the Site. Former operations included lumber milling, truck fueling and equipment maintenance, and olivine ore and cement processing. The western portion of this area was a former bulk fuel terminal (Time Oil).

1.2 Site Features and Use

Operations at the Site are currently of mixed use (i.e., Marine Trade designation), including a combination of industrial, commercial, and institutional operations. The Port owns and leases most of the land within the Site. Current Port tenants include boat maintenance and storage (Landings at Colony Wharf), Technology Development Center for educational purposes (Bellingham Technical Institute) within the warehouse building, seafood processing (Bornstein Seafoods), boat storage and lift service (Hilton Harbor), concrete and shore-protection structures (Bellingham Marine Industries), and ship manufacturing (All American Marine). The street rights-of-way within the Site are public streets with rights of use by the local jurisdictions. Two properties along Roeder Avenue on the east side of the Site are owned and operated by Puget Sound Energy (PSE) and Sanitary Services Company (SSC) for electrical substation operations and refuse and recycling truck maintenance and storage, respectively.

The Site was divided into three subareas in the RI/FS and CAP: the Landfill and Perimeter subarea (Roeder Avenue Landfill and its perimeter), the C Street Properties subarea (former Chevron Terminal and Colony Wharf), and the Hilton Avenue Properties subarea (former Olivine Uplands and former Time Oil facility). These designations will be used throughout this work plan and in future addenda to support further investigation and organization of Site information.

1.3 Current Environmental Conditions Summary

Numerous environmental investigations and interim cleanup actions have been conducted throughout the Site since the 1980s. Site interim cleanup actions included underground storage tank decommissioning and petroleum-related contamination cleanup within the C Street Properties subarea (former Chevron Terminal); construction of the Georgia Pacific warehouse and All American Marine buildings, both having LFG control systems; and, the C Street Terminal project, which removed impacted soils and improved stormwater and utility infrastructure.

Contaminants of concern within the Roeder Avenue Landfill subarea include metals; gasoline-range, diesel-range, and motor oil-range total petroleum hydrocarbons (TPH-G, TPH-D, and TPH-O, respectively); PAHs; volatile organic compounds (VOCs, specifically benzene); and semivolatile organic compounds (SVOCs) in soil and groundwater. LFG from the degradation of refuse impacts soil and potential interior air within structures at the Site. LFG contamination consists of VOCs released within

the soil (soil gas vapor) and potentially through concrete slabs of Site structures within the Landfill and Perimeter subarea (Ecology 2020).

Contaminants of concern within the C Street Properties subarea include petroleum hydrocarbons and associated constituents (i.e., TPH-G, TPH-D, and TPH-O), benzene, PAHs, metals, and VOCs in soil, groundwater, soil gas, sediment porewater, and sediments (Ecology 2020).

Contaminants of concern within the Hilton Avenue Properties subarea include petroleum hydrocarbons (i.e., TPH-G), metals (arsenic and lead), and PAHs in soil. Soil impacts in this subarea are not a source of groundwater contamination (Ecology 2020).

2.0 CLEANUP ACTION PLAN REQUIREMENTS

The cleanup action for the Site must achieve the requirements outlined under the Model Toxics Control Act (Chapter 70.105D of the Revised Code of Washington), as required in the Agreed Order (AO) and detailed in the final CAP (Ecology 2020). This section briefly highlights the basis for and elements of the planned cleanup action.

2.1 Agreed Order Amendment

AO DE 3441, entered into by Ecology, the Port, and the City in 2006, required completion of an RI/FS. The first amendment (August 2012) required an interim action to excavate and remove non-aqueous phase liquid (NAPL) petroleum and petroleum-contaminated soils and sediment from the former Chevron area. The second amendment (November 2018) required a public review of the draft CAP. The third amendment (February 2020) requires the preparation and submittal (for Ecology's review and approval) of the documents necessary to complete the design and permitting phase of the cleanup action described in the final CAP. This Project Plan (and associated future addenda) has been prepared to address the requirement of the third amendment to the AO.

The third amendment Scope of Work is divided into three major tasks:

- Task 1: PRDI Project Plan and Implementation. Describes the work necessary to further investigate the Site to inform effective design of the prescribed remedy. Planned activities include investigating existing surface conditions to assess their current adequacy and required improvements to meet cleanup objectives, to delineate the hotspot removal area, and to investigate LFG and the potential need for a gas collection system for existing and planned buildings within the Landfill and Perimeter subarea.
- Task 2: Engineering Design Report (EDR). Preparation of Ecology review draft and final EDRs that provides sufficient information for the development and review of construction plans and specifications.
- Task 3: Construction Plans and Specifications. Preparation of Ecology review and final construction plans and specifications based on the final EDR.

2.2 Cleanup Action Plan Elements

The final CAP's selected cleanup action consists of the following elements (Figure 2-1):

- Previous completed cleanup and/or interim actions
- Hotspot soil removal in the C Street Properties subarea
- Reduced-permeability cap within the landfill footprint and C Street Properties subarea
- Physical barrier cap within the Hilton Avenue Properties subarea
- Clay berm/Aerated Stabilization Basin (ASB) groundwater diversion wall on the western boundary of the landfill footprint subarea (pending future ASB redevelopment scenarios)
- Groundwater monitored natural attenuation (MNA)

- Engineering controls (soil vapor intrusion and LFG)
- Institutional controls
- Compliance monitoring to evaluate long-term performance.

2.3 Deliverables and Milestones

The third amendment to the AO specifies the requirements for preparation of the following deliverables and the schedule for which they must be submitted.

- Preparation of draft PRDI Project Plan for Ecology's review 120 calendar days following the effective date of the third amendment (February 18, 2020).[1] Preparation of final documents 30 calendar days following the receipt of Ecology's comments. The PRDI Project Plan consists of a Work Plan (this document), Sampling and Analysis Plan (SAP; Appendix A), Quality Assurance Project Plan (QAPP; Appendix B), Health and Safety Plan (HASP; Appendix C), and Inadvertent Discovery Plan (IDP; Appendix D).
- Implementation and completion of work described in PRDI Project Plan 120 calendar days following Ecology's approval of the Final PRDI Project Plan.
- Preparation of the draft EDR for Ecology's review 180 calendar days following the completion of field investigations. The EDR shall incorporate the PRDI findings and the results of engineering evaluations required to complete the design. Preparation of the final EDR 60 calendar days following the receipt of Ecology's comments.
- Preparation of the 90 percent complete Construction Plans and Specifications package for Ecology review, followed by a complete 100 percent plans and specification package 90 calendar days following the receipt of Ecology's comments. The Construction Plans and Specifications shall be based on the EDR.

[1] A 60-day extension was requested by the Port on June 17, 2020 and approved by Ecology on June 18, 2020 (Guenther 2020).

3.0 PRELIMINARY INVESTIGATION ACTIVITIES

To support effective planning for and execution of the PRDI, a topographical survey of the Site was conducted by Wilson Engineering (Wilson) and a site reconnaissance was completed by LAI technical staff to confirm current Site conditions and inform the strategy for additional investigative work. A summary of the results of these preliminary activities is included in this section.

3.1 Site Reconnaissance

A Site reconnaissance was conducted by LAI's technical team on July 14, 2020 to further assess current Site conditions and gather additional Site-specific information to inform effective preparation and execution of the PRDI Project Plan and development of the remedial design materials. LAI's technical team was joined by Port staff and representatives from Wilson during the Site reconnaissance.

During the Site reconnaissance, the following activities were conducted to further evaluate the necessary elements of the PRDI:

- Visual observation of existing pavement, surface types, and ground cover conditions to better define areas needing further assessment and exploration, including access constraints to be managed in support of further exploration (e.g., driller access, additional survey requirements, etc.)
- Initial identification and inventory of the potential presence, condition, and relevance of the existing groundwater monitoring well network at the Site
- Limited visual observations of Site stormwater infrastructure (those that were accessible at the time of the Site reconnaissance) and of current Site features and infrastructure (e.g., buildings, tenant operational requirements, Site access, etc.) that may be affected by changing drainage patterns as a result of the planned remedy implementation (i.e., grading/capping)
- Continued data exchange and coordination with Port staff on current Site knowledge and future remedy requirements, including review of past investigation and interim cleanup action activities, groundwater monitoring well network information, tenant coordination requirements, and identification of areas of the existing stormwater infrastructure that may require further evaluation, etc.
- Initial identification of the potential presence, condition, and relevance of current LFG sampling locations, based on access constraints.[2]

Evaluation of the interior of buildings at the Site (e.g., the Technology Building [i.e., Tissue Building]) to assess the existing LFG mitigation system and to prepare for planned PRDI-related sampling will be completed concurrent with the onset of Site field activities. At that time, additional Site reconnaissance will be conducted to collect specific information (i.e., photographs, etc.) on Site

[2] Due to the COVID-19 pandemic and per LAI's Health and Safety Field Guidance and the current requirements of the Governor's office, access into and assessment of LFG systems inside Site buildings was postponed until PRDI implementation.

buildings, to prepare for the air quality sampling program, and access to building interiors, crawl spaces, etc., as required.

3.2 Site Topographical Survey

LAI contracted with Wilson to provide a comprehensive update to Site topographical survey information to aid in effective development of the PRDI and the ultimate remedial design. Wilson and LAI contracted with Applied Professional Services, Inc. for utility locate services to support implementation and management of the Site-wide survey. The survey covered the full extent of the planned cleanup area, as defined by the AO and the final CAP. Wilson's knowledge of and past survey work at adjacent cleanup sites on Port property helped to expedite completion of the Site survey and provided the basis for secondary confirmation of localized survey results.

Given the size of the area scoped for survey, the Site was divided into quadrants (Zones A through D), to help implement the survey program and manage the resulting data. Round 1 of the survey program was conducted between May 18 and June 15, 2020. As the scope of the survey program focused on providing support for soil removal and remedial design, most of the surveying was completed by using a tightly controlled, unmanned aerial vehicle (i.e., drone). This technology, when adequately controlled, can produce large-area topography at the ± 5-centimeter (± 0.16-foot) level of local precision.

Round 2 of the survey scope will include direct capture of approximately 200 higher-precision elements (e.g., monitoring wells, catch basins, filter structure, and manhole rims, etc.). Initial identification of these additional features began during the preliminary Site reconnaissance (see Section 3.1) and in coordination with representatives from the Port and Wilson. Round 2 of the survey program will be conducted in additional phases (during the course of PRDI implementation and preparation of the EDR) as additional key Site elements are identified for further evaluation to support the remedial design. Updated information from the recent survey has been incorporated into this PRDI Project Plan, as appropriate.

4.0 PRE-REMEDIAL DESIGN INVESTIGATION ACTIVITIES

This section summarizes the data gaps and investigation activities planned to support further development of the required elements of the Site's remedial design program. Section 5 includes additional details on the procedures and methods to be used to implement the PRDI activities discussed in this section.

It is anticipated that Site investigation activities will be implemented across multiple mobilizations as new Site data are evaluated and additional focused activities are planned and undertaken. Additional future Site investigation activities, as required, will be detailed in addenda to this Project Plan for review and approval in advance of further Site work.

The following documents have been prepared to support execution of the planned investigation activities, management of the resulting data, and support for remedy design:

- PRDI Work Plan (this document)
- SAP (Appendix A)
- QAPP (Appendix B)
- HASP (Appendix C)
- IDP (Appendix D).

4.1 Containment (Capping) Evaluation

Existing Site surface conditions as they relate to the planned containment (i.e., capping) of underlying contamination and the controlled management of LFG will be evaluated. This evaluation will include visually assessing and documenting the condition of existing paved areas (e.g., concrete, asphalt, etc.) at the Site, excavating a series of exploratory test pits, and installing both temporary and permanent LFG probes. The exploratory test pits (and LFG probes) are proposed at the locations shown on Figure 4-1.

Visually assessing and documenting the condition of existing paved areas at the Site will help in evaluating whether existing paved areas are adequate to satisfy containment requirements. Based on the CAP, a reduced-permeability cap and physical barrier are required in the landfill footprint and C Street Properties subareas, and a physical barrier is required in certain areas of the Hilton Avenue Properties subarea. Existing surface conditions in the landfill footprint subarea and the southwestern portion of the C Street Properties subarea are expected to limit infiltration sufficiently to meet the requirements of a reduced permeability cap (Ecology 2020). However, under the selected cleanup action, a physical barrier (e.g., soil/gravel and/or hard surface) is needed to supplement existing graveled areas to address the soil pathway for direct contact protection and erosion potential of soils.

The purpose of excavating the proposed exploratory test pits is to define the thickness of the existing gravel sections at discrete locations within the portion of the Site proposed for capping. Information

regarding the depth to groundwater and the depth to landfill refuse will be recorded, if observed within the depths of the exploratory test pits and the borings advanced for the LFG probes. Geotechnical information collected from the proposed test pits (and LFG probes) will also be used to inform the design of elements such as flexible and rigid pavement sections.

The proposed locations of the exploratory test pits were selected based on three primary criteria. First, to avoid the need for costly surface restoration, the proposed test pits locations are located in unpaved areas of the Site. Second, the test pits are proposed only within portions of the Site that will be capped. Finally, an attempt was made to evenly distribute the proposed test pits (and LFG probe borings) across the portion of the Site that will be capped. Areas of the Site that were specifically avoided for test pit explorations include areas that would be difficult to access (e.g., the steep, sloped portions of the Site; areas of the Site that are occupied by equipment, boats, and materials); and the PSE substation area.

To the extent possible, Site data-gathering activities will also include Site stormwater drainage patterns and peak stormwater flow information as they will relate to future upgrades and revisions to stormwater management resulting from containment requirements. Information relating to stormwater management requirements will be more fully assessed during preparation of the EDR.

4.2 C Street Properties Subarea

The selected cleanup action for the C Street Properties subarea includes hotspot soil removal of remaining petroleum contamination and installation of a reduced-permeability cap. The proposed hotspot removal area is defined in the CAP as an estimated 1,000 cubic yards of soil with TPH concentrations that exceed a remediation level of 19,000 milligrams per kilogram (mg/kg), which is the estimated residual saturation concentration for light non-aqueous phase liquid (LNAPL; i.e., free product) associated with the former Chevron Terminal Facility (within the southwestern portion of the C Street Properties subarea)(Ecology 2020).

The area proposed for hotspot removal in the CAP is not clearly defined (see Figure 4-2), is based on limited data, and does not include all historical sampling locations where TPH concentrations were previously identified as greater than 19,000 mg/kg. The historical boring information also does not consistently include Global Positioning System (GPS) or survey data to precisely identify previous sampling locations. Due to the uncertainties in the exact sampling locations associated with existing data, a limited supplemental soil investigation will be conducted to more clearly define the vertical and horizontal extent of contaminated soil to be excavated as part of the planned hotspot removal action.

The CAP also identified monitored natural attenuation (MNA) as a primary method of longer-term cleanup for residual groundwater contamination in the C Street Properties subarea (specifically in the area of the former Chevron Terminal Facility area with remaining TPH and metals contamination). The selection of MNA for groundwater cleanup is derived primarily from TPH data trends (which is a

strong indicator of the occurrence of natural attenuation). However, only limited collection and evaluation of typical MNA parameters (e.g., sulfate, nitrate, and methane) has been completed. Evaluation of these parameters is necessary to provide direct evidence that biodegradation of TPH is occurring, to understand how it might be enhanced, and to establish baseline conditions by which MNA progress can be assessed. Therefore, a limited supplemental groundwater investigation will also be conducted to more clearly identify reduction-oxidation (redox) conditions in C Street Properties subarea groundwater and to determine the type and extent of biologically mediated natural attenuation currently occurring. A limited tidal study will also be conducted to determine the general influence of tidal cycles on groundwater flow combined with sulfate sampling to determine the extent of sulfate recharge during high tide cycles.

Finally, the CAP requires installation of a reduced-permeability cap in the C Street Properties subarea to reduce infiltration of precipitation and thereby reduce potential leaching of soil contamination into groundwater. The installed cap (in combination with required institutional and environmental controls) will also prevent direct contact with and minimize erosion of contaminated soil in the hotspot area. Existing surface conditions in the southwestern portion of the C Street Properties subarea are expected to limit infiltration sufficiently to meet the requirements of a reduced-permeability cap (Ecology 2020). Therefore, further evaluation of the capping strategy for the C Street Properties subarea will focus on assessing a physical barrier to prevent direct contact, based on the minimum design requirements provided in the final CAP and AO.

4.2.1 Soil Quality Evaluation

For the C Street Properties subarea hotspot investigation, a direct-push drill rig will be used to sample soils in the southwestern portion of the subarea to further delineate the vertical and horizontal extent of TPH-contaminated soil with concentrations near or exceeding the 19,000 mg/kg residual saturation concentration. Field activities will include investigation with a direct-push drill rig for soil sample collection and subsequent laboratory analysis for petroleum constituents. Soil samples will, in general, be analyzed for TPH-G, TPH-D, and TPH-O for comparison and to further evaluate the TPH residual saturation concentration.

The 10 new boring locations (i.e., CS-01 through CS-10) to be used for further hotspot soil investigation are shown on Figure 4-2. The number of soil samples to be collected for analysis will be determined based on screening in the field; however, a maximum of 30 soil samples for laboratory analysis are assumed. Soil samples will be collected, managed, and analyzed based on the information presented in the SAP (Appendix A). Additional information on procedures and assumptions for the investigation are included in Section 5.

4.2.2 Groundwater Evaluation

Up to six new monitoring wells will be installed in the C Street Properties subarea, to be used for additional TPH and MNA evaluation. These new wells will include wells upgradient of and within the

TPH groundwater plume. Groundwater samples will be collected from up to 10 wells total (i.e., 6 new and 4 existing) and will be analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX), metals, TPH-G, TPH-D, and TPH-O. Additionally, MNA parameters will be measured in the field during sampling or determined through laboratory analysis. The information obtained from the investigation will provide baseline data for further evaluation of MNA effectiveness within the hotspot area. Proposed locations for the six new groundwater monitoring wells for MNA evaluation are shown on Figure 4-3.

These same 10 wells will also be used for recording groundwater elevations throughout a semi-diurnal tidal cycle to determine the extent of tidal influence and associated groundwater flow variation. Up to five additional groundwater samples will be collected shortly after high tide for sulfate analysis to determine the approximate extent and magnitude of tidally influenced sulfate recharge to Site groundwater from the adjacent Whatcom Waterway.

4.2.3 Reduced-Permeability Cap

As noted in the CAP, existing surface conditions in the southwestern portion of the C Street Properties subarea are currently sufficient to limit infiltration to meet the requirements of a reduced-permeability cap (Ecology 2020). However, further containment evaluation of the area to determine the need for additional protection from direct contact is required. Containment evaluation in the area will be completed as discussed in Section 4.1.

4.3 Landfill Gas Management

Preliminary estimates of LFG production from the former Roeder Avenue Landfill indicate that a relatively small amount of gas continues to be produced as degradable waste is broken down in natural microbial processes. The PRDI will evaluate the LFG generation using a combination of modeling and field investigation. The assessment will provide the data to support design of the final cleanup action, which will include the combination of a landfill cover system and other LFG mitigation or monitoring elements, as needed.

As part of the final cleanup action for the Site, LFG must be mitigated to protect Site workers and Site visitors from exposure, prevent offsite migration, protect indoor air quality, and prevent the accumulation of LFG to unsafe or unhealthy levels beneath impermeable surfaces. As noted in the CAP, existing surface conditions in the Landfill and Perimeter subarea are currently sufficient to limit infiltration to meet the requirements of a reduced-permeability cap (Ecology 2020). However, further containment evaluation of the area is required to determine the need for additional protection from direct contact (see Section 4.1).

A computer model will be used to estimate the LFG production rate to design potentially required collection and mitigation systems. Additionally, a field investigation will be conducted to evaluate the lateral extent of LFG in the subsurface and collect VOC data to refine the modeling results. These data

will be developed by installing and monitoring temporary LFG probes to assess LFG in soil vapor; conducting indoor air monitoring with a flame ionization detector (FID) to evaluate for vapor intrusion into existing buildings; installing and monitoring permanent LFG monitoring probes to assess LFG migration and provide for long-term compliance monitoring; and compiling the modeled estimate of the LFG production and emissions information to support design, permitting, and construction of the final cleanup remedy. The following subsections provide the summarized approach to filling perceived data gaps to support the LFG management remedial design element; additional details related to conducting the work is provided in Section 5 and in the SAP (Appendix A).

4.3.1 Landfill Gas Production Modeling

Current levels of LFG production will be estimated using modeling software [Landfill Gas Emissions Model (LandGEM)] developed by the US Environmental Protection Agency (EPA). The EPA developed the modeling software to provide a consistent approach for landfill owners to estimate the rate of LFG production and evaluate potential emissions. Existing LFG production models prepared by LAI during earlier phases of this cleanup project will be further evaluated for continued application through preparation of final remedy design.

The model is commonly used to estimate LFG production to inform LFG control system design and to support air permitting requirements. LandGEM assumes a first-order decay to model the process of anaerobic decomposition of organic waste, which produces LFG. The model uses emission factors compiled from landfills nationwide (EPA 1995) for some parameters, which can result in overestimates of VOC concentrations and emissions for older landfills, such as the Roeder Avenue Landfill. As a result, it is necessary to supplement the modeling effort with data collected in the field. The modeling results will be combined with the field-collected data and documented in the EDR to support the basis and rationale for the design of the LFG control system.

4.3.2 Soil Vapor Evaluation

Soil vapor quality will be evaluated for the presence of LFG initially at the 14 temporary gas probe locations and 5 existing groundwater monitoring well locations shown on Figure 4-4. Details on the monitoring probe installation and LFG data evaluation are provided in Section 5.3; further details are included in the SAP (Appendix A). Additionally, seven permanent LFG monitoring probes (designated as gas monitoring probes [GMPs]) will be installed to further assess lateral migration and provide for long-term compliance monitoring. The proposed locations for the seven permanent LFG monitoring probes are also shown on Figure 4-4. However, the actual installation locations for the GMPs may vary somewhat from what is currently presented, based on the monitoring results from the temporary probes, and to avoid conflicts in areas that might require resurfacing or paving activities. Necessary revisions to the currently planned locations will be documented in future work plan addenda, as appropriate.

The primary tool for evaluating soil vapor for the presence of LFG will be a hand-held LFG analyzer (Landtec™ GEM 2000 or 5000). The analyzer measures methane, oxygen, carbon dioxide, carbon monoxide, hydrogen sulfide, and static pressure – which can be elevated in areas where LFG is produced and not readily ventilated.

In addition to monitoring for the gases noted above using the hand-held analyzer, soil vapor samples will be collected from select locations and submitted to a laboratory for analysis for VOCs by EPA Method TO-15, to determine whether other compounds are present that will require treatment, and to support air permitting considerations. Selective ion monitoring will be conducted for vinyl chloride to achieve the lowest possible reporting limits. Sampling and analysis procedures are described further in Section 5.3 and in the SAP (Appendix A).

4.3.3 Indoor Air Quality

Indoor air will be monitored for LFG to screen for potential accumulation of LFG in existing structures and to help inform potential mitigation design requirements for future planned buildings/facilities at the Site. Since methane is the primary component of LFG (present at much higher concentrations than other potentially-present constituents), methane will be used as an indicator substance for monitoring purposes. Many buildings have been occupied and operating at the Site for several decades without reported incidents of LFG vapor intrusion. It is anticipated that the evaluation will confirm safe conditions.

Assessment of buildings interiors at the Site (e.g., the Technology Building) to support effective evaluation of indoor air quality during the course of the PRDI will be completed concurrent with mobilization for the first field activities at the Site.[3] At that time, additional Site reconnaissance will be conducted to collect specific information (i.e., photographs, etc.) on Site buildings, to prepare for the indoor air quality sampling program, and access to building interiors, crawl spaces, etc., as required.

4.4 Aerated Stabilization Basin and the Clay Berm

Containment of groundwater at the Site is a key element of the remedial design for the Landfill and Perimeter subarea. Currently, a clay berm exists between the Site and the adjacent ASB. Historically, surface-water levels in the ASB and elevations in the neighboring Site groundwater have been comparatively flat, within a half-foot of each other. When water elevations in the ASB are higher than that of seasonal Site groundwater, the head difference results in a mounding of groundwater on the west side of the landfill footprint area (as evidenced by localized higher groundwater elevations), which limits groundwater flow from the Site.

[3] Assessment of areas for planned indoor air quality evaluation was postponed due to the COVID-19 pandemic and per LAI's Health and Safety Field Guidance and the current requirements of the Governor's office. Indoor air quality sampling will be conducted after access into Site buildings and assessment of existing LFG systems can be completed safely.

The Port has indicated that redevelopment and reuse of the ASB is under consideration, including redevelopment as a new marina with integrated public shoreline access and habitat enhancements. Because the clay berm and the adjacent ASB are directly influencing groundwater containment dynamics at the Site, further evaluation into effective, long-term groundwater containment options, in the event that the current makeup and use of the ASB changes, may be warranted to support the remedial design.

Given that the long-term strategies have not been finalized for ASB redevelopment, additional investigation activities along the western border of the landfill footprint will be limited to further evaluation of the influence on upland groundwater from the ASB and the hydraulic connectivity dynamics between the two. To support this further evaluation, four new groundwater wells will be installed adjacent to the ASB's perimeter. Dataloggers will be installed in the new wells to monitoring fluctuations in groundwater elevations and to support further re-evaluation of hydraulic connectivity with the ASB. The new wells may also be used in the future assessment of groundwater quality to support Site-wide compliance performance, as necessary.

4.5 Shoreline Condition and Groundwater Quality Assessment (Site Containment)

The Landfill and Perimeter subarea extends into the Hilton Harbor Boatyard area, which is adjacent to the I&J Waterway, at the northwestern corner of the Site. Evaluating the current status of groundwater quality in this area and the condition of the shoreline features is warranted to understand the need for enhanced containment conditions in this area of the Site.

To support further evaluation of groundwater quality, one groundwater monitoring well will be installed proximal to the shoreline in this area for sampling and analysis (see Figure 4-3). Surface conditions will also be evaluated at the time of well installation to help inform appropriate containment design strategies, as appropriate. To assess the current condition of existing shoreline features, a shoreline evaluation will be conducted of the waterfront structural features and shoreline. The limits of the evaluation will be approximately between the northern tip of the ASB and the southern limits of the I&J Waterway remedial action activities (being conducted by others on behalf of the Port). The evaluation will include review of available reference documents and pertinent reports, a site reconnaissance to observe and assess current conditions, and preparation a brief condition report to summarize the findings and assist in informing needs for the remedial design (if necessary).

Further details on the elements of the shoreline evaluation are as follows:

- Review of Reference Documents and Pertinent Reports: Available reference documents will be reviewed prior to conducting a site reconnaissance. Reference documents may include record drawings, photographs, sketches, previous inspection reports, and environmental reports, as applicable to the scope of the shoreline evaluation.

- Site Reconnaissance: The visual evaluation will be conducted by walking the shoreline during a low-tide event to assess the bulkhead, shore slope, riprap, and other visible shoreline features. Inspectors will note general conditions, damage or deterioration, and compare layouts and dimensions to those in reference documents (if available). Photographs will be taken to document the observations.
- Condition Report: A condition report will be prepared to summarize the scope of work, inspection methodology, observations, and findings. The report will include photographs of typical conditions and damage or deterioration. Where possible, mechanisms producing the damage or deterioration will be discussed, and methods for additional evaluation will be provided for further consideration. The findings of the condition report will be used to inform related elements of the remedial design program for the Site, as appropriate.

5.0 FIELD METHODS AND LABORATORY ANALYSIS

This section provides further detail on the methods and procedures to be used during the course of the PRDI activities discussed in Section 4. Information on specific sampling and analysis procedures, quality assurance/quality control (QA/QC) requirements, and analytical laboratory control information is provided the SAP (Appendix A) and QAPP (Appendix B).

5.1 Soil Investigation

The following subsections describe area-specific soil monitoring, investigation, evaluation, and sampling activities to be performed during the PRDI.

5.1.1 Push Probe Borings

Prior to subsurface explorations, LAI and its subcontractor team will contact the public one-call utility locating service to identify public utilities in the investigation area. Additionally, a private utility locating service will be contacted to mark private utilities within the work area. LAI will be on Site during the private utility locate.

To better define the extent of the hotspot to inform the remedial design, soil sampling and screening in the C Street Properties Hotspot area will be conducted using direct-push drilling techniques. Field activities will include drilling and collecting soil samples at 10 new soil boring locations (see Figure 4-2), with subsequent soil analysis. A maximum of 30 soil samples will be collected for laboratory analysis based on conditions observed during the course of boring advancement.

Each soil boring exploration will be advanced by direct-push (i.e., Geoprobe™) technology to a maximum target depth of 2 to 4 feet (ft) below the groundwater table or 20 ft below ground surface (bgs). Each sampling interval will be logged in accordance with Unified Soil Classification System classification procedures. A portion of the sample interval will be field-screened for the possible presence of contamination visually (signs of sheen or staining) and with a photoionization detector to monitor for VOCs. Field-screening results will be used to select soil samples for laboratory analysis. The soil samples will also be visually classified for soil type.

Samples will be placed in laboratory-supplied sample containers and put on ice prior to transport to the analytical laboratory. Soil samples collected for analysis for volatile petroleum constituents (i.e., TPH-G and BTEX) will be collected by EPA Method 5035.

Hotspot soil investigation samples will be analyzed for:

- BTEX
- TPH-G, TPH-D, and TPH-O

- RCRA 8 metals.[4]

Retained samples will be managed and handled as outlined in the SAP (Appendix A) and will be submitted to Analytical Resources, Inc. (ARI) for analysis.

Following sampling at each investigation location, the borings will be decommissioned with hydrated bentonite chips. Quick-set concrete will be used to patch each hole drilled through concrete. Asphalt patch will be used to patch holes drilled through asphalt.

5.2 Test Pit Exploration

Prior to conducting test pit explorations, LAI will mark the proposed exploration locations on the ground using white spray paint. LAI and its subcontractor team will then contact the public one-call utility locating service to identify public utilities in the investigation area. Additionally, a private utility locating service will be subcontracted to mark private utilities within the work area. LAI will be on Site during the marking of private utilities.

To define the thickness of the existing gravel section at discrete locations within the portion of the Site proposed for capping, a series of exploratory test pits will be excavated using a subcontracted backhoe or excavator. The backhoe or excavator will arrive at the Site decontaminated. In addition, before moving between test pit locations, the bucket of the excavator will be dry-brushed as needed to remove soil and debris.

Exploratory test pits will be advanced within portions of the Site that are unpaved at approximately 17 locations (see Figure 4-1). Each exploratory test pit will be advanced to a maximum depth of 10 ft bgs. If landfill refuse or groundwater is encountered prior to reaching a depth of 10 ft, the test pit exploration will be terminated at that depth.

Test pit exploration activities will be coordinated and monitored on a full-time basis by LAI personnel who will obtain representative soil samples, maintain a detailed record of the observed subsurface soil and groundwater conditions, and describe the soils encountered by visual and textural examination. Each representative soil type observed in the exploratory test pits will be described in general accordance with ASTM International D 2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)* (ASTM 2017). Summary logs of the exploratory test pits will be prepared and these logs will represent LAI's interpretation of subsurface conditions identified during the test pit exploration program.

One representative grab sample of the soil encountered in each test pit will be obtained for possible subsequent laboratory testing. Samples will be stored in 1-gallon plastic bags for transport to LAI's laboratory. Laboratory testing may include up to 15 combined sieve and hydrometer analyses

[4] The Resource Conservation and Recovery Act (RCRA) 8 metals are arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

(i.e., grain-size analyses). Information from the grain-size analyses could be used to estimate the potential infiltration rate of stormwater through the gravel layer using published grain size-based infiltration rate correlations. This information will be used to assess if additional physical barriers (e.g., soil/gravel and/or asphalt/concrete surfaces, etc.) will be needed to supplement existing graveled areas to address the soil pathway for direct contact and erosion of soils.

Upon completion of logging and sampling of the test pits, the excavations will be backfilled with the soil that was removed during excavation of the test pits. The backfill soil will be placed in lifts and each lift of soil will be tamped with the backhoe's bucket. No excavations will be left unattended by LAI personnel or a subcontractor team member and all excavations will be completely backfilled before leaving the Site for the day. The ground surface at each test pit location will be restored to its original condition, to the extent practicable.

5.3 Groundwater Investigation

MNA relies on natural processes (physical, chemical, or biological) that can lead to the reduction of mass, toxicity, mobility, volume, or concentration of organic contaminants in soil or groundwater. MNA will be evaluated in the C Street Properties subarea through performance sampling to demonstrate that it will address residual contamination that exceeds applicable groundwater cleanup levels.

Four new groundwater wells will also be installed along the border between the Landfill and Perimeter subarea and the ASB. Although these wells could be used for groundwater quality evaluation (especially aligned with future compliance demonstrations), the purpose of these wells will be to support the further evaluation of hydraulic conductivity between the Site and the ASB as it relates to required Site containment and potential future ASB redevelopment scenarios. An additional well will be installed in the Hilton Harbor Boatyard area, to assess current groundwater quality conditions, and to provide data to inform an appropriate containment design strategy, if warranted, for this area of the Site.

The following subsections further describe groundwater investigation activities to be conducted during the PRDI. As the results of initial phases of the PRDI (hotspot soil investigation, Site-wide monitoring, etc.) will influence ideal placement of new groundwater monitoring wells, the planning and strategy for additional groundwater quality evaluation will be further detailed in future PRDI Project Plan addenda, if appropriate.

5.3.1 Existing Well Survey/Reconnaissance

The current condition of the existing groundwater monitoring network and its use for future groundwater quality evaluation and compliance monitoring is unclear. During the course of the PRDI, supplemental well condition surveys, to the extent possible, will be completed to identify the number

and location of viable groundwater monitoring wells that can be used for MNA groundwater quality monitoring and relevant long-term compliance monitoring.

The initial phase of the well survey was conducted during the site reconnaissance in July 2020 (see Section 3.1). Additional well survey activities will be ongoing during PRDI implementation and may include the following activities:

- An electromagnetic survey of approximately known locations of wells that appear to have been covered by gravel, soil, or pavement, will be conducted to attempt to locate "missing" wells that remain potentially relevant to further Site and remedial design evaluation.
- For those wells that can be located and are deemed relevant to support remedial design and long-term compliance:
  - A visual inspection will be conducted of the well monument/cover, well cap, and visible section of well casing for evidence of damage to the well
  - The well will be gauged with an oil/water interface probe to determine a) approximate depth to water; b) potential presence of LNAPL petroleum in the well; and c) total well depth (which will be compared to well installation logs (as available) to confirm well construction details and determine if well redevelopment is necessary).
- A downhole camera may also be used to visually inspect the interior of the well for evidence of cracks, holes, joint separation, and screen condition, depending on the results of the initial survey.

The information from the well survey will be used to determine the number and location of viable and existing monitoring wells relevant to future Site evaluation and how many new monitoring wells may need to be installed to adequately supplement the groundwater monitoring network in the C Street Properties subarea, along the Site's boundary with the ASB, and with respect to the demonstration of long-term Site-wide compliance performance. The groundwater network surveys will be conducted during implementation of the various planned phases of the PRDI.

5.3.2 Groundwater Well Installation/Development

Once the rationale for the locations of the new monitoring wells is finalized, each new monitoring well will be installed using hollow-stem auger drilling equipment. Soil cores will be collected every 4 ft with a hammer-driven split-spoon soil sampler and observed for stratigraphic logging. The drilling depth for each well will be approximately 20 ft bgs.

Each new monitoring well will be constructed of 2-inch-diameter, flush-threaded, polyvinyl chloride (PVC) well casing with a 10-ft screen. Well screens will be 0.020-inch slot size and the sand pack (2/12 or 10/20 Colorado sand) will extend 1 to 2 ft above and approximately 1 ft below the well screen. A well seal consisting of 5 to 7 ft of bentonite chips will be placed immediately above the sand pack and then bentonite grout will extend to the surface completion. The bentonite chips will be allowed to hydrate for 30 minutes prior to placement of the bentonite grout to prevent potential liquid grout migration into the sand pack. Monitoring wells will be finished with blank Schedule

40 PVC casings extending from the top of screen to about 0.5 ft bgs for flush-mounted wells and extended approximately 2.5 ft above ground surface for above-grade surface completions. Wells will be installed in accordance with the Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 of the Washington Administrative Code).

The wells will be developed after construction to remove formation material from the well bore and the filter pack prior to groundwater sampling. Similarly, existing wells that are determined to be viable for groundwater monitoring and sampling (see Section 5.3.1) may also be redeveloped to remove sediment that may have accumulated in the well screen and filter pack over time (depending on the well's conditions and the results of groundwater network survey activities). The wells will be developed by purging up to 10 casing volumes of groundwater, or until the groundwater becomes free of turbidity (less than 5 nephelometric turbidity units). The wells will be surged during development to assist in removal of fines from the sand pack.

Prior to drilling activities, LAI will collect approximate well and boring location coordinates using a map-grade Trimble XRS or GeoXT differentially corrected GPS unit. The finished elevation of the wells (top of PVC casing and ground surface) will be surveyed to an accuracy of 1/100 (0.01) of a foot.

Further details on procedures and methods for installation of new groundwater monitoring well at the Site are provided in the SAP (Appendix A).

5.3.3 C Street Properties Subarea Groundwater Evaluation

To support further evaluation of the effectiveness of MNA, up to 10 new and existing monitoring wells in the C Street Properties subarea will be sampled using peristaltic pumps with dedicated tubing for each well to prevent cross-contamination between wells. Low-flow sampling techniques will be used for purging and sample collection. Additional information on the methods and techniques to be used for groundwater sampling is provided in the SAP (Appendix A).

Samples will be collected shortly after low tide, to the extent practicable. Samples will be retained in laboratory-supplied sample containers and put on ice prior to transport to the analytical laboratory. Groundwater samples will be analyzed for:

- BTEX
- Metals[5]
- TPH-G, TPH-D, and TPH-O
- MNA parameters including:
  - pH, dissolved oxygen, oxidation reduction potential, and temperature with a YSI field meter

[5] Metals to include arsenic, cadmium, chromium (total, hexavalent, and trivalent), copper, lead, mercury, nickel, selenium, silver, and zinc.

  - Ferrous (dissolved) iron with Hach test kits
  - Dissolved (field-filtered) manganese
  - Nitrate and sulfate
  - Methane
  - Total organic carbon
  - Alkalinity.

Additionally, groundwater samples will be collected from up to five of these same wells shortly after high tide to determine the approximate extent and magnitude of tidally-influenced sulfate recharge to Site groundwater from the Whatcom Waterway. These groundwater samples will be analyzed for:

- Chloride
- Total dissolved solids.

Groundwater samples will be managed and handled as outlined in the SAP (Appendix A) and submitted to ARI for analysis.

The new and existing wells in the C Street Properties subarea will also be used for recording groundwater elevations throughout a semi-diurnal tidal cycle to determine the extent of tidal influence and associated groundwater flow variation.

5.3.4 Aerated Stabilization Basin Groundwater Evaluation

As mentioned previously, four new groundwater wells will be installed along the border between the Landfill and Perimeter subarea and the ASB. The primary purpose of these wells is to support the further evaluation of hydraulic conductivity between the Site and the ASB as it relates to required Site containment and potential future ASB redevelopment scenarios. However, to better understand groundwater quality conditions in those areas of discharge around the ASB, groundwater samples will be collected for analysis at the two new wells installed adjacent to the corners of the ASB (see Figure 4-3).

Groundwater samples will be collected using peristaltic pumps with dedicated tubing for each well to prevent cross-contamination between wells. Low-flow sampling techniques will be used for purging and sample collection. Additional information on the methods and techniques to be used for groundwater sampling is provided in the SAP (Appendix A).

Samples will be collected and retained in laboratory-supplied sample containers and put on ice prior to transport to the analytical laboratory. Groundwater samples will be analyzed for:

- TPH-G, TPH-D, and TPH-O
- VOC (benzene)

- Metals[6]
- PAHs
- SVOC [bis(2-ethylhexyl) phthalate].

5.3.5 Hilton Harbor Boatyard Groundwater Evaluation

The new groundwater well to be installed proximal to the shoreline in the Hilton Harbor Boatyard will be sampled with a similar approach as those ASB wells discussed in Section 5.3.4. The well will be sampled using peristaltic pumps with dedicated tubing for each well to prevent cross-contamination between wells. Low-flow sampling techniques will be used for purging and sample collection. Additional information on the methods and techniques to be used for groundwater sampling is provided in the SAP (Appendix A).

Similar to the samples collected from the ASB wells, samples will be collected and retained in laboratory-supplied sample containers and put on ice prior to transport to the analytical laboratory. Groundwater samples will be analyzed for:

- TPH-G, TPH-D, and TPH-O
- VOC (benzene)
- Metals[6]
- PAHs
- SVOC [bis(2-ethylhexyl) phthalate].

5.3.6 Site-Wide Compliance Monitoring

A supplemental Site-wide well survey will be completed to identify the number and location of currently viable monitoring wells that may be representative of groundwater quality to support longer-term compliance demonstration. It is anticipated that a select number of new groundwater wells (in addition to those described herein for the C Street Properties subarea, adjacent to the ASB, and at the Hilton Harbor Boatyard) will need to be installed in order to develop a network that can be used for long-term compliance monitoring. The locations of and potential need for additional wells will be evaluated during implementation of the PRDI. The rationale relating to future groundwater wells will be discussed in future work plan addenda, if appropriate.

5.4 Landfill Gas, Soil Vapor, and Indoor Air

As summarized in Section 4.3, additional information is needed to support the remedial design for mitigating LFG conditions at the Site. The information needed for design includes an estimate of the rate of LFG production, characterization data to understand the concentrations of potentially hazardous components of the LFG, a refined understanding of the extent of LFG distribution in the

[6] Metals to include dissolved and total arsenic, cadmium, chromium (total, hexavalent, and trivalent), copper, lead, mercury, nickel, selenium, silver, and zinc.

subsurface, and an evaluation of existing structures to determine if retrofitted building mitigation systems will be required to protect indoor air quality. This section provides further details for conducting the evaluation; sampling and data quality-related information is provided in the SAP (Appendix A).

5.4.1 Monitoring Probe Installation

To characterize soil vapor quality and determine the lateral extent of LFG in the subsurface, the PRDI will include installation of 14 temporary and 7 permanent LFG monitoring probes. The actual number of probes and exact locations may vary from what is proposed herein based on conditions in the field that can affect the locations of installations (e.g., subsurface utilities, etc.), and the ongoing findings of the field investigation.

5.4.2 Temporary Landfill Gas Monitoring Probes

Temporary LFG monitoring probes will be constructed to provide subsurface sampling ports in locations currently covered with asphalt/concrete paving. The proposed locations (Figure 4-4) were selected to provide Site-wide coverage to evaluate LFG concentrations throughout the former Landfill and Perimeter subarea. The locations coincide with surface paving to provide greater accuracy by limiting impacts from ambient air dilution, which is impeded by the low-permeability of the pavement.

The probes will be installed by a licensed well driller after coring through the asphalt/concrete paving to document existing pavement type and thickness. The pavement information will be incorporated into the overall assessment of the existing cap/containment conditions, discussed in Section 4.1. After documenting the existing pavement conditions, a direct-push drilling rig will advance a boring of approximately 4 to 5 ft in depth (depending on the tooling length) with an approximate diameter of 3 inches. A ½-inch-diameter PVC casing with sample screen will be installed into the boring and sealed, and the monitoring probe will be completed with a flush-mounted monument at the ground surface to provide some protection for continued pavement trafficking. It is assumed these probe locations will be temporary, so it is not necessary that their construction consider a useful life beyond several months. Appendix A provides additional construction details for the temporary LFG probes.

5.4.3 Permanent Landfill Gas Monitoring Probes

Permanent LFG monitoring probes will be installed by a licensed well driller using a truck- or track-mounted, hollow-stem auger drilling rig. The borings will be approximately 6 inches in diameter and will be advanced to approximately 15 ft bgs. The monitoring probes will be constructed using ½-inch-diameter PVC and machine slotted perforations to provide for sample collection. Depending upon location, these probes may be completed at the ground surface (where vehicular traffic is expected), or completed above ground using steel protective monuments. It is anticipated that the permanent LFG monitoring probes will be installed during a separate mobilization from the temporary probes, and after at least an initial monitoring event is conducted at the temporary probes to develop a

preliminary understanding of the lateral extent of LFG in the subsurface. Additional details regarding the probe construction is provided in Appendix A.

5.4.4 Soil Vapor Monitoring and Analyses

After the probe installations have been in-place for at least 24 hours, LFG monitoring will be conducted during two discrete field events, separated by a minimum of 2 weeks. The monitoring events will be scheduled to occur when barometric pressure is decreasing to prevent air intrusion into the cover from diluting the sample. The second monitoring event will be conducted to account for the variability in sampling conditions based on changing weather and the logistics of field investigations.

The handheld LFG analyzer will be used during the first monitoring event. At each monitoring location, field personnel will verify an airtight seal at the wellhead, connect the analyzer, and measure static pressure above atmosphere. Afterwards, the sampling location will be purged of air using the LFG analyzer, removing air that may have accumulated in well casings or within the sampling equipment. No minimum purge volume is required for sampling the temporary monitoring probes, only a requirement that the gas concentration readings are stabilized. When concentrations are stable, the data will be recorded onto a field form (SAP, Attachment A-1). Field personnel will record the sample time, purge volume, gas concentrations, and other relevant observations or notes.

During the second monitoring event, the general procedures described above will be repeated for data confirmation and to prevent barometric pressure changes from biasing the monitoring results. Monitoring will be conducted at the temporary LFG monitoring probes and other existing groundwater monitoring wells that might provide useful soil vapor data. If the permanent monitoring probes have been installed by the time of the second monitoring event, these locations will also be monitored. In addition to collecting LFG data with the hand-held analyzers, soil vapor samples will be collected during this second event and submitted to ALS Environmental (ALS) for analysis of VOCs. The VOC data will be used to evaluate for the presence of other compounds potentially present in the LFG that could require treatment as part of the final cleanup remedy, and to support future air permitting considerations.

Six soil vapor samples (and one additional QA/QC sample of ambient air) will be collected into pre-evacuated Summa canisters; each individually-certified clean by the laboratory (i.e., ALS) assuring they are clean of contamination. Samples will be collected using dedicated Teflon® tubing through a stainless steel flow regulator set by the laboratory to collect the sample over a ½-hour period, to prevent overdrawing the sampling points and diluting the sample. The samples will be collected from the four locations exhibiting the highest methane concentrations observed during the first round of monitoring to determine the highest VOC concentrations in soil vapor in the LFG. In addition to these four locations, two monitoring probes located nearest the C Street Properties subarea will be sampled to evaluate for VOCs associated with petroleum hydrocarbons present in this area. It is anticipated that these six subsurface locations will provide adequate Site-wide coverage and assist in determining

the worst-case VOC concentrations to incorporate into the remedial design. The ambient air sample will be collected in an upwind location to provide background air quality data for QA purposes.

Selective ion monitoring will be conducted for vinyl chloride to achieve the lowest possible reporting limits. Sampling and analysis procedures are further described in the SAP (Appendix A).

5.4.5 Indoor Air Monitoring

As noted in Section 4.3, indoor air monitoring will be conducted to evaluate for LFG intrusion. The indoor air monitoring will include floor-level, breathing-zone, and ceiling monitoring to screen for accumulations in areas of occupied building on the Site. The indoor air monitoring will be carried out using a FID capable of detecting methane at concentrations as low as 1 part per million.

In order to monitor the worst-case conditions when LFG intrusion could occur, the monitoring events will be conducted during periods of falling barometric pressure, with heating, ventilation, and air-conditioning systems turned off, and doors and windows closed. Barometric pressure will be recorded on the field forms, and actual barometric pressure from a nearby weather station will accompany the field dataset, confirming monitoring during optimal weather conditions.

Two existing buildings (the All American Marine building and the Technology Building) have existing LFG mitigation systems to prevent soil vapor intrusion. Monitoring and as-built information is available for the All American Marine Building and additional monitoring is not included in this PRDI as the existing system is deemed sufficient to provide necessary mitigation. Mitigation system as-built information and monitoring results are not available for the Technology Building**,** so monitoring at this building will be included in the PRDI. This will include indoor air monitoring with the FID (as with other buildings) and vent monitoring using a Landtec GEM 5000 multi-gas meter or equivalent capable of measuring methane, carbon dioxide, oxygen, and balance gases. The lower level of detection for methane concentrations will be 0.1 percent by volume.

Calibration and calibration check procedures for the LFG analyzer will be conducted in accordance with the manufacturer's recommended procedures, as discussed in the SAP (Appendix A).

5.5 Investigation-Derived Waste

Investigation-derived waste (e.g., soil cuttings, purge water, decontamination water) will be stored in appropriately labeled Washington State Department of Transportation-approved drums at a pre-approved temporary storage location at the Site. After analytical results are received, LAI will make arrangements for appropriate disposal.

6.0 INVESTIGATION AND REPORTING SCHEDULE

The following table presents a schedule for implementation of the planned field events included in the PRDI work plan. As the results of the investigation elements associated with the initial mobilizations will inform the next steps in the investigation process, this schedule has been prepared only to highlight the major steps of the PRDI. Actual schedule and sequencing of necessary field activities are likely to change. Updated schedule will be provided in future addenda or separate reporting, as appropriate.

Investigation Element	Field Activities	Duration	Notes
Mobilization 1			
Indoor Air Monitoring Evaluation	Indoor air sample location evaluation of Site buildings	1 day	Port and tenant coordination.
Hotspot Investigation	Up to 10 direct-push soil boring locations in C Street area	3 days	Soil analytical sampling only; including surface condition assessment (as appropriate).
LFG Monitoring: Temporary Probes	Up to 15 direct-push borings for installation of temporary LFG probes	2-3 days	Probe installation including surface conditions assessment (pavement coring/logging) probe construction and surface completion. Conduct 1st round of LFG monitoring.
Containment: Test Pits	Up to 17 excavator/backhoe test pit locations Site-wide	3 days	Surface condition assessment; soil quality sampling (geotechnical).
Mobilization 2			
LFG Monitoring: Temporary Probe Monitoring – Round 2; Indoor Air Monitoring	Subsurface LFG monitoring at and collection of subsurface VOC samples Monitoring indoor air for intrusion of LFG	3 days	Collect LFG and VOC data from new temporary probes and select existing groundwater monitoring wells. Conduct indoor air monitoring.
Mobilization 3			
ASB Monitoring Well Installation; Sampling	Up to 4 hollow-stem auger monitoring wells with data loggers along ASB boundary	2 days	Includes surface condition assessment (as appropriate).
Monitoring Well Installation – Hilton Harbor Boatyard; Sampling	Install 1 hollow-stem auger monitoring well near shoreline in the Hilton Harbor Boatyard area	1 day	Includes surface condition assessment (as appropriate).

Investigation Element	Field Activities	Duration	Notes
LFG Monitoring: Permanent Probes Installation and Sampling	Up to 8 hollow-stem auger LFG probe locations to assess migration and provide for long-term compliance monitoring	3 days	Install permanent LFG monitoring probes. Timing of installation dependent upon findings during previous monitoring and cap/pavement assessment.
MNA Monitoring Well Installation and Development; Sampling	6 hollow-stem auger monitoring wells in C Street area	3 days	Includes surface condition assessment (as appropriate).
Mobilization 4			
Monitoring Well Samples	Collect groundwater samples and elevations from MNA monitoring wells (including tidal study – multiple events) and other Site-wide wells, as appropriate	2 days	Schedule to be determined.

7.0 USE OF THIS PLANNING DOCUMENT

This Pre-Remedial Design Investigation Work Plan has been prepared for the exclusive use of the Port of Bellingham for specific application to the Central Waterfront Cleanup Site Remedial Design and Permitting project. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. LAI makes no other warranty, either express or implied.

8.0 REFERENCES

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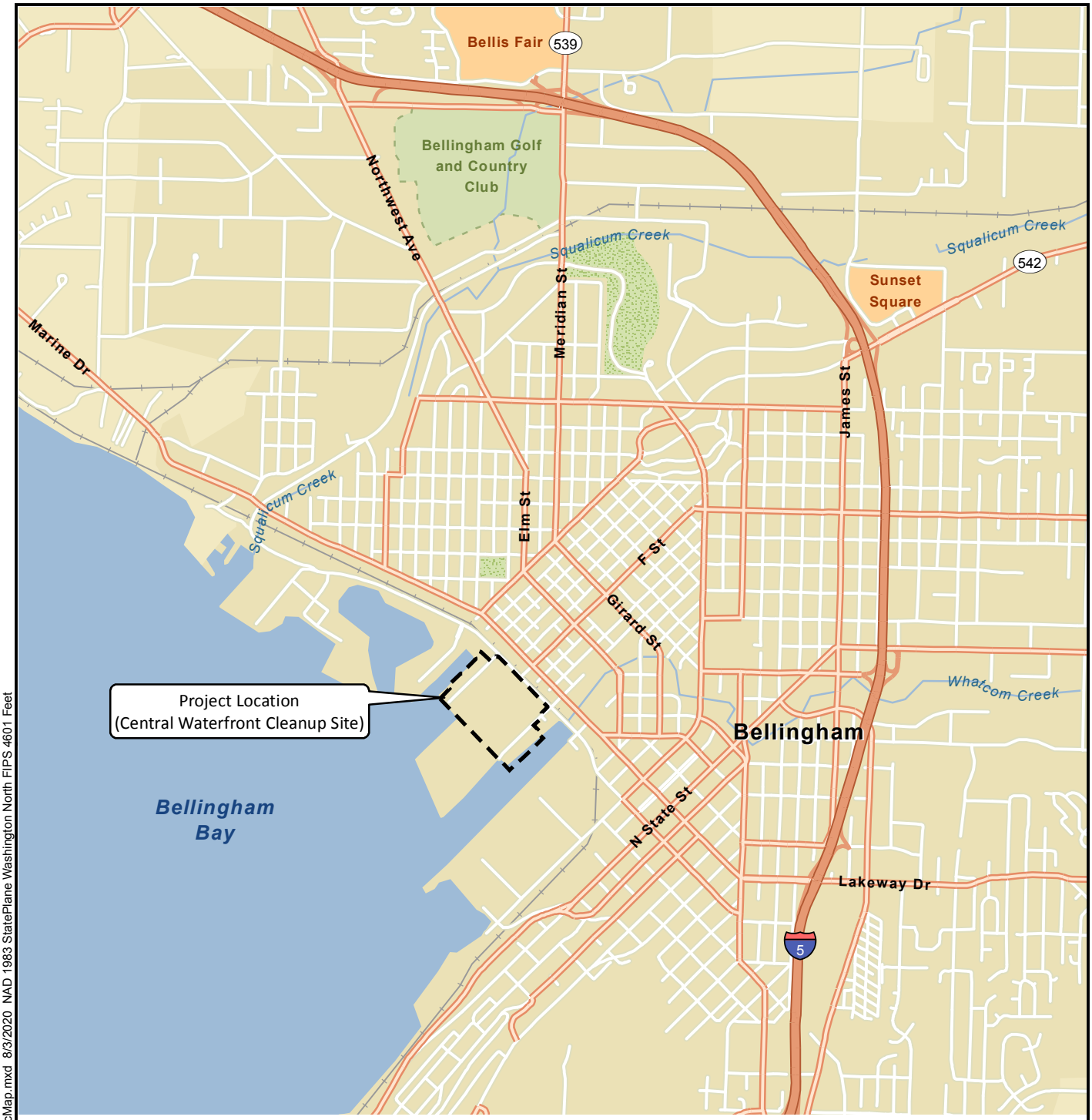

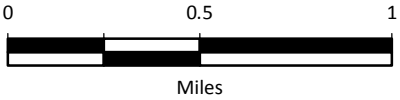

Data Source: Esri 2012

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LANDAU ASSOCIATES

Central Waterfront PRDI Work Plan Bellingham, Washington	**Vicinity Map**	Figure 1-1

Roeder Ave
Hilton Ave
G St
C St
W Chestnut St
W Maple St
I & J Waterway
Whatcom Creek Waterway
Aerated Stabilization Basin
US Army Reserve
Former USTs (#1)
PSE Substation
Former USTs (#7)
Metal Refab and Wood Shop
Former USTs (#6)
Disposal Company (Sanitary Services)
Boat Storage and Maintenance
Seafood Processing
Lumber Mill and Olivine Facility
Former USTs (#2)
Olivine Facility and Track Dispatch
Squalicum Peninsula Material Staging
Storkcraft/ Technology Development Center
Cement Plant
Foundry and Boat Wash Area
Former USTs (#5)
Former USTs (#3)
Bornstein Seafood
Time Oil Facility and Tank Yard
Log Rafting and Roeder Avenue Landfill
Chevron Terminal North Tank Yard and Gravel Hauling
Hydraulic Ramp
Coal Storage and Boat Maintenance
Former USTs (#4)
Hawley's Hilton Marina
Chevron Terminal South Tank Yard
Existing UST
Dock Area

Legend
Historical Operations Areas
Central Waterfront Cleanup Site

0 150 300
Scale in Feet

True North
Project North

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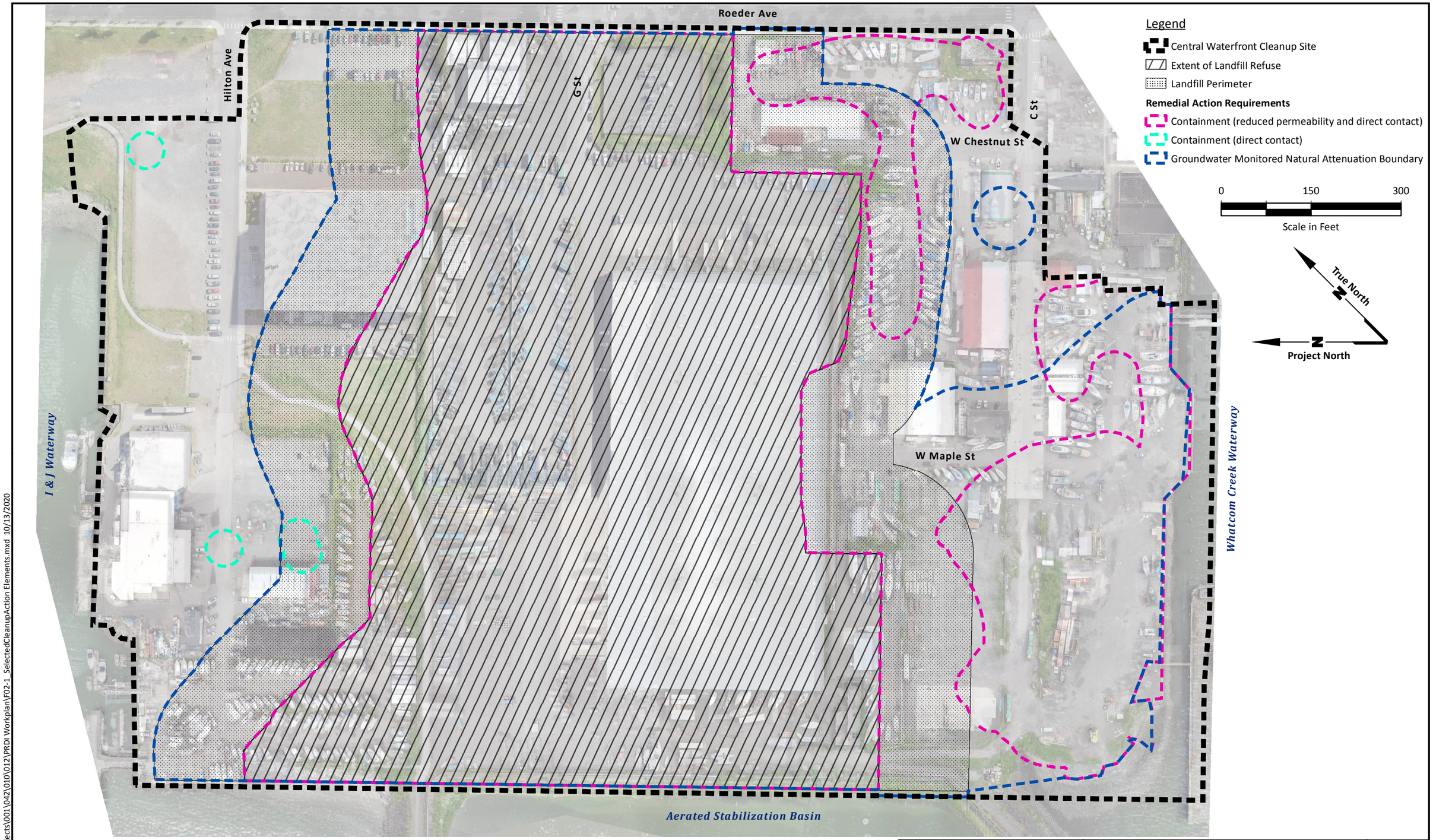
Note
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

LANDAU ASSOCIATES

Central Waterfront
PRDI Work Plan
Bellingham, Washington

Site Map and Historical Operations

Figure
1-2



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Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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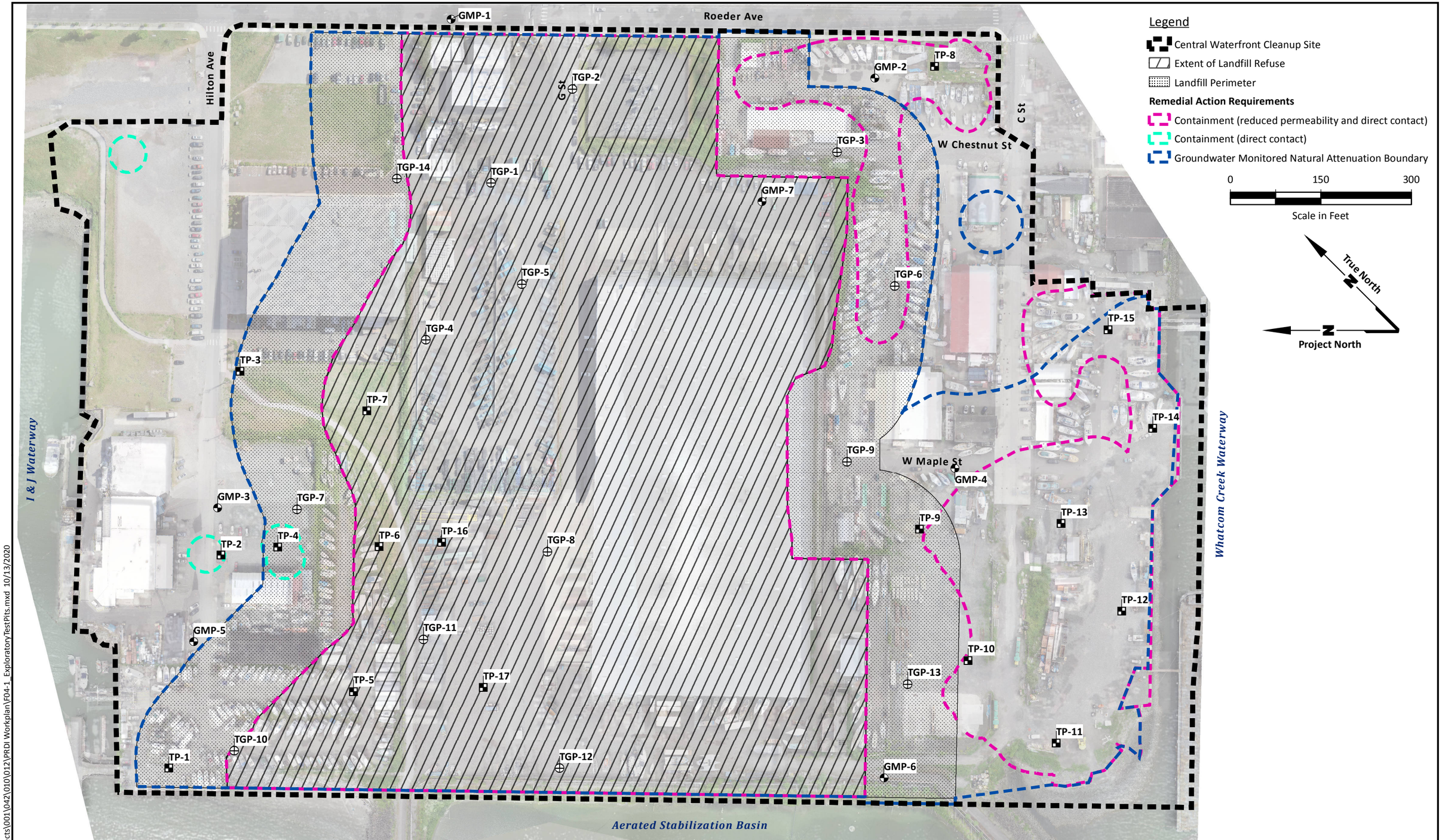
Central Waterfront PRDI Work Plan Bellingham, Washington	**Selected Cleanup Action Elements**	Figure 2-1



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Note

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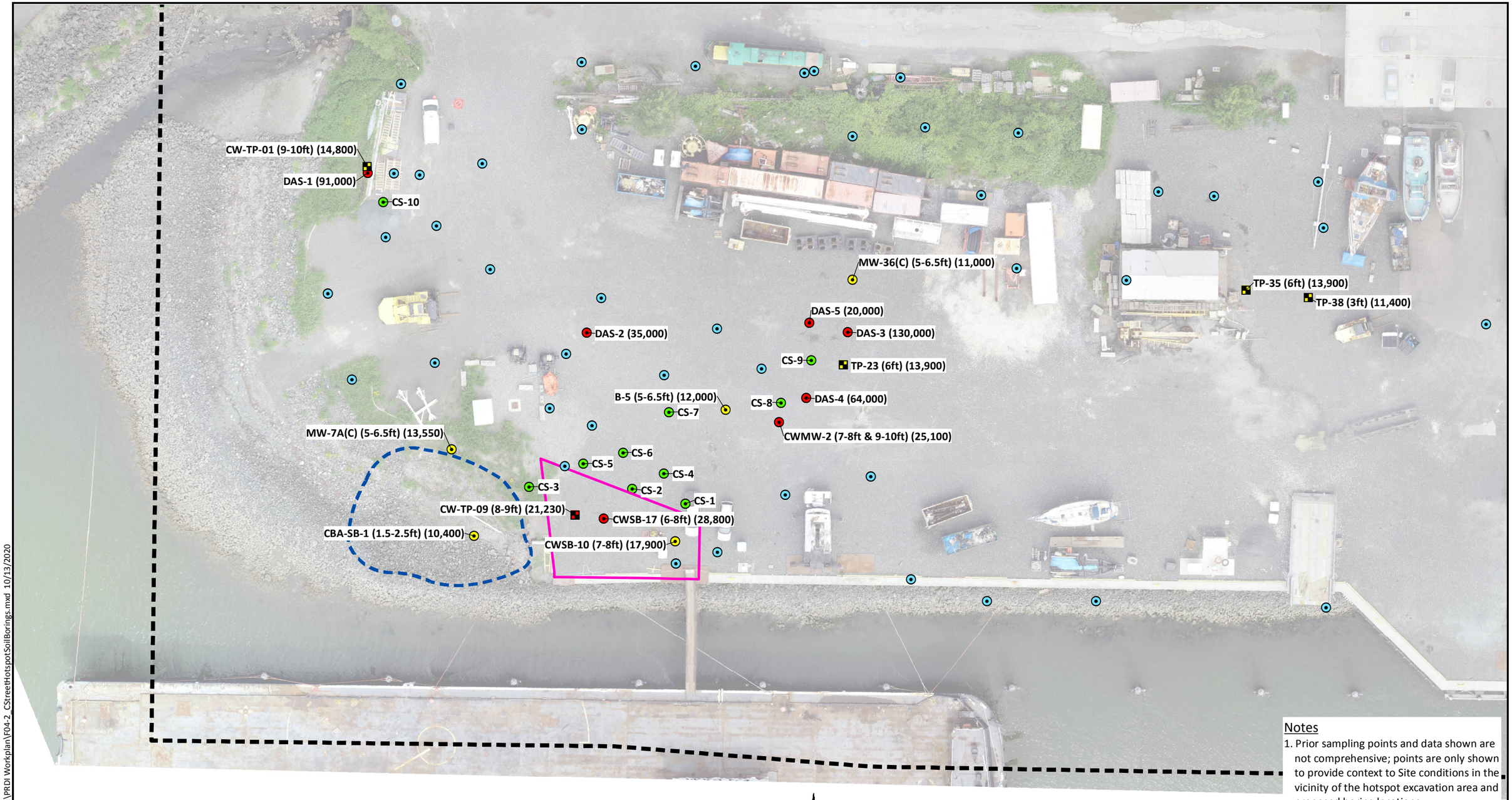
Central Waterfront
PRDI Work Plan
Bellingham, Washington

Exploratory Test Pit Locations

Figure
4-1



Legend

TPH Results

- Proposed Soil Boring
- Historical Soil Boring
- Historical Test Pit
- TPH < 10,000 mg/kg
- 10,000 ≤ TPH > 19,000 mg/kg
- TPH > 19,000 mg/kg
- Chevron Area Interim Action
- Proposed Hotspot Removal Area (Cleanup Action Plan, January 2020)
- Central Waterfront Cleanup Site

Project North

True North

0 40 80

Scale in Feet

Notes

1. Prior sampling points and data shown are not comprehensive; points are only shown to provide context to Site conditions in the vicinity of the hotspot excavation area and proposed boring locations.
2. mg = milligrams/kilogram
   TPH = total petroleum hydrocarbons.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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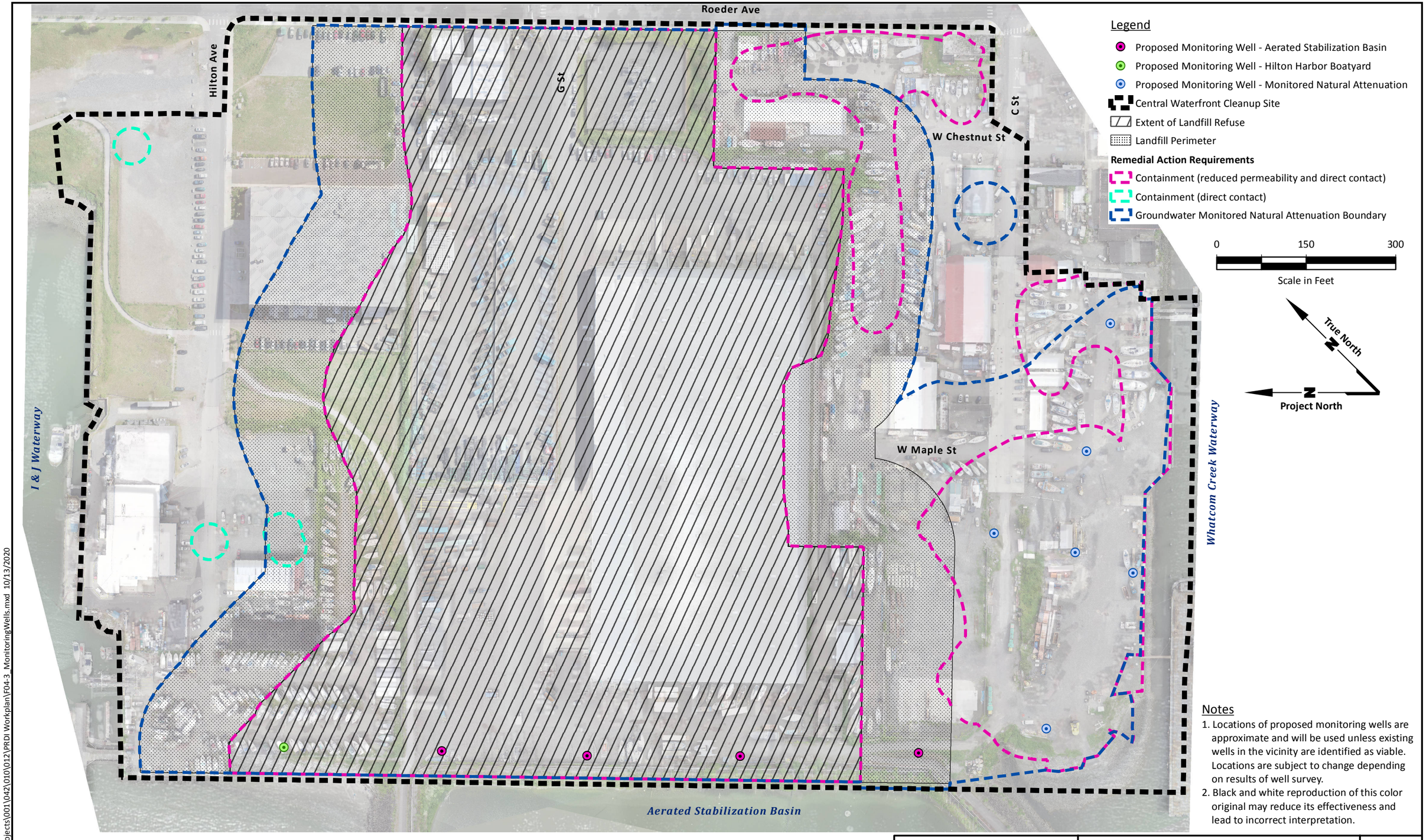
Central Waterfront PRDI Work Plan Bellingham, Washington	**C Street Hotspot Soil Boring Locations**	Figure 4-2

G:\Projects\001\042\010\012\PRDI Workplan\F04-2_CStreetHotspotSoilBorings.mxd 10/13/2020



Notes

1. Locations of proposed monitoring wells are approximate and will be used unless existing wells in the vicinity are identified as viable. Locations are subject to change depending on results of well survey.
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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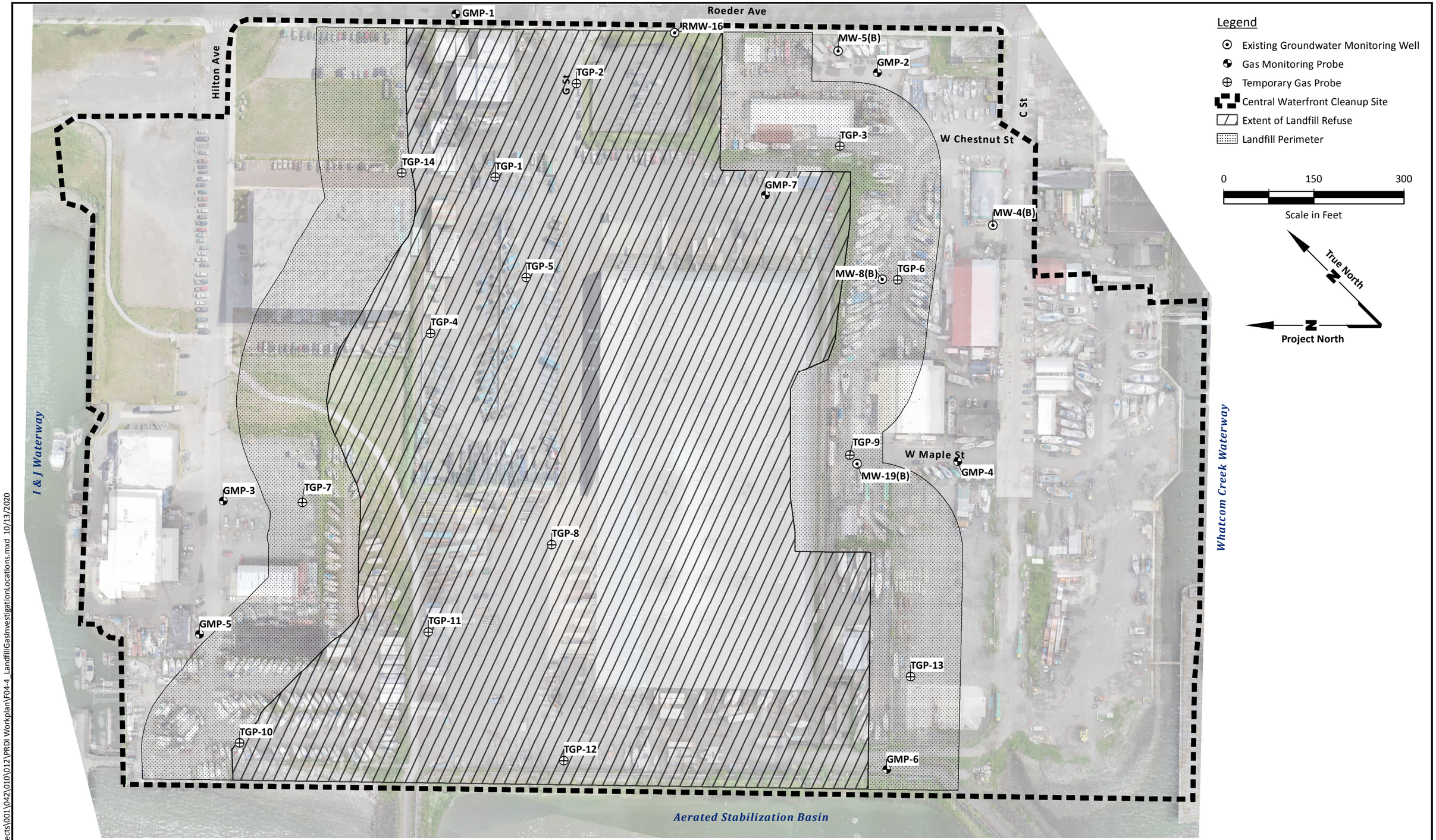
Central Waterfront PRDI Work Plan Bellingham, Washington	**Proposed Monitoring Well Locations**	Figure 4-3



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Note

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Central Waterfront
PRDI Work Plan
Bellingham, Washington

Landfill Gas Investigation Locations

Figure
4-4

APPENDIX A

Sampling and Analysis Plan

Pre-Remedial Design Investigation
Sampling and Analysis Plan
Central Waterfront Cleanup Site
Bellingham, Washington

October 14, 2020

Prepared for

Port of Bellingham
Bellingham, Washington

LANDAU ASSOCIATES

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TABLE OF CONTENTS

TABLES

ATTACHMENT

LIST OF ABBREVIATIONS AND ACRONYMS

ALS ..... Analytical Laboratory Services, Inc.
ARI ..... Analytical Resources, Inc.
bgs ..... below ground surface
BTEX ..... benzene, toluene, ethylbenzene, xylene
CFR ..... Code of Federal Regulations
COC ..... chain of custody
CS ..... C Street
Ecology ..... Washington State Department of Ecology
EDR ..... Engineering Design Report
EPA ..... US Environmental Protection Agency
FID ..... flame ionization detector
GMP ..... gas monitoring probe
H&S ..... health and safety
HASP ..... health and safety plan
LAI ..... Landau Associates, Inc.
LFG ..... landfill gas
LNAPL ..... light non-aqueous phase liquid
mL ..... milliliters
mL/min ..... milliliters per minute
MNA ..... monitored natural attenuation
MW ..... monitoring well
OSHA ..... Occupational Safety and Health Administration
PID ..... photoionization detector
PM ..... project manager
PPE ..... personal protective equipment
PRDI ..... pre-remedial design investigation
PVC ..... polyvinyl chloride
QA ..... quality assurance
QAPP ..... quality assurance project plan
QC ..... quality control
RPD ..... relative percent difference
SAP ..... sampling and analysis plan
Site ..... Central Waterfront Cleanup Site
TGP ..... temporary gas probe
TP ..... test pit
TPH-D ..... diesel-range total petroleum hydrocarbons
TPH-G ..... gasoline-range total petroleum hydrocarbons
TPH-O ..... oil-range total petroleum hydrocarbons
VOC ..... volatile organic compound

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1.0 INTRODUCTION

Landau Associates, Inc. (LAI) prepared this Sampling and Analysis Plan (SAP) for the Port of Bellingham in support of the Central Waterfront remedial design and permitting project. This SAP presents the project organization, objectives, and specific quality assurance (QA) and quality control (QC) activities associated with the collection of supplemental environmental data for the Pre-Remedial Design Investigation (PRDI) and to inform the Engineering Design Report (EDR) at the Central Waterfront Cleanup site (Site) in Bellingham, Washington. This SAP meets the requirements of the Model Toxics Control Act (Washington Administrative Code 173-340-820). QA/QC procedures detailed in this SAP are in accordance with applicable professional technical standards, Washington State Department of Ecology (Ecology) guidelines and project-specific goals. This SAP is included as part of the Central Waterfront PRDI Project Plan and describes the procedures that will be implemented to ensure that the precision, accuracy, representativeness, and completeness of the project data are sufficient to satisfy the project objectives.

The Site is part of a historical and active waterfront industrial property that is bordered to the north by I & J Waterway, the south by Whatcom Waterway, the east by Roeder Avenue, and the west by the Aerated Saturation Basin and Bellingham Bay (see Figure 1-1 of the PRDI Project Plan). The Site comprises approximately 51 acres of upland area. The adjacent intertidal and sediment areas are not included within the Site boundary. The upland area has been impacted by historical landfilling and industrial activity. Site contamination includes landfill refuse, total petroleum hydrocarbons, polycyclic aromatic hydrocarbons, metals, and landfill gas (LFG).

Numerous environmental investigations have been conducted to date at the Site, documenting the nature and extent of Site contamination. Supplemental Site evaluations, including data collection and analysis, will be used in conjunction with historical sampling results to support development of the preferred cleanup method described in the Cleanup Action Plan (Ecology 2020) to be documented in the EDR. Necessary future revisions to the SAP will be addressed in addenda to the PRDI Project Plan.

2.0 PROJECT ORGANIZATION

The organizational structure for the project will consist of a Project Manager (PM), Task Manager, Health and Safety Manager, Project Engineer/Scientist, QA Officer/Data Validator, Site Safety Officer, and Laboratory Coordinator.

2.1 Responsibilities of Project Personnel

The responsibilities of project personnel are described below.

Title/Role	Responsibilities
LAI Project Manager (PM)	Supervises and coordinates project team members and work associated with the project. These responsibilities include project planning and execution, scheduling, staffing, data evaluation, report preparation, subcontracts, and review and approval of project deliverables.
Task Manager*	Leads and coordinates field activities with Field Lead, including documentation, sampling, and sample handling. Assists with budget and invoice review, and monitoring of project deliverable. Prepares subcontractor agreements and reviews/approves related performance documentation and invoices. Reports directly to the LAI PM.
Field Lead/Field Engineer or Scientist**	Coordinates with subcontractors. Oversees and reviews subcontractors' work. Maintains field equipment and daily field notebook. Conducts sampling operations and verifies compliance with team members in accordance with this SAP. Coordinates and verifies bottle order with laboratory. Prepares chain-of-custody (COC) forms and verifies delivery of samples to laboratory. Supports preparation of project deliverables.
Quality Assurance Officer (QA)	Oversees and directs QA reviews for the project, including laboratory analytical results and necessary corrective actions. Coordinates and reviews data validation. Has oversight responsibility for management and integrity of project data.
Data Validator	Reviews laboratory analytical data and provides data validation.
Health and Safety (H&S) Manager	Coordinates with LAI PM/Task Manager as necessary on matters of health and safety. Approved Health and Safety Plan (HASP). If Site conditions change, amends and approves HASP. Ensures proper health and safety equipment is available for the project.
Site Safety Officer (SSO)	Leads daily Tailgate Safety Meeting and prepares necessary documentation. Modifies health and safety equipment or procedure requirements based on data gathered during Site work. Evaluates field health and safety conditions, and communicates and coordinates with H&S Manager, if conditions change (i.e., upgrade PPE requirements).

* Task Manager may operate as Field Lead and/or Site Safety Officer, as required.
** Field Lead/Field Engineer or Scientist may operate as Site Safety Officer, as required.

2.2 Special Training Requirements/Certification

Specific training requirements for performing fieldwork at the Site are as follows:

- Field personnel assigned to the Site must have successfully completed 40 hours of training for hazardous site work in accordance with Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120(e)(3) and be current with their 8-hour refresher training in accordance with OSHA 29 CFR 1910.120(e)(8). Documentation of OSHA training is required prior to personnel being permitted to work on Site.

- Personnel assigned to the Site must be enrolled in a medical surveillance program meeting the requirements of OSHA 29 CFR 1910.120(f). Personnel must have successfully passed an occupational physical during the past 12 months and be medically cleared to work on a hazardous waste site and capable of wearing appropriate personal protective equipment (PPE) and respiratory protection as required.
- Personnel assigned to the Site who must wear a respirator must be familiar with the OSHA respiratory standard (29 CFR 1910.134). Personnel who are required to wear respirator protection must have successfully passed a respirator fit test within the past 12 months.

It is the responsibility of the employing organization to provide their employees with the required training, medical monitoring, and fit testing prior to assigning them to work at this Site. Each employing organization will be responsible for providing documentation of training, monitoring, and fit testing (with make/model of respirator) to the PM and H&S Manager prior to sending their employees to the Site to work.

3.0 QUALITY ASSURANCE OBJECTIVES

Soil, groundwater, and landfill gas will be collected for laboratory analysis as described in Section 4. To help achieve these data quality requirements, the following quality-control parameters will be evaluated throughout the course of this project:

- Reporting limits
- Data precision
- Data accuracy
- Representativeness
- Comparability and completeness.

These quality-assessment parameters are described in greater detail in the following subsection and the Quality Assurance Project Plan (QAPP; Appendix B of the PRDI Project Plan).

3.1 Reporting Limits

Analytical methods and target laboratory reporting limits for groundwater, soil, and LFG are provided in Tables A-1a and A-1b of this SAP. These reporting limits will be observed for laboratory analyses performed during this project, except where matrix interferences and high concentrations of target and non-target compounds increase the reporting detection limits.

3.2 Precision

Precision will be determined for field duplicate samples by examining sample results for degree of variance and determining if sampling error has occurred.

Precision is a measure of agreement among individual measurements of the same parameter, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. The relative percent difference (RPD) parameter will be calculated to define the precision between duplicate analyses.

The RPD for each component is calculated using the following equation:

$$\% \text{ RPD} = \frac{(X_2 - X_1)}{[(X_1 + X_2)/2]} \times 100$$

where:

X_1 = first duplicate sample value
X_2 = second duplicate sample value

The laboratory objective for precision is to generate RPD values that fall within the established control limits for the method employed. The field objective for precision is to generate RPD values that are between 0 and 20 percent for groundwater samples. If the criteria are not met, the data reviewer will examine other quality-control criteria to determine the need for qualification of the data. Due to the inherent heterogeneity of the matrix, field duplicates will not be collected for soil.

3.3 Accuracy

Accuracy is defined as the degree of agreement between a measurement and an accepted reference of true concentration. Accuracy is determined by spiking samples with a known concentration of standard compounds and comparing the analytical results with the known value. Data accuracy will be assessed by determining the percent recovery of a spiked compound. Percent recovery (%R) is determined by the equation:

$$\%\,R = \frac{(C_1 - C_0)}{C_S} \times 100$$

where:

C_1 = measured concentration in the spiked sample
C_o = measured concentration in the unspiked sample
C_s = concentration at which the sample was spiked.

The concentration at which the sample was spiked (C_s) is calculated, using the following equation:

$$C_S = \frac{(C_{spike} \times V_{spike})}{V_{sample} + V_{spike}}$$

where:

C_s = concentration at which the sample was spiked
C_{spike} = spike concentration
V_{spike} = volume of spike
V_{sample} = volume of sample.

The laboratory objective for accuracy is to generate percent recoveries that fall within established control limits for the method employed.

Surrogate and matrix spiking compounds and sample selection for spiking are determined by current US Environmental Protection Agency (EPA) SW-846 methodologies. Percent recoveries indicate the actual performance of the analytical method on real-world samples. Surrogate spikes, matrix spikes, matrix spike duplicates, and QC spikes will be conducted using standard laboratory methods.

3.4 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic population, a process control, or an environmental condition. Appropriate sampling procedures will be implemented so that the samples are representative of the environmental matrices from which they were obtained.

3.5 Comparability and Completeness

Comparability is achieved using analytical methods similar to ones that were used previously, through use of trained personnel and by following the SAP. Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. The minimum completeness goal is 90 percent.

4.0 SOIL, GROUNDWATER, AND LANDFILL GAS SAMPLING

This section outlines the sample collection procedures for conducting the soil, groundwater, and LFG sampling described in the PRDI Work Plan. The locations planned for soil, groundwater, and LFG sampling, and surface condition assessment, are shown on the figures in the PRDI Work Plan. Tables in the PRDI Work Plan also list the samples to be collected at each location and the associated chemical and/or physical analyses. Additional investigation and sampling activities, as required, will be detailed in future addenda, including associated figures and tables to support the planned field program activities.

Specific sampling equipment and methodology may vary based upon Site features and conditions, and planned activities. Modifications and/or deviations from the approved SAP will be documented in an appendix to the EDR, as appropriate.

4.1 Navigation, Positioning, and Location Control

Positioning and navigation for sampling locations will be accomplished using a high-performance Global Navigation Satellite System receiver with an integrated antenna that allows sub-meter horizontal accuracy. For this project, a Trimble R1 GNSS receiver or similar device will be employed. The R1 receiver achieves real-time performance using a satellite-based augmentation system real-time correction source. Data deliverables will include latitude/longitude, northing/easting, and elevation, where applicable.

4.2 Sample Handling and Logging Procedures

Appropriate, pre-cleaned sample containers will be provided by the laboratories. Sample containers required for the media to be sampled during the PRDI are listed in Table A-2. Each sample container will be clearly labeled with the project name, sample identification, sample collection date and time, sample matrix, chemical analysis, and initials of person(s) preparing the sample. Groundwater and soil samples will be stored at < 6 degrees Celsius (°C) until transported to the appropriate laboratory.

4.2.1 Sample Logging Procedures

Upon transfer of sample possession to the laboratory, the chain-of-custody (COC) form will be signed by the persons transferring custody of the sample containers. Archived samples awaiting chemical results will be maintained under LAI or laboratory custody. COC forms are used internally by LAI and laboratories to track sample handling and final disposition.

After sample collection, the following information will be recorded on the field log sheet, soil or groundwater sampling form, and/or the field notebook (see Attachment 1).

- Date, time, and name of person logging sample
- Weather conditions

- Sampling location number and coordinates
- Sample name with field duplicate location where applicable
- Project designation
- Depth of water at the sampling location and surface elevation
- Number of samples collected
- Physical observations such as grain size, color, odor, density, layering, anoxic contact, and presence of sheen, shells, and/or debris.

4.2.2 Sample Designation and Labeling

Samples collected during this investigation will be identified by a unique sample designation. Sample naming schemas for each matrix are provided below:

- Soil samples collected from borings will include the soil boring location, followed by the sample depth interval. For example, soil samples collected from a C Street (CS) soil boring will have a sample designation CS001-10-11, which identifies a soil sample collected from CS-01, at a depth interval starting at 10 feet (ft) and ending at 11 ft below ground surface (bgs).
- Soil samples collected from test pits (TP) will include the test pit location, followed by the end depth of the sample. For example, sample designation TP01-2 identifies a soil sample collected from the first test pit (i.e., test pit 01) at an excavation depth of 2 ft bgs.
- Groundwater samples will include the monitoring well (MW) name followed by the date of collection. For example, sample designation MW-01-20200803 identifies a groundwater sample collected from monitoring well MW-01 on August 3, 2020.
- Groundwater field duplicates will be submitted without the sampling location, following a sequential numbering scheme. For example, sample designation DUP01 is the first field duplicate collected; sample designation DUP02 is the second field duplicate collected.
- LFG samples collected from temporary gas probes (TGPs) will include the location name followed by the date of collection. For example, sample designation TGP-01-20200803 identifies a landfill gas sample collected from a temporary probe on August 3, 2020.
- LFG samples collected from gas monitoring probes (GMPs), i.e., a permanent probe, will include the location name followed by the date of collection. For example, sample designation GMP-01-20200803 identifies a LFG sample collected from a permanent probe on August 3, 2020.
- LFG samples collected from groundwater monitoring wells will include the location name, media type, and the date of collection. For example, sample designation MW-19(B)-LFG-20200803 identifies a LFG sample collected from the vadose zone of an existing monitoring well screen on August 3, 2020.

4.3 Surface Soil Sample Collection

Surface soil sampling is currently not planned as part of proposed additional investigation activities associated with the PRDI. If surface soil sampling is required, landscaping, sod, gravel/rock (including any soil that appears mixed with these materials) will be scraped off and removed until base soil is

encountered prior to sample collection. Field screening may include observation of soil staining, sheen, and/or odor, and screening of the sample with a photoionization detector (PID), where detections of volatile organic compounds (VOCs) may occur. Clean nitrile gloves will be donned prior to collecting each sample. Care will be taken to collect representative soil samples to limit the risk of cross-contamination.

Soil samples collected for analysis for volatile parameters will be collected before non-volatile samples and in accordance with EPA Method 5035A, which is a soil sampling method intended to reduce volatilization and biodegradation of samples. The EPA Method 5035A procedure for soil sample collection is as follows:

- Collect soil samples from the soil volume using coring devices (i.e., EnCore® sampler, EasyDraw Syringe®, or a Terra Core™ sampling device). Each core will consist of approximately 5 grams of soil. Collect three discrete cores from each sampling location. One EasyDraw Syringe or one Terra Core sampling device can be used to collect the three discrete cores at each sampling location; however, if the EnCore samplers are used, then three sampling devices are required.
- Remove excess soil from the coring device. If an EasyDraw Syringe or Terra Core sampling device is used for sample collection, place the "cored" soil directly into three preserved 40 milliliter (mL) vials with a stirbar. Vials will be preserved as indicated in Table A-2. If the EnCore sampler is used, then close the sampler for transport to the laboratory.
- Collect an additional 2 ounces of soil and place it in a laboratory-supplied jar for moisture content analysis and laboratory screening purposes. Fill the jar to minimize headspace.

Soil samples to be analyzed for non-volatile parameters will be collected from the identified soil sampling intervals using the following methods:

- Scrape the top of the ground surface to expose an undisturbed area using a clean, decontaminated stainless-steel spoon.
- Homogenize the soil in a decontaminated stainless-steel bowl using a newly decontaminated stainless-steel spoon.
- Transfer the homogenized soil into the appropriate laboratory-supplied sample container.

Surface soil samples will be collected and placed in laboratory-supplied sampling containers for laboratory analysis. Hand tools and sampling equipment will be decontaminated between sample locations, as appropriate. Each surface soil sample will be properly labeled, identifying each sample by name/location (see Section 4.2.2) and date. Observations will be recorded on a soil sampling sheet that will include the sample number, sampling location, depth, Unified Soil Classification type, soil-screening results, and date and time of sample collection. In addition, each sample will be recorded on a COC form for transfer to the analytical laboratory.

4.4 Subsurface Soil Sample Collection

Subsurface soil samples will be collected primarily through use of either direct-push drilling methods or by test pit excavations. Samples will be collected to inform soil contamination issues, soil quality, and to evaluate surface capping requirements. Subsurface soil samples will be collected at the locations specified in the figures and tables included in the PRDI Project Plan (and future addenda, as required). The samples will be collected from soils ranging approximately from 1 to 20 ft in depth; soil observations will be noted, as appropriate.

4.4.1 Direct-Push Soil Sampling

Borehole drilling will occur throughout the Site. Soil borings will be advanced and temporary LFG probes managed using direct-push Geoprobe® technology. Soil sampling will be performed at the appropriate depth interval that is obtained from the Geoprobe continuous coring sampler. If subsurface conditions do not allow for direct-push Geoprobe technology (i.e., refusal or sample quantity) then other methods may be used.

Soil analytical methods and reporting limits are provided in Table A-1a, containers and preservation requirements are listed in Table A-2, and a summary of field QC sample collection and frequency is in Table A-3. Subsurface soil samples will be analyzed for the following constituents:

- Total petroleum hydrocarbons (gasoline-, diesel-, and oil-range [TPH-G, TPH-D, and TPH-O, respectively])
- Benzene, toluene, ethylbenzene, and total xylenes (BTEX)
- RCRA 8 metals.[1]

Subsurface soil samples analyzed for volatile constituents will be collected following Method 5035 procedures. Field QC sample requirements are provided in Table A-4. Samples will then be handled according to the procedures specified in the QAPP.

The specific locations planned for subsurface soil sample collection and the associated analyses are provided in figures and tables in the PRDI Work Plan. Additional subsurface sampling to be conducted in future field events, if required, will be detailed in future PRDI Work Plan addenda, as appropriate.

Soil samples for geologic logging and potential analytical testing will be obtained from the Geoprobe continuous coring sampler. A portion of soil collected from the soil core will be placed in sample jars, chilled in a cooler with ice, and retained for analysis. After securing the soil for testing, the remaining soil will be screened for visual and olfactory evidence of contamination and field-screened using a PID. The remaining soil will also be examined and the soil characteristics will be described by a qualified

[1] The Resource Conservation and Recovery Act (RCRA) 8 metals are arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

environmental professional. Observations will be recorded on the boring log and the appropriate field forms (Attachment 1).

Soil sampling locations and observations of potential contamination and soil quality will be recorded. Sufficient sample quantity will be collected so that the appropriate and required analyses can be performed. Soil boring locations will be decommissioned by backfilling with hydrated bentonite chips and like surface materials to match the original grade (e.g., gravel, asphalt patch, or concrete patch).

4.4.2 Test Pit Excavations

The Site's near-surface conditions will be evaluated at discrete locations in those areas requiring further assessment for capping and containment, as identified in the PRDI Project Plans. Surface conditions will be evaluated during boring advancement and test pit excavation. Test pits will be advanced using an excavator or backhoe. Each exploratory test pit will be advanced to a maximum depth of 10 ft bgs. If landfill refuse or the groundwater table is encountered prior to reaching a depth of 10 ft bgs, the test pit exploration will be terminated at that depth and observations will noted accordingly.

Subsurface conditions at each test pit location will be recorded and documented. Soil samples, as appropriate, will be collected from the bucket of the excavator or backhoe, placed in 1-gallon plastic bags, and transported to LAI's laboratory for further evaluation. Laboratory testing may be performed on select soil samples to assess if a physical barrier (e.g., soil/gravel and/or other reduced permeability or impermeable surface) will be needed to supplement existing Site surfaces (e.g., gravel, soil, etc.) to address the soil pathway for direct contact and the erosion potential of Site soils.

If performed, physical testing may include:

- Moisture content determination
- Combined sieve and hydrometer analysis (i.e., grain size analysis).

Upon completion of logging and sampling of the test pits, the excavations will be backfilled with the soil that was removed during excavation of the test pits. The backfill soil will be placed in lifts and each lift of soil will be tamped with the backhoe's bucket. The ground surface at each test pit location will be restored to its original condition, to the extent possible.

4.5 Groundwater Sampling

Groundwater sampling to support PRDI activities may include groundwater collected from existing (intact and relevant) monitoring wells and from new monitoring wells to be installed within the C Street Properties subarea and along the western Site boundary proximal to the aerated stabilization basin. Additional new groundwater wells may be installed in other areas of the Site to further support demonstration of long-term compliance requirements, as needed.

Groundwater sampling results will be used in conjunction with data from previous environmental investigations to assess current groundwater quality at the Site, as it relates to the requirements of the approved cleanup remedy, including monitored natural attenuation (MNA) parameters. Existing monitoring wells and potential locations for new monitoring wells that may be sampled during the PRDI are discussed in the PRDI Work Plan and will be further outlined in subsequent Work Plan addenda, if appropriate.

Groundwater analytical methods and reporting limits are provided in Table A-1a, containers and preservation requirements are listed in Table A-2, and a summary of field QC sample collection and frequency is provided in Table A-3.

Groundwater samples from select wells may be analyzed for the following constituents based on the rationale in the PRDI Work Plan and associated future addenda:

- Petroleum hydrocarbons (TPH-G, TPH-D, and TPH-O)
- Volatile organic compounds (i.e., BTEX)
- Metals[2]
- Polycyclic aromatic hydrocarbons
- Semivolatile organic compounds, (bis[2-ethylhexyl] phthalate).

MNA parameters will also be selectively analyzed, based on the rationale in the PRDI Work Plan and future addenda, using field and laboratory methods, and may include:

- Nitrate
- Sulfate
- Manganese (dissolved)
- Iron (dissolved)
- Alkalinity
- Methane
- Total organic carbon
- Hardness
- Field measurements including ferrous iron, dissolved oxygen, pH, redox and electrical conductivity
- Total dissolved solids and chloride will also be measured to evaluate the extent of tidal influence (marine water intrusion) on Site groundwater.

[2] Metals to include (total and dissolved) arsenic, cadmium, chromium (total, hexavalent, and trivalent), copper, lead, mercury, nickel, selenium, silver, and zinc.

Samples collected for dissolved metals analysis will be field-filtered. An in-line, 0.45-micron cartridge filter will be attached to the sample discharge line. Surface water will be passed through the filter for approximately 1 minute prior to filling the sample bottle. The bottle will then be filled directly from the discharge outlet on the filter. The bottle will be filled to just below the neck to prevent overfilling and loss of the sample preservative.

Field duplicates will not be labeled as such on the sample labels or COC forms, but they will be identified as such in the field notebook and on the sample logs. Field QC sample requirements are provided in Table A-4.

4.6 Groundwater Monitoring Well Installation

New monitoring wells will be installed with a hollow-stem auger drilling rig. Monitoring well borings will be drilled to the total desired depth of the well (approximately 5 ft below the seasonally/tidally low groundwater table elevation). Monitoring wells will be completed with 0.010-slot, 2-inch-diameter, Schedule 40 polyvinyl chloride (PVC) screen with a flush-threaded bottom cap no greater than 6 inches long. As a standard, planned screen lengths will be 10 ft; however, lengths may change based on conditions observed in the field or on the specific rationale for the well's location as detailed in the PRDI Work Plan or associated future addenda. Blank Schedule 40 PVC casings will extend from the top of the screen to about 0.5 ft bgs for flush-mounted wells and extend about 2.5 ft above ground surface for above-grade surface completions. The top of the PVC will be fitted with a standard lockable well plug.

A sand pack equivalent to 10/20 silica sand will be placed in the bottom of the borehole to 2 ft above the top of the screen in each upland monitoring well. The monitoring well will be surged prior to placement of the bentonite seal to prevent bridging and facilitate settling of the sand pack. A seal consisting of bentonite chips will be placed directly above the sand pack to a depth of approximately 1.5 ft below grade or less. The depth to the top of the sand pack and the bentonite will be tagged with a weighted tape to ensure well completion materials are installed to the correct depth.

Neat cement grout will then be placed on top of the bentonite seal extending to the ground surface. The neat cement grout shall consist of Portland cement types I, II, or III with 5 percent by dry weight of bentonite. The grout will be emplaced through the augers.

Flush-mount monuments will be constructed above the top of the well casing in locations were vehicular traffic or other Site/facility operations will not allow for aboveground well completions. Flush-mounted installations will consist of traffic-rated steel well monuments and bolt-on well covers, set slightly above the surrounding grade (to promote stormwater runoff away from the well monument) embedded in concrete tapered away from the well cover.

Aboveground well completions will consist of a protective steel casing placed around the PVC and extending from at least 6 inches above the PVC to at least 2 ft bgs. A 2-ft-diameter surface cement

pad extending to a depth of 2 ft will be placed around the steel casing. Three protective metal bollards at least 3 inches in diameter will be placed in a triangular arrangement around the casing and cement pad. The bollards will extend from a minimum of 3 ft bgs to a minimum of 3 ft above ground. The well shall be identified with a permanently affixed and clearly labeled well identification tag.

4.7 Groundwater Well Development

New monitoring wells will be developed prior to gauging (e.g., groundwater level measuring) or groundwater sampling. Prior to new groundwater well development, each well will be inspected for integrity and the results documented on field activity logs. Existing groundwater monitoring wells may also be redeveloped in advance of sampling depending on age, span of time since last sampled, and current condition/integrity, as assessed in the field.

Monitoring wells must be developed for the following reasons:

- To restore the natural permeability of the formation adjacent to the borehole to permit the water to flow into the screen easily
- To remove the clay, silt, and other fines from the formation so that during subsequent sampling the water will not be turbid or contain suspended matter, which could easily interfere with chemical analysis
- To remove any formation damage that may have occurred as a result of well drilling.

Well development is necessary for newly completed wells and may be required for wells that have been left dormant for some time or have accumulated significant quantities of sediment in the well, gravel pack, or surrounding formation. Well development should remove clay particles deposited on the borehole wall along with a sufficient quantity of water to ensure the removal of fluids introduced into the formation during drilling. The development process should also effectively loosen and remove finer particles from the formation matrix.

Well development is accomplished by causing the natural formation water inside the well to move vigorously in and out through the screen. The suspended sediment is then removed from the well by bailing or pumping. Several techniques may be employed in developing a well. To be effective, all techniques require reversals or surges in flow to avoid bridging by particles. These surges can be created by using surge blocks, airlifts, bailers, or pumps. The use of water other than the natural formation water is not recommended during well development.

Before developing the well, water depth, and well depth will be measured using an electronic or mechanical device (see Section 4.8). Approximately 10 well casing volumes (calculated from the length of the water column and the well casing diameter) should be removed from the well during development. The discharge from the well should be continuously monitored and development should be continued until a particulate-free discharge is apparent and the field parameters (pH, conductivity, and temperature) have stabilized within 10 percent of the previous reading. Field

parameters should be recorded on the well development form after each volume is removed. Materials and equipment used in conjunction with development must be decontaminated prior to use and all provisions made to prevent cross-contamination during development. Well depths will be measured following development to determine whether sand or silt has accumulated in the well.

Regardless of the method employed, discharges from the well must be properly disposed of depending on the nature of the liquid removed from the well. Additionally, materials and equipment placed into the well in conjunction with development must be decontaminated prior to use. The following subsections summarize methods of well development that may be used at the Site. A surge block or bailer will be used initially to flush the sand pack followed up by a submersible pump.

4.7.1 Surge Block

A surge block is a round plunger with pliable edges that will not catch on the well screen. The surge block assembly is lowered by hand down the well by connecting sections of threaded pipe. Once within the screen interval, the block is rapidly raised and lowered to agitate the water within the well.

If the surge block method is employed, development can be continued using a nitrogen-driven bladder pump to evacuate the well. The bladder pump is lowered down the well and is connected to a section of Teflon® tubing. The nitrogen supply is turned on to activate the pump and discharge liquid from the well.

4.7.2 Bailer

A bailer, sufficiently heavy so that it will sink rapidly through the water, can be raised and lowered through the well screen. The resulting agitation action of the water is similar to that caused by a surge block. The bailer, however, has the added advantage of removing the fines each time it is brought to the surface and emptied. Bailers can be custom-made for small diameter wells and can be hand-operated in shallow wells.

4.7.3 Pumping

Starting and stopping a pump so that the water is alternately pulled into the well through the screen and back-flushed through the screen is an effective development method. Periodically pumping the well water will remove the fines from the well and permit checking the progress to ensure that development is complete. Continue pumping until the well yields water with a turbidity of 50 nephelometric turbidity units or until a minimum of 10 casing volumes have been pumped from the well. If water is added to the well during drilling, a minimum of 200 percent of the volume of water added to the well must be purged during development. Record the final turbidity of the well on the well development log.

4.8 Groundwater-Level Measurement (Gauging)

Groundwater-level data are used to indicate the directions of groundwater flow and areas of recharge and discharge, to evaluate the effects of manmade and natural stresses on the groundwater system, to define the hydraulic characteristics of aquifers, and to evaluate surface water-groundwater interactions.

When taking a series of fluid-level measurements at a number of monitoring wells, it is generally good practice to go in order from the least- to most-likely contaminated well. Additionally, the measurement of Site wells should be done consecutively and before sampling activities begin. This will ensure the data are representative of aquifer conditions. Pertinent data will be entered in the fluid-level monitoring log sheet or the project field book.

4.8.1 Well Evaluation

Prior to measuring groundwater levels in a given monitoring well, the surface seal and well protective casing should be examined for evidence of frost heaving, cracking, or vandalism. Observations should be recorded in the fluid-level monitoring log or the project field book.

4.8.2 Measuring Point Location

The measuring point location for the groundwater well should be clearly marked on the inner casing (PVC riser) or identified in previous sample collection records. This point is usually established on the well casing itself, but may be marked on the protective steel casing in some cases. In either case, it is important that the marked point coincide with the same point of measurement used by the surveyor. If not marked from previous investigations, the water-level measuring point should be marked on the north side of the well casing and noted in the fluid-level monitoring log or the project field book. Monitoring well measurements for total depth and water level should be consistently measured from one reference point so that these data can be used for assessing groundwater elevation trends.

4.8.3 Groundwater-Level Measurement Methods

Groundwater-level measurements will be made using either an electronic or mechanical device and measurements will be taken for both the presence of light non-aqueous phase liquid (LNAPL) and groundwater levels. Many types of electrical instruments are available for manual and automated groundwater level measurements.

4.8.3.1 Manual Measurements

Most manual groundwater-level measurement instruments operate on the principle that a circuit is completed when two electrodes are immersed in water. Before lowering the probe in the well, the circuitry can be checked by dipping the probe in water and observing the indicator (a light, sound, and/or meter).

To obtain a manual groundwater-level measurement, the decontaminated probe will be slowly lowered into the monitoring well until the indicator (light, sound, and/or meter) shows water contact. The exact measurement will be determined by repeatedly raising and lowering the tape or cable to converge on a consistent value. Manual water-level (and LNAPL thickness, if present) measurements will be entered in the fluid-level monitoring log or the project field book (Attachment 1).

4.8.3.2 Automated Measurements

Most automated fluid-level measurement instruments operate on the principle of hydrostatic pressure and typically consist of a pressure transducer and an accompanying datalogger encased in a single shared submersible stainless-steel metal body (herein referred to as the transducer). A transducer may be vented to the atmosphere (including a vent tube extending from the transducer to the well cap and open to the atmosphere), in which case it would measure hydrostatic pressure (i.e., the height of the fluid column above the transducer) only.

Alternatively, a transducer may be unvented to the atmosphere, in which case it would measure absolute pressure (i.e., the sum of hydrostatic pressure plus atmospheric pressure). Unvented transducers require a companion barometric pressure transducer installed in a secure nearby location open to the atmosphere (e.g., installed in open air, in the airspace of an unsealed well, or in a vented shed or outbuilding) to compensate (i.e., subtract out the barometric pressure component of) the absolute pressure measurements.

Automated raw (and compensated, if necessary) groundwater-level measurements will be converted to depth-to-water below ground surface or groundwater-level elevations and will be correlated with manual water-level measurements taken as close as practical in time to a transducer reading with the transducer installed at its installed depth (i.e., if the transducer is hung from the bottom of a well cap, the transducer reading used for correlation should be from a time when the well cap was in place).

To obtain automated water-level measurements from a well, a transducer will be programmed to record pressure readings with a chosen interval (e.g., on a regular/consistent hourly basis) and hung in the well on low-stretch, high-strength string or stainless-steel cable at a depth where it will be submerged in all anticipated groundwater-level conditions (but within the manufacturer's recommended maximum submergence depth). A corresponding manual water-level measurement will be taken as close in time as practical to a programmed transducer reading with the transducer installed at its installed depth.

If a vented transducer is used, care should be taken so that adequate desiccant is present in the vent tube. If an unvented transducer is used, a companion barometric pressure transducer should be programmed on the same interval as the groundwater-level transducer and installed in a secure location nearby that is open to the atmosphere. A single barometric pressure transducer can be used to compensate for absolute pressure readings from multiple water-level transducers. Transducer data will be downloaded and processed in accordance with the manufacturer's instructions or guidance.

Groundwater fluid-level measurement devices will be decontaminated prior to and immediately after use following the procedures in Section 4.11.

4.8.4 Measurement of Total Depth

During groundwater-level measurement and after groundwater sampling, the total depth of the well will also be measured. This measurement gives an indication of possible sediment buildup within the well that may significantly reduce the screened formation interval. When total depth is measured, the same methods used for measuring groundwater levels (e.g., steel tape or electrical probes) will be used to measure the total well depth. The appropriate time to measure the total well depth is immediately following groundwater sampling to prevent suspension of sediment into the screen interval during sampling. The measurement device (steel tape or electrical probe) will be lowered down the well until the measurement tape becomes slack indicating the weighted end of the tape or probe has reached the bottom of the well. The total well depth will be recorded in the field book.

4.9 Sample Collection (Low-Flow Methods)

Groundwater withdrawal using pumps is commonly performed with centrifugal, peristaltic, submersible, or bladder pumps. Peristaltic and centrifugal pumps are limited to conditions where groundwater need only be raised through approximately 25 ft of vertical distance. Submersible or bladder pumps can be used when groundwater is greater than 25 ft below grade.

4.9.1 Groundwater-Level Measurement

After unlocking and/or opening a monitoring well, the first task will be to obtain a groundwater-level measurement. A static-water level will be measured in the well prior to the purging and collection of samples. The groundwater level is needed for estimating the purge volume and may also be used for mapping the potentiometric groundwater surface. Groundwater-level measurements will be made using an electronic or mechanical device following the methods described in Section 4.8.3.

4.9.2 Purging

Groundwater well water purging is required prior to sample collection when using low flow techniques. Low-flow purging is conducted at a flow rate that is approximately equal to the recharge rate of the well (i.e., where minimal to no drawdown is observed in the well during pumping), and purging is considered complete when groundwater parameters are determined to be stable.

Specifically, groundwater parameters are considered stable when at least three consecutive measurements, taken approximately 1 to 5 minutes apart (time required to “turn over” at least one flow-through-cell volume), of turbidity, dissolved oxygen, oxidation reduction potential (redox), pH, and specific conductance are within 10 percent of the previous measurement, and when consecutive measurements of temperature and conductivity are within 3 percent.

4.9.3 Sample Collection

Samples will be collected using either dedicated pumps in each monitoring well or a single pump use for wells to be sampled. If a single pump is used, new, clean tubing will be used at each well, and equipment that contacts water directly will be decontaminated as appropriate.

Upon stabilization of parameters, the purge rate will be reduced to approximately between 100 and 200 milliliters per minute (mL/min). Samples are collected from the discharge tube of the pump into appropriate sample containers. Table A-2 summarizes the appropriate sampling containers and handling requirements (i.e., preservation and headspace) for specific sampling constituents.

4.9.4 Quality Control of Sample Collection

At least one duplicate sample shall be collected for each 20 groundwater samples collected. Duplicate groundwater samples will be collected by filling two containers (or sets of containers) simultaneously from the sampling device. Table A-3 provides the necessary frequencies for QC sample collection.

Trip blanks will be submitted each day that groundwater is sampled for volatile constituents (i.e., TPH-G and BTEX). Trip blanks will be prepared by the laboratory by filling representative glassware with known de-ionized water. These samples will be transported with the sample collection glassware and analyzed for evidence of systematic contamination from sample transport, glassware cleaning, and laboratory storage. Trip blanks will be sent with each cooler containing water samples to be analyzed for VOCs.

Samples collected for VOC analysis will be placed in two 40-mL volatile organic analyte vials with zero headspace. Agitation will be minimized during sampling to reduce potential losses of volatile constituents.

4.9.5 Documentation

Various documents will be completed and maintained as a part of groundwater sample collection. These documents will provide a summary of the sample collection procedures and conditions, shipment method, analyses requested, and the custody history. These documents will include:

- Field book
- Groundwater sampling forms
- Sample labels
- COC forms
- Shipping receipts.

Documentation will be stored in the project files (hard copy and electronic, as appropriate).

4.10 Landfill Gas Evaluation

LFG data will be collected from the subsurface and from within existing buildings. New temporary and permanent LFG monitoring probes will be installed by a licensed well-driller, to provide for the collection of subsurface soil vapor data.

4.10.1 Landfill Gas Monitoring Probe Installation – Temporary

The temporary LFG monitoring probes will be constructed using a direct-push boring rig to advance a 3-inch-diameter boring to the desired depth of 4 to 5 ft bgs. After removing the direct-push tooling, a 4-inch pea-gravel bedding will be placed into the bottom of the boring, then a ½-inch-diameter PVC pipe with open-bottom and ⅛-inch field-constructed perforations will be lowered into the boring. The annular space between the PVC casing and borehole wall will be packed with pea gravel from the bottom up to within 18 inches of the ground surface. The upper 18 inches of the probe will include a 12-inch bentonite seal, and a temporary flush-mounted monument to allow for continued surface trafficking. The top of the ½-inch PVC casing will be outfitted with a valve and ½-inch sample port below ground surface to provide for future monitoring. No PVC glue will be used in constructing the monitoring probe, to prevent interference with future monitoring of VOCs.

4.10.2 Landfill Gas Monitoring Probe Installation – Permanent

The permanent LFG monitoring probes will be installed with a hollow-stem auger drilling rig to advance a 6-inch-diameter boring to the desired depth of approximately 15 ft bgs. The monitoring probes will be completed using ½-inch-diameter, Schedule 40 PVC, with 0.03 to 0.04-inch machine-slotted perforations in the lowest 5-ft section. No bottom cap will be installed on the casing, and no glue will be used in the casing or valve port construction. Blank Schedule 40 PVC casing will extend from the top of the screen to about 0.5 ft bgs for flush mounted wells and extend about 2.5 ft above ground for above-grade surface completions.

A sand pack equivalent of pea gravel will be placed in the bottom of the borehole to 2 ft above the top of the screen in each probe. A bentonite seal consisting of hydrated bentonite chips will be placed directly above the sand pack to a depth of approximately 1.5 ft below grade or less. The depth to the top of the sand pack and the bentonite will be tagged with a weighted tape to ensure well completion materials are installed to the correct depth.

Neat cement grout will then be placed on top of the bentonite seal extending to the ground surface. The neat cement grout shall consist of Portland cement types I, II, or III with 5 percent by dry weight of bentonite. The grout will be emplaced through the augers.

The top of the PVC will be fitted with a standard PVC slip cap to a National Pipe Tapered adapter, a ball valve, and a 0.25-inch-diameter sample collection port.

Flush-mount monuments will be constructed above the top of the well casing in locations were vehicular traffic or other Site/facility operations will not allow for aboveground well completions. Flush-mounted installations will consist of traffic-rated steel well monuments and bolt-on well covers, set slightly above the surrounding grade (to promote stormwater runoff away from the well monument) embedded in concrete tapered away from the well cover.

Aboveground well completions will consist of a protective steel casing placed around the PVC and extending from at least 6 inches above the PVC to at least 2 ft bgs. A 2-ft-diameter surface cement pad extending to a depth of 2 ft will be placed around the steel casing. Three protective metal bollards at least 3 inches in diameter will be placed in a triangular arrangement around the casing and cement pad. The bollards will extend from a minimum of 3 ft bgs to a minimum of 3 ft above ground. The well shall be identified with a permanently affixed and clearly labeled well identification tag.

4.10.3 Soil Vapor Monitoring

Soil vapor quality will be monitored for the presence of LFG using a Landtec GEM 2000 or GEM 5000 handheld LFG analyzer, capable of providing a lower reporting limit for methane of 0.1 percent by volume. Prior to monitoring, field personnel will verify an airtight seal has been created between the instrument and the monitoring port, and the static pressure will be measured and recorded to the nearest 0.05 inches of water column. After measuring pressure, the handheld LFG analyzer will be used to purge the monitoring probe, while the field personnel observe the reported concentrations of oxygen, carbon dioxide, methane, and balance gas for relative stability. It is assumed that stability will be achieved in less than 120 seconds.

Instrument calibration will be conducted in accordance with the manufacturer's recommendations, and verification of calibration will be recorded on field forms.

At locations to be selected based on the preliminary round of monitoring using the hand-held analyzer, soil vapor samples will be collected from the monitoring probes into 6-liter Summa canisters with a laboratory-supplied and calibrated flow control valve. The flow control valve will be calibrated to a flow rate not to exceed 200 mL/min (collection time of approximately 30 minutes). After connecting the flow controller to the Summa canister, and the sample tubing to the flow controller inlet, field personnel will open the valve on the sample tubing, then the needle valve on the Summa canister. A pressure gauge on the flow control valve will be monitored as the sample is collected. When the pressure gauge reads approximately 5 inches of mercury vacuum, the canister valve and then the tubing valve will be closed and the canister will be detached.

Soil vapor samples will be analyzed for the VOCs listed in Table A-1b (using EPA Method TO-15), and as detailed in the Work Plan and associated addenda.

4.10.4 Indoor Air Monitoring

Indoor air monitoring will be conducted using a flame ionization detector (FID). The FID measures methane concentrations based on the calibrated detection of ions formed during combustion of organic compounds in a hydrogen flame. Prior to use, the FID will be calibrated per the manufacturer's specifications and bump-tested using methane calibration gas to qualitatively verify operation. These calibrations will be noted on field forms. The lower limit of detection for the FID will be 1 part per million. The FID will be used only for monitoring indoor air and other structures, as it is ineffective at detecting methane from subsurface probes due to the typically depleted levels of oxygen associated with LFG.

Within buildings, the FID will be used to monitor air quality near the floor at utility penetrations, in the breath-airspace, and near ceilings where accumulation could occur. Field personnel will operate the unit continuously while walking a serpentine path through the building, stopping approximately every 20 ft for at least 5 seconds to observe the FID measurements, recording the walking pathway and any observable detections. Potential interferences are common in industrial commercial settings, so elevated indoor air concentrations will be investigated further to determine if the source is inside the building, or indicative of potential soil vapor intrusion from the subsurface.

4.11 Decontamination

Decontamination is performed as a quality assurance measure and as a safety precaution, prevents cross-contamination between samples, and helps maintain a clean working environment. Equipment requiring decontamination may include hand tools, monitoring and testing equipment, and PPE.

Decontamination is achieved mainly by rinsing with liquids such as soap and/or detergent solutions, tap water, distilled water, and methanol. Equipment may be allowed to air-dry after being cleaned or may be wiped dry with paper towels or chemical-free cloths.

Sampling equipment will be decontaminated prior to use and between each sample collection point. Waste products produced by decontamination procedures such as rinse liquids, solids, rags, gloves, etc., will be collected and disposed of properly based on the nature of Site impacts and Site protocols. Materials and equipment that will be reused must be decontaminated or properly protected before being taken off Site.

The following are decontamination procedures:

- Remove gross visible solids from the equipment by brushing and then rinse with tap water.
- Wash with detergent or soap solution (e.g., Alconox® and tap water).
- Rinse with tap or distilled water.
- Repeat entire procedure or any parts of the procedure as necessary.
- Rinse with distilled water.

- After decontamination procedure is completed, avoid placing equipment directly on ground surface.

No additional decontamination procedures will be required if the equipment appears to be visually clean. If impacts are visible after hot water/steam cleaning, then a detergent wash solution with brushes (if necessary) will be used.

5.0 SAMPLE CUSTODY

The following sample custody and handling procedures will be followed for PRDI media collection.

5.1 Procedures

COC procedures are intended to document sample possession from the time of collection to disposal. COC procedures are detailed below.

Samples must be packaged so that they do not leak, break, vaporize, or cause cross-contamination of other samples. Waste samples and environmental samples (e.g., groundwater, soil, etc.) should not be placed in the same container. Each individual sample must be properly labeled and identified. Each shipping container must be accompanied by a COC form. When refrigeration is required for sample preservation, samples must be kept cool during the time between collection and final packaging.

Samples must be clearly identified immediately upon collection. Each sample bottle label will include the following information:

- Client or project name, or unique identifier, if confidential
- A unique sample description
- Sample collection date and time
- Sampler's name or initials
- Indication of filtering or addition of preservative, if applicable
- Analyses to be performed.

After collection, identification, and preservation (if necessary), the samples will be maintained under COC procedures, described further in Section 5.2.

5.2 Chain-Of-Custody Procedures

A sample is considered to be under custody if it is in someone's possession, view, or in a designated secure area. Transfers of sample custody must be documented by COC forms. The COC form will include, at a minimum, the following information:

- Client or project name, or unique identifier, if confidential
- Sample collector's name
- Company's (LAI) mailing address and telephone number
- Designated recipient of data (name and telephone number)
- Analytical laboratory's name and city
- Description of each sample (i.e., unique identifier and matrix)
- Date and time of collection

- Quantity of each sample or number of containers
- Type of analysis required
- Date and method of shipment.

Additional information may include type of sample containers, shipping identification air bill numbers, etc.

When transferring custody, both the individual(s) relinquishing custody of samples and the individual(s) receiving custody of samples will sign, date, and note the time on the form. If samples are to leave the collector's possession for shipment to the laboratory, the packaging procedures described below will be followed.

5.3 Packing for Shipment

To prepare a cooler for shipment, the sample bottles will be inventoried and logged on the COC form. At least one layer of protective material will be placed in the bottom of the container. As each sample bottle is logged on the COC form, it should be wrapped with protective material (e.g., bubble wrap, matting, plastic gridding, or similar material) to prevent breakage. Each sample bottle should be placed upright in the shipping container. Each sample bottle cap should be checked during wrapping and tightened if needed. Avoid over-tightening, which may cause the bottle cap to crack and allow leakage. Additional packaging material such as bubble wrap or Styrofoam™ pellets should be spread throughout the voids between the sample bottles.

Most samples require refrigeration as a minimum preservative. If needed, reusable cold packs or ice placed in heavy-duty Ziploc®-type bags should be distributed over the top of the samples. Two or more cold packs or bags should be used. Additional packing material should then be placed to fill the balance of the cooler or container.

The original completed COC form will be placed in a Ziploc-type plastic bag and the bag will then be placed on top of the contents within the cooler or shipping container. Alternatively, the bag may be taped to the underside of the container lid. Retain a copy of the COC form with the field records.

The top or lid of the cooler or shipping container will then be closed and rotated/shaken to verify that the contents are packed so that they do not move. Add additional packaging if needed and reclose. Place the signed and dated COC seal at two different locations (front and back) on the cooler or container lid and overlap with transparent packaging tape. The COC seal should be placed on the container in such a way that opening the container will destroy the tape. Packaging tape should encircle each end of the cooler at the hinges.

Sample shipment should be sent via courier or an overnight express service that can guarantee 24-hour delivery. Retain copies of all shipment records as provided by the shipper.

COC forms will be maintained in an appropriate file with the PM. Copies of these records will be submitted in an appendix to the final report. COC information will also be recorded in field notebooks.

5.4 Sample Log-In

Upon receipt of samples (which will be accompanied by a completed COC record detailing requested analyses), the Laboratory Coordinator(s) or his/her designee will:

- Verify all paperwork, COC records, and similar documentation
- Log in samples, assign unique laboratory sample numbers, and attach the numbers to the sample container(s)
- Store samples in a refrigerated sample bank.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

This section establishes the procedures for maintaining the accuracy of instruments and measuring equipment to conduct field measurements and tests.

6.1 Responsibilities

The Field Lead/Field Engineer or Scientist is responsible for the calibration of field equipment in accordance with manufacturers' specifications. Information on field equipment calibration requirements is included in Table A-4.

6.2 General Calibration Procedures

Field-testing equipment used for general soil and water quality parameter measurements fall into two categories, those calibrated prior to each use and those calibrated on a scheduled periodic basis. The frequency of calibration will be based on the type of equipment, inherent stability, manufacturer's recommendations, national standard values, the intended use, and operator experience. Table A-4 provides the calibration frequency of field-sampling equipment.

Equipment will be calibrated using reference standards (i.e., National Bureau of Standards or accepted values of natural physical constants). If national standards do not exist, the basis for calibration will be documented in the daily field activity log. Field equipment calibration will be performed according to equipment manufacturer instructions.

Calibrated equipment will be uniquely identified by using the manufacturer's serial number or other means. A label with the identification number and the date when the next calibration is due will be physically attached to the equipment. If this is not possible, records traceable to the equipment will be readily available for reference.

Scheduled periodic calibration of testing equipment will not relieve field personnel of the responsibility to verify that equipment is functioning properly. If an individual suspects an equipment malfunction, he/she will remove the device from service, tag it so that it is not inadvertently used, and see that recalibration is performed or substitute equipment is obtained. Instruments past due for calibration will be calibrated prior to further use.

6.3 Calibration Failures

Equipment that fails calibration or becomes inoperable during use will be removed from service, tagged to indicate that it is out of calibration, and segregated to prevent inadvertent use. Such equipment will be repaired and recalibrated or replaced as appropriate.

Results of activities performed using equipment that has failed recalibration will be evaluated by the Project Engineer. If the activity results are adversely affected, the results of the evaluation will be

documented, and the appropriate personnel notified. If water-level measurements are found to be in error due to recalibration failure of the water-level probe, the appropriate modifications will be made to the measurement according to the recalibration data and recorded in the data logbook. If pH, conductivity, or temperature meters fail recalibration, the data will be reviewed to determine whether alternate parameter data are sufficient to accept the groundwater sampling results. For instance, if the conductivity meter fails recalibration, pH and temperature readings will be used to verify that the purge water has stabilized. Since these parameters are calibrated prior to each use, it is unlikely that the data will be unacceptable.

6.4 Calibration Records

Calibration records will be maintained in daily field activity logs or on appropriate forms (see Attachment 1).

6.5 Maintenance

Each piece of equipment used in activities affecting data quality will be maintained according to the specifications provided by the manufacturer. The Field Lead or Field Engineer/Scientist will be responsible for performing routine maintenance and will have available tools and spare parts to conduct routine maintenance. If the equipment or instrument cannot be maintained to the manufacturer's specifications or cannot be properly calibrated, it will be returned to the manufacturer or other repair facility for proper maintenance and repair. Once received back from the manufacturer, the instrument will be checked for compliance to project specifications before being returned to routine field use.

7.0 ANALYTICAL PROCEDURES

Analytical testing will be in accordance with the methodologies established in Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846; EPA; accessed July 27, 2020), Standard Methods for the Examination of Water and Wastewater, 23rd edition (Baird et al. 2017), or approved ASTM International standard methods.

7.1 Analytical Laboratories

Analytical Resources, Inc. (ARI) will perform the laboratory chemical analysis of soil and groundwater. LFG samples will be analyzed by Analytical Laboratory Services, Inc. (ALS). Environmental laboratories performing work under this SAP will maintain current accreditation through Ecology for applicable methods and analytes. Geotechnical analysis will be managed by LAI at its internal soils laboratory. Contact information for the primary consultant and laboratories are provided below.

Contact	Responsibility
LAI 130 2nd Avenue South Edmonds, WA 98020 Telephone: (425) 778-0907	Geotechnical testing
ARI 4611 South 134th Place, Suite #100 Tukwila, WA 98168 Telephone: (206) 695-2600	Chemical analysis
ALS 2655 Park Center Drive, Suite A Simi Valley, CA 93065 Telephone: (805) 577-2086	Landfill gas testing

8.0 REFERENCES

Baird, Roger B., Andrew D. Eaton, and Eugene W. Rice, eds. 2017. *Standard Methods for the Examination of Water and Wastewater, 23rd Edition*. American Public Health Association, American Water Works Association, and Water Environment Federation. January 1.

Ecology. 2020. Final: Cleanup Action Plan, Central Waterfront Site, Bellingham, Washington. Washington State Department of Ecology. January.

EPA. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*. Third Edition Final Updates I (1993), II (1995), IIA (1994), IIB (1995), III (1997), IIIA (1999), IIIB (2005), IV (2008), and V (2015). SW-846. US Environmental Protection Agency. https://www.epa.gov/hw-sw846.

Table A-1a
Target Reporting Limits for Soil and Groundwater
Pre-Remedial Design Investigation Sampling and Analysis Plan
Central Waterfront Project – Bellingham, Washington

Analyte	CAS No.	Soil		Groundwater	
		Method	Reporting Limit (mg/kg)	Method	Reporting Limit (µg/L)
Volatile Organic Compounds					
Benzene	71-43-2	EPA 8260D	0.050	EPA 8260D	1.00
Toluene	108-88-3	EPA 8260D	0.050	EPA 8260D	1.00
Ethylbenzene	100-41-4	EPA 8260D	0.050	EPA 8260D	1.00
Total Xylenes	1330-20-7	EPA 8260D	0.100	EPA 8260D	2.00
Petroleum Hydrocarbons					
TPH-G (NWTPH-Gx)	N/A	NWTPH-Gx	5.00	NWTPH-Gx	100
TPH-D (NWTPH-Dx)	N/A	NWTPH-Dx	5.00	NWTPH-Dx	100
TPH-O (NWTPH-Dx)	N/A	NWTPH-Dx	10.0	NWTPH-Dx	200
TPH (calculation)	N/A	Calculation	(a)	Calculation	(a)
Semivolatile Organic Compounds					
bis(2-Ethylhexyl)phthalate	117-81-7	--	--	EPA 8270E	3.00
PAHs					
Naphthalene	91-20-3	--	--	EPA 8270E SIM	0.01
2-Methylnaphthalene	91-57-6	--	--	EPA 8270E SIM	0.01
1-Methylnaphthalene	90-12-0	--	--	EPA 8270E SIM	0.01
2-Chloronaphthalene	91-58-7	--	--	EPA 8270E SIM	0.01
Biphenyl	92-52-4	--	--	EPA 8270E SIM	0.01
2,6-Dimethylnaphthalene	581-42-0	--	--	EPA 8270E SIM	0.01
Acenaphthylene	208-96-8	--	--	EPA 8270E SIM	0.01
Acenaphthene	83-32-9	--	--	EPA 8270E SIM	0.01
Dibenzofuran	132-64-9	--	--	EPA 8270E SIM	0.01
2,3,5-Trimethylnaphthalene	2245-38-7	--	--	EPA 8270E SIM	0.01
Fluorene	86-73-7	--	--	EPA 8270E SIM	0.01
Dibenzothiophene	132-65-0	--	--	EPA 8270E SIM	0.01
Phenanthrene	85-01-8	--	--	EPA 8270E SIM	0.01
Anthracene	120-12-7	--	--	EPA 8270E SIM	0.01
Carbazole	86-74-8	--	--	EPA 8270E SIM	0.01
Fluoranthene	206-44-0	--	--	EPA 8270E SIM	0.01
Pyrene	129-00-0	--	--	EPA 8270E SIM	0.01
1-Methylphenanthrene	832-69-9	--	--	EPA 8270E SIM	0.01
Benzo(a)anthracene	56-55-3	--	--	EPA 8270E SIM	0.01
Chrysene	218-01-9	--	--	EPA 8270E SIM	0.01
Benzo(b)fluoranthene	205-99-2	--	--	EPA 8270E SIM	0.01
Benzo(k)fluoranthene	207-08-9	--	--	EPA 8270E SIM	0.01
Benzo(j)fluoranthene	205-82-3	--	--	EPA 8270E SIM	0.01
Benzofluoranthenes, Total	N/A	--	--	EPA 8270E SIM	0.01
Benzo(e)pyrene	197-97-2	--	--	EPA 8270E SIM	0.01
Benzo(a)pyrene	50-32-8	--	--	EPA 8270E SIM	0.01
Perylene	1985-5-0	--	--	EPA 8270E SIM	0.01
Indeno(1,2,3-cd)pyrene	193-39-5	--	--	EPA 8270E SIM	0.01
Dibenzo(a,h)anthracene	53-70-3	--	--	EPA 8270E SIM	0.01
Benzo(g,h,i)perylene	191-24-2	--	--	EPA 8270E SIM	0.01
Conventionals					
Sulfate	14808-79-8	--	--	EPA 300.0	100
Nitrate	14797-55-8	--	--	EPA 300.0	100
Chloride	7647-14-5	--	--	EPA 300.0	100
Methane	74-82-8	--	--	RSK-175	0.654

Table A-1a
Target Reporting Limits for Soil and Groundwater
Pre-Remedial Design Investigation Sampling and Analysis Plan
Central Waterfront Project – Bellingham, Washington

Analyte	CAS No.	Soil		Groundwater	
		Method	Reporting Limit (mg/kg)	Method	Reporting Limit (µg/L)
Total Dissolved Solids	N/A	--	--	SM 2540	5,000
Alkalinity, Total (µg/L CaCO3)	N/A	--	--	SM 2320	1,000
Total/Dissolved Metals					
Arsenic	7440-38-2	EPA 6010C	5.00	EPA 6020A UCT	0.200
Barium	7440-39-3	EPA 6010C	0.300	N/A	--
Cadmium	7440-43-9	EPA 6010C	0.200	EPA 6020A UCT	0.100
Chromium, Total	7440-47-3	EPA 6010C	0.500	EPA 6020A UCT	0.500
Chromium, Hexavalent (SM 3500)	18540-29-9	--	--	SM 3500	10.0
Chromium, Trivalent (calculated)	16065-83-1	--	--	Calculation	N/A
Copper	7440-50-8	--	--	EPA 6020A UCT	0.500
Hardness (calculated)	N/A	--	--	EPA 6010C	N/A
Iron	7439-89-6	--	--	EPA 6020A UCT	20.0
Lead	7439-92-1	EPA 6010C	2.00	EPA 6020A UCT	0.100
Manganese	7439-96-5	--	--	EPA 6020A UCT	0.500
Mercury	7439-97-6	EPA 7471B	0.025	EPA 7470A	0.0200
Nickel	7440-02-0	--	--	EPA 6020A UCT	0.500
Selenium	7782-49-2	EPA 6010C	5.00	EPA 6020A UCT	0.500
Silver	7440-22-4	EPA 6010C	0.300	EPA 6020A UCT	0.200
Zinc	7440-66-6	--	--	EPA 6020A UCT	4.00

Notes:

(a) TPH will be calculated as the sum of detections.

Acronyms/Abbreviations:

CaCO3 = calcium carbonate
CAS = Chemical Abstracts Service
EPA = US Environmental Protection Agency
µg/L = micrograms per liter
mg/kg = miligrams per kilogram
N/A = not applicable
-- = not scheduled for analysis
NWTPH-Dx = Northwest Total Petroleum Hydrocarbon diesel extended
NWTPH-Gx = Northwest Total Petroleum Hydrocarbon gasoline extended
RL = reporting limit
SM = Standard Methods
TPH = total petroleum hydrocarbons
TPH-D = diesel-range total petroleum hydrocarbons
TPH-O = oil-range total petroleum hydrocarbons
UCT = universal cell technology

Table A-1b
Target Reporting Limits for Landfill Gas
Pre-Remedial Design Investigation Sampling and Analysis Plan
Central Waterfront Project – Bellingham, Washington

Analyte	CAS No.	Target Reporting Limits Landfill Gas ($\mu g/m^3$)
Volatile Organic Compounds by EPA Method TO-15		
1,1,1-Trichloroethane	71-55-6	0.54
1,1,2,2-Tetrachloroethane	79-34-5	0.54
1,1,2-Trichloroethane	79-00-5	0.54
1,1-Dichloroethane	75-34-3	0.55
1,1-Dichloroethene	75-35-4	0.54
1,2,4-Trichlorobenzene	120-82-1	0.54
1,2,4-Trimethylbenzene	95-63-6	0.54
1,2-Dibromo-3-chloropropane	96-12-8	0.53
1,2-Dibromoethane	106-93-4	0.54
1,2-Dichloro-1,1,2,2-tetrafluoroethane (CFC 114)	76-14-2	0.53
1,2-Dichlorobenzene	95-50-1	0.54
1,2-Dichloroethane	107-06-2	0.54
1,2-Dichloropropane	78-87-5	0.54
1,3,5-Trimethylbenzene	108-67-8	0.53
1,3-Butadiene	106-99-0	0.53
1,3-Dichlorobenzene	541-73-1	0.54
1,4-Dichlorobenzene	106-46-7	0.54
1,4-Dioxane	123-91-1	0.54
2-Butanone (MEK)	78-93-3	1.1
2-Hexanone	591-78-6	0.54
2-Propanol (Isopropyl Alcohol)	67-63-0	2.1
3-Chloro-1-propene (Allyl Chloride)	107-05-1	0.54
4-Ethyltoluene	622-96-8	0.54
4-Methyl-2-pentanone	108-10-1	0.53
Acetone	67-64-1	5.3
Acetonitrile	75-05-8	0.53
Acrolein	107-02-8	1.0
Acrylonitrile	107-13-1	0.53
alpha-Pinene	80-56-8	0.54
Benzene	71-43-2	0.53
Benzyl Chloride	100-44-7	1.1
Bromodichloromethane	75-27-4	0.54
Bromoform	75-25-2	0.54
Bromomethane	74-83-9	0.54
Carbon Disulfide	75-15-0	1.1
Carbon Tetrachloride	56-23-5	0.53
Chlorobenzene	108-90-7	0.54
Chloroethane	75-00-3	0.54
Chloroform	67-66-3	0.54
Chloromethane	74-87-3	0.53
cis-1,2-Dichloroethene	156-59-2	0.53
cis-1,3-Dichloropropene	10061-01-5	0.52
Cumene	98-82-8	0.54
Cyclohexane	110-82-7	1.1
Dibromochloromethane	124-48-1	0.54

Table A-1b
Target Reporting Limits for Landfill Gas
Pre-Remedial Design Investigation Sampling and Analysis Plan
Central Waterfront Project – Bellingham, Washington

Analyte	CAS No.	Target Reporting Limits Landfill Gas ($\mu g/m^3$)
Volatile Organic Compounds by EPA Method TO-15		
Dichlorodifluoromethane (CFC 12)	75-71-8	0.53
d-Limonene	5989-27-5	0.54
Ethanol	64-17-5	5.2
Ethyl Acetate	141-78-6	1.1
Ethylbenzene	100-41-4	0.54
Hexachlorobutadiene	87-68-3	0.53
m,p-Xylenes	179601-23-1	1.1
Methyl Methacrylate	80-62-6	1.1
Methyl tert-Butyl Ether	1634-04-4	0.54
Methylene Chloride	75-09-2	0.53
Naphthalene	91-20-3	0.52
n-Butyl Acetate	123-86-4	0.55
n-Heptane	142-82-5	0.54
n-Hexane	110-54-3	0.54
n-Nonane	111-84-2	0.54
n-Octane	111-65-9	0.54
n-Propylbenzene	103-65-1	0.54
o-Xylene	95-47-6	0.54
Propene	115-07-1	0.53
Styrene	100-42-5	0.53
Tetrachloroethene	127-18-4	0.52
Tetrahydrofuran (THF)	109-99-9	0.55
Toluene	108-88-3	0.54
trans-1,2-Dichloroethene	156-60-5	0.54
trans-1,3-Dichloropropene	10061-02-6	0.53
Trichloroethene	79-01-6	0.54
Trichlorofluoromethane	75-69-4	0.53
Trichlorotrifluoroethane	76-13-1	0.54
Vinyl Acetate	108-05-4	5.4
Vinyl Chloride	75-01-4	0.54
Volatile Organic Compounds by EPA Method TO-15 SIM		
Vinyl Chloride	75-01-4	0.025

Acronyms/Abbreviations:

CAS = Chemical Abstracts Service
EPA = US Environmental Protection Agency
SIM = selected ion monitoring
$\mu g/m^3$ = micrograms per cubic meter

Table A-2
Sample Containers, Preservatives, and Holding Times
Pre-Remedial Design Investigation Sampling and Analysis Plan
Central Waterfront Project – Bellingham, Washington

Matrix	Analyte	Method	Container	Preservative	Holding Time (a)	Laboratory
Soil	TPH-G	NWTPH-Gx	2 x 40 mL vial	Cool to < 6°C, MeOH	14 days	ARI
Soil	TPH-D, TPH-O	NWTPH-Dx	4 oz jar (b)	Cool to < 6°C	14 days	ARI
Soil	BTEX	EPA 8260D	3 x 40 mL vial	Cool to < 6°C, 1 vial MeOH	14 days	ARI
Soil	Metals	EPA 6010C	4 oz jar (b)	Cool to < 6°C	6 months	ARI
Soil	Mercury	EPA 7471B	4 oz jar (b)	Cool to < 6°C	28 days	ARI
Soil	Grain Size/Hydrometer	ASTM D422	1 gallon plastic bag	N/A	N/A	LAI
Groundwater	TPH-G	NWTPH-Gx	2 x 40 mL vial	Cool to < 6°C, HCl	14 days preserved 7 days unpreserved	ARI
Groundwater	TPH-D, TPH-O	NWTPH-Dx	2 x 500 mL Amber	Cool to < 6°C	7 days	ARI
Groundwater	BTEX	EPA 8260D	2 x 40 mL vial	Cool to < 6°C, HCl	14 days preserved 7 days unpreserved	ARI
Groundwater	SVOCs	EPA 8270E	2 x 500 mL Amber	Cool to < 6°C, HCl	7 days/40 days	ARI
Groundwater	PAHs	EPA 8270E SIM	2 x 500 mL Amber	Cool to < 6°C, HCl	7 days/40 days	ARI
Groundwater	Total and Dissolved Metals	EPA 6020A UCT	500 mL HDPE	Cool to < 6°C HNO3 (c)	6 months	ARI
Groundwater	Total and Dissolved Mercury	EPA 7470A	500 mL HDPE	Cool to < 6°C HNO3 (c)	28 days	ARI
Groundwater	Hexavalent Chromium	SM 3500	500 mL HDPE	Cool to < 6°C, buffer to pH 9.3 to 9.7	28 days 24 hours (d)	ARI
Groundwater	Anions	EPA 300.0	500 mL HDPE	Cool to < 6°C	48 hrs (nitrate) 28 days (sulfate) (chloride)	ARI
Groundwater	Dissolved Gases	RSK-175	3 x 40 mL vial	Cool to < 6°C	14 days	ARI
Groundwater	Alkalinty	SM 2320B	500 mL HDPE	Cool to < 6°C	14 days	ARI
Groundwater	Total Organic Carbon	SM 5310B	250 mL glass	Cool to < 6°C, pH <2 H2SO4	28 days	ARI
Groundwater	Total Dissolved Solids	SM 2540C	1 Liter HDPE	Cool to < 6°C	7 days	ARI
Landfill Gas	VOCs	TO-15/TO-15 SIM	6-L Summa	N/A	30 days	ALS

Table A-2
Sample Containers, Preservatives, and Holding Times
Pre-Remedial Design Investigation Sampling and Analysis Plan
Central Waterfront Project – Bellingham, Washington

Note:

(a) Time from sample collection to extraction/time from sample extraction to analysis.
(b) Combined analytical suite may be analyzed using 1-8 oz jar per sample.
(c) Total metals or field-filtered samples only.
(d) If buffer is not used.

Acronyms/Abbreviations:

°C = degrees Celsius
ASTM = ASTM International
ALS = Analytical Laboratory Services, Inc.
ARI = Analytical Resources, Inc.
BTEX = benzene, ethylbenzene, toluene, total xylenes
EPA = US Environmental Protection Agency
H2SO4 = sulfuric acid
HCl = hydrochloric acid
HDPE = high-density polyethylene
HNO3 = nitric acid
L = liter
LAI = Landau Associates, Inc.
MeOH = methanol
mL = milliliter
N/A = not applicable
NWTPH-Dx = Northwest Total Petroleum Hydrocarbon diesel extended
NWTPH-Gx = Northwest Total Petroleum Hydrocarbon gasoline extended
oz = ounces
SIM = selected ion monitoring
SM = Standard Methods
TPH-D = diesel-range total petroleum hydrocarbons
TPH-G = gasoline-range total petroleum hydrocarbons
TPH-O = oil-range total petroleum hydrocarbons
UCT = universal cell technology
VOCs = volatile organic compounds

Table A-3
Field Quality Control Sample Summary
Pre-Remedial Design Investigation Sampling and Analysis Plan
Central Waterfront Project – Bellingham, Washington

Matrix	Collection Frequency		
	Field Duplicates	Matrix Spike/ Matrix Spike Duplicates	Trip Blanks
Soil	N/A	1 per 20 samples	1 per each cooler containing samples scheduled for volatile analyses
Groundwater	1 per 20 samples	1 per 20 samples	1 per each cooler containing samples scheduled for volatile analyses
Landfill Gas	N/A	N/A	N/A

Acronyms/Abbreviations:
N/A = not applicable

Table A-4
Equipment Calibration Requirements
Pre-Remedial Design Investigation Sampling and Analysis Plan
Central Waterfront Project – Bellingham, Washington

Instrument	Calibration Procedure	Calibration Frequency
pH meter	Three-point calibration with pH buffers 7, 4, and 10, as appropriate	Daily
Conductivity meter	One-point calibration with 1,500 microSiemen/centimeter (µS/cm) standard solution for non-saline water, or 2,880 µS/cm standard solution for saline waters	Daily
Dissolved Oxygen meter	100% saturation using tap water exposed to ambient air, in accordance with manufacturer's specifications.	Daily and/or when weather (pressure and/or temperature) changes are significant
Redox meter	None	N/A
Thermometer	Check with ohm meter or standard thermomter	Annually
Electric water-level probe	Test probe in tap water; check tape against known length	Probe; as needed if malfunctions; tape length: annually
Photoionization detector (PID)	Isobutylene gas and bump test	Daily
Flame ionization detector (FID)	Calibrate per manufacturer's recommendations and bump test	Daily

ATTACHMENT A-1

Field Forms

LANDAU ASSOCIATES

Air Monitoring Log

Project Name _____ Project No. _____

Location _____ Date _____

_____ Landau Rep. _____

Client _____ Weather _____

Meter Number 1, Type _____ Calibrated _____ Checked _____

Meter Number 2, Type _____ Calibrated _____ Checked _____

Meter Number 3, Type _____ Calibrated _____ Checked _____

Meter Number 4, Type _____ Calibrated _____ Checked _____

Meter	Time	Background Reading	Drillers Breathing Zone	Samplers Breathing Zone	Other Reading	Comments

LANDAU ASSOCIATES

Chain-of-Custody Record

☐ **Seattle/Edmonds** (425) 778-0907 ☐ **Spokane** (509) 327-9737
☐ **Tacoma** (253) 926-2493 ☐ **Portland** (503) 542-1080
☐ _____

Date _____

Page _____ of _____

Turnaround Time:
Standard _____
Accelerated _____

Project Name _____ Project No. _____

Project Location/Event _____

Sampler's Name _____

Project Contact _____

Send Results To _____

Testing Parameters

Special Handling Requirements:

Shipment Method: _____

Stored on ice: Yes / No

Sample I.D.	Date	Time	Matrix	No. of Containers	Observations/Comments

_ Allow water samples to settle, collect aliquot from clear portion ☐

_ NWTPH-Dx - Acid wash cleanup ☐
- Silica gel cleanup ☐

_ Dissolved metal samples were field filtered

Other _____

Relinquished by	Received by	Relinquished by	Received by
Signature	Signature	Signature	Signature
Printed Name	Printed Name	Printed Name	Printed Name
Company	Company	Company	Company
Date Time	Date Time	Date Time	Date Time

Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number:	Turn-around Requested:	Date:	
ARI Client Company:	Phone:	Page:	of
Client Contact:		No. of Coolers:	Cooler Temps:
Client Project Name:			
Client Project #:	Samplers:		

Analytical Resources, Incorporated
Analytical Chemists and Consultants
4611 South 134th Place, Suite 100
Tukwila, WA 98168
206-695-6200 206-695-6201 (fax)

Sample ID	Date	Time	Matrix	No. Containers	Analysis Requested								Notes/Comments

Comments/Special Instructions	Relinquished by: (Signature)	Received by: (Signature)	Relinquished by: (Signature)	Received by: (Signature)
	Printed Name:	Printed Name:	Printed Name:	Printed Name:
	Company:	Company:	Company:	Company:
	Date & Time:	Date & Time:	Date & Time:	Date & Time:

Limits of Liability: *ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.*

Sample Retention Policy: Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.

Air - Chain of Custody Record & Analytical Service Request

Page _____ of _____

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

ALS Project No.

Company Name & Address (Reporting Information)

Project Name

Project Number

ALS Contact:

Analysis Method

Project Manager

P.O. # / Billing Information

Phone | Fax

Email Address for Result Reporting

Sampler (Print & Sign)

Comments
e.g. Actual Preservative or specific instructions

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code #- FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume			

Report Tier Levels - please select

Tier I - Results (Default if not specified) _____
Tier II (Results + QC Summaries) _____
Tier III (Results + QC & Calibration Summaries) _____
Tier IV (Data Validation Package) 10% Surcharge _____

EDD required Yes / No
Type: _____ Units:_____

Chain of Custody Seal: (Circle)
INTACT BROKEN ABSENT

Project Requirements (MRLs, QAPP)

Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:

Cooler / Blank Temperature ____°C

Daily Health and Safety Report

Project Name: _____ Project Number: _____

Client: _____ Date: _____

Field Safety Manager: _____ Project Manager: _____

Safety Topics Discussed – As Reference in Project HASP (check topics covered)

- ☐ PPE and Exposure Monitoring
- ☐ Chemical of Concern
- ☐ Slip/Trips/Falls
- ☐ Traffic Control
- ☐ Drilling Safety
- ☐ Excavation Safety
- ☐ Confined Space Entry
- ☐ Hand-operated Power Tools
- ☐ Hot Work Permit Activities
- ☐ Work in Waterways
- ☐ Emergency Procedures
- ☐ COVID19 (social distancing, self-health check, masks): _____

Describe planned daily activities, potential hazards, and methods to mitigate risks: _____

Signature of People Participating in the Daily Safety Meeting

Signature	Firm

LANDAU ASSOCIATES

Drum/Tank Inventory

Project Name _____ Project Number _____

Location _____ Date _____

Client _____ Landau Representative _____

Drum/Tank Number	Date Generated	Contents	Estimated Quantity	Suspected Contaminants	Generation Source	Disposal Method / Date Disposed	Sketch of Site and Drum/Tank Location

LANDAU ASSOCIATES

PAGE: _____ OF _____

Field Nuclear Density Test Report

PROJECT NAME _____ PROJECT NO.: _____
LOCATION: _____ DATE: _____ REPORT #: _____
CLIENT: _____ GENERAL CONTRACTOR: _____
WEATHER: _____ SUBCONTRACTOR: _____

METHOD OF COMPACTION

VIBRATING PLATE _____
VIBRATING ROLLER _____
HOE-PACK _____
SHEEPS FOOT ROLLER _____

GAGE TYPE/NUMBER: _____
STANDARD COUNTS: MC= _____
DC= _____

MODIFIED PROCTOR [ASTM D 1557] TEST RESULTS (MDD-Maximum Dry Density, OMC-Optimum Moisture Content)

SAMPLE	MDD	OMC	DESCRIPTION/SOURCE

FIELD TEST DATA

TEST NO.	GENERAL LOCATION	ELEVATION (ft)	BELOW FINISH GRADE	SOIL TYPE	DRY DENSITY	MOISTURE	REL. OMC +/-	COMPACTION (%) FIELD	COMPACTION (%) SPECIFICATION	TEST RESULTS

REMARKS: _____

TESTED BY: _____

Landau Associates' representatives are onsite solely to observe operations of the contractor identified, to form opinions about the adequacy of those operations, and report those opinions to our client. The presence and activities of our field representative do not relieve the contractor from its obligation to meet contractual requirements. The contractor retains sole responsibility for site safety and the methods, operations, and sequences of construction.

REVIEWED BY: _____

LANDAU ASSOCIATES

Field Report

Project No.: _____ Report No.: _____

Client: _____ Date: _____

Project Name: _____ DPD Permit No.: _____

Location: _____

Weather Conditions: _____

Prepared By: _____

Visitors: _____

Unsatisfactory Conditions & Recommended Correction: _____

Attachments: _____

Signed: _____

LANDAU ASSOCIATES

Groundwater Low-Flow Sample Collection Form

Project Name: _____ Project Number: _____

Event: _____ Date/Time: _____

Sample Number: _____ Weather: _____

Landau Representative: _____

WATER LEVEL/WELL/PURGE DATA

Well Condition: Secure (YES or NO) Damaged (YES or NO) Describe: _____

DTW Before Purging (ft) _____ Time: _____ Flow through cell vol. _____ GW Meter No.(s) _____

Begin Purge: Date/Time: _____ End Purge: Date/Time: _____ Gallons Purged: _____

Purge water disposed to: ☐ 55-gal Drum ☐ Storage Tank ☐ Ground ☐ Other _____

Time	Temp (°F/°C)	Cond. (uS/cm)	D.O. (mg/L)	pH	ORP (mV)	Turbidity (NTU)	DTW (ft)	Internal Purge Volume (gal)	Comments/ Observations
Purge Goals: Stablization of Parameters for three consecutive readings within the following limits								**>/= 1 flow through cell**	
	+/- 3%	**+/- 3%**	**+/- 10%**	**+/- 0.1 units**	**+/- 10 mV**	**+/- 10%**	**< 0.3 ft**		

SAMPLE COLLECTION DATA

Sample Collected With: ☐ Bailer ☐ Pump/Pump Type _____

Made of: ☐ Stainless Steel ☐ PVC ☐ Teflon ☐ Polyethylene ☐ Other ☐ Dedicated

Decon Procedure: ☐ Alconox Wash ☐ Tap Rinse ☐ DI Water ☐ Dedicated

(By Numerical Order) ☐ Other _____

Sample Description (color, turbidity, odor, sheen, etc.): _____

Replicate	Temp (°F/°C)	Cond. (uS/cm)	D.O. (mg/L)	pH	ORP (mV)	Turbidity (NTU)	DTW (ft)	Ferrous iron (Fe II)	Comments/ Observations
1									
2									
3									
4									
Average:									

QUANTITY	TYPICAL ANALYSIS ALLOWED PER BOTTLE TYPE (Circle applicable or write non-standard analysis below)		
	(8260) (8010) (8020) (NWTPH-G) (NWTPH-Gx) (BTEX)	WA ☐	OR ☐
	(8270) (PAH) (NWTPH-D) (NWTPH-Dx) (TPH-HCID) (8081) (8141) (Oil & Grease)	WA ☐	OR ☐
	(pH) (Conductivity) (TDS) (TSS) (BOD) (Turbidity) (Alkalinity) (HCO3/CO3) (Cl) (SO4) (NO3) (NO2) (F)		
	(COD) (TOC) (Total PO4) (Total Kiedahl Nitrogen) (NH3) (NO3/NO2)		
	(Total Cyanide) (WAD Cyanide) (Free Cyanide)		
	(Total Metals) (As) (Sb) (Ba) (Be) (Ca) (Cd) (Co) (Cr) (Cu) (Fe) (Pb) (Mg) (Mn) (Ni) (Ag) (Se) (Tl) (V) (Zn) (Hg) (K) (Na)		
	(Dissolved Metals) (As) (Sb) (Ba) (Be) (Ca) (Cd) (Co) (Cr) (Cu) (Fe) (Pb) (Mg) (Mn) (Ni) (Ag) (Se) (Tl) (V) (Zn) (Hg) (K) (Na) (Hardness) (Silica		
	VOC (Boeing short list)		
	Methane Ethane Ethene Acetylene		
	others		

Duplicate Sample No(s): _____

Comments: _____

Signature: _____ Date: _____

GAS MONITORING DATA

Monitoring Location	Time	Depth to water (ft)	Purged Volume (10X Casing Vol.)	Number of Strokes	Stabilization Time	CH4 (%)	CO2 (%)	O2 (%)	Balance (%)	H2 (ppm)	CO (ppm)	H2S (ppm)	Differential Pressure (inch WC)
Ambient Air													

Project Name:
Project Number:
Monitoring Date:
toring Personnel:
Calibration Date:

LANDAU ASSOCIATES

Exploration No. _____
Date _____ Hour _____

Log of Exploration

Project Name _____ Project No. _____

Client/Owner _____ Exploration Operator _____

Exploration Method _ _____

_____

Logged by _ ___ Exploration Completed _____

Ground Surface Conditions _____

Weather Conditions _____

Location Sketch (show dimensions to mapped features)

North Arrow

(East) (North)

Coordinates: "x" _____ "y" _____ Method _____

Elevations _____ Datum _____

Sample Depth (top) (ft.)	Sample Length (ft.)	Recovery Length (ft.)	Retained Depth (top) (ft.)	Retained Length (ft.)	Sample Number	Sampler/Hammer Codes	Blow Counts	Other Test Data) _____	USCS Symbol / Unit Contact	Depth Scale (ft)	Sample Description Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components (density/consistency, moisture)(geologic unit)	Comments on Heave, Water Conditions, & Drilling Action
										0		
										1		
										2		
										3		
										4		
										5		
										6		
										7		
										8		
										9		
										0		
										1		
										2		
										3		
										4		
										5		
										6		
										7		
										8		
										9		
										0		

Sampler and Hammer Information

a = 3.25-in. O.D. – D&M	1 = 300-lb./30-in. Drop
b = 2.0-in. O.D. – SPT	2 = 140-lb./30-in. Drop
c = Shelby Tube	3 = Pushed
d = Grab Sample	4 = Vibrocore
g = 2.5-in. O.D.– WSDOT	5 = _____
h = 3.0-in. O.D. – M.Calif.	
i = _____	

Water Level Information

Date		
Time		
Depth to Water		
Hole Depth		
Casing Depth		

Total Depth _____ Finish Date _____ Hour _____ Continued

Exploration No._____

Date _____ Hour_____

LANDAU ASSOCIATES

Log of Test Pit

Project Name _____ Project No. _____

Client/owner _____ Exploration Operator _____

Logged by _____ Exploration Completed _____

Ground Surface Conditions _____

Weather Conditions _____

Location Sketch (show dimensions to mapped features)

North Arrow

Groundwater seepage:
none slow moderate rapid
@ _____ feet

(East) (North)
Coordinates: "x" _____ "y" _____ Method _____

Elevations _____ Datum _____

Sample Depth (top) (ft.)	Sample Length (ft.)	Sample Number	(Other Test Data) ____	USCS Symbol	Depth Scale (ft)
					0

Sample Description
Color, secondary soil type, PRIMARY SOIL TYPE with modifiers and minor components
(density/consistency, moisture)(geologic unit)

Length of Test Pit (ft.) (View Direction) _____

Total Depth _____ Finish Date _____ Hour _____

Comments/Field Notes: _____

Soil Sample Collection Form

Sample ID	Date	Time	Soil Description (classification, density, moisture, odor, sheen)	QA Sample ID (Duplicate or MS/MSD ID)	Sampling Equipment	Notes

Vapor Intrusion – Building Assessment

LANDAU ASSOCIATES

Project Name: _____ Project No.: _____

Client: _____ Date/Time: _____

Project Location: _____ Prepared by: _____

Weather Conditions (note wind direction/intensity): _____

OCCUPANT: Interviewed ☐ Yes ☐ No

Last Name: _____ First Name: _____

Phone Info: _____ Email: _____

Number of Occupants/Persons at this Location: _____

Age(s) of Occupant(s): _____

OWNER OR LANDLORD: Interviewed ☐ Yes ☐ No Check if same as Occupant: ☐

Name: _____ Phone: _____

Address: _____ Email: _____

BUILDING CHARACTERISTICS:

a. Type of Building: (Check appropriate response)

☐ Residential ☐ School ☐ Commercial/Multi-use ☐ Industrial

☐ Church ☐ Other _____

b. If the property is residential, type? (Check appropriate response)

☐ Ranch ☐ Split Level ☐ Mobile Home ☐ Townhouse/Condos

☐ Duplex ☐ Apartment House ☐ Other: _____

If multiple units, how many? _____

If the property is commericial, what type? _____

Does it include residences (i.e., multi-use)? ☐ Yes ☐ No If yes, how many?

OCCUPANT/OWNER QUESTIONNAIRE

Building age and typical hours home and rooms most occupied: _____

_____

_____

Type of heating used in the building: (Check all that apply – note primary)

☐ Hot air circulation ☐ Heat pump ☐ Hot water baseboard ☐ Space heaters
☐ Steam radiation ☐ Radiant floor ☐ Electric baseboard
☐ Wood stove ☐ Outdoor wood boiler ☐ Other: _____

Primary type of fuel used in the building:

☐ Natural gas/Fuel oil ☐ Kerosene/Propane ☐ Electric ☐ Solar
☐ Wood ☐ Other: _____

Location of boiler/furnace:

☐ Basement ☐ Outdoors ☐ Main floor ☐ Other: _____

Ventilation:

☐ Central air ☐ Window units ☐ Open window ☐ Heat pump
☐ Ceiling fan ☐ None

Is there a radon mitigation system for the building/structure? ☐ Yes ☐ No

Date of installation: _____ System: ☐ Active ☐ Passive

If a non-residential bldg, do they know if the building is under positive or negative pressure? ☐ Yes ☐ No

Water Supply:

☐ Public water ☐ Drilled well ☐ Driven well ☐ Dug well
☐ Other: _____

Sewage Disposal:

☐ Public sewer ☐ Septic tank ☐ Leach field ☐ Dry well
☐ Other: _____

How is roof runoff/storm drainage routed?

☐ Downspouts directly to surface ☐ Directed to the surface away from the building
☐ Infiltrated ☐ Collected and reused

Is the basement/lowest level occupied?

☐ Full time ☐ Occasionally ☐ Seldom ☐ Almost never

Does the garage have a separate heating unit? ☐ Yes ☐ No

Has the building ever had a fire? When? _____ ☐ Yes ☐ No

Is a kerosene or unvented gas space heater present? Where: _____ Type: _____ ☐ Yes ☐ No

Is there a workshop or hobby/craft area? Where: _____ Type: _____ ☐ Yes ☐ No

Is there a smoking area in the building? Frequency: _____ ☐ Yes ☐ No

Have cleaning products been used recently: When: _____ Type: _____ ☐ Yes ☐ No

Have cosmetic products been used recently: When: Type: _____ ☐ Yes ☐ No

Has painting/staining been done within the last 6 months? Where: _____ When: _____ ☐ Yes ☐ No

Is there new carpet, drapes, or other textiles? Where: _____ When: _____ ☐ Yes ☐ No

Have air fresheners been used recently? When: _____ Type: _____ ☐ Yes ☐ No

Is there a clothes dryer? ☐ Yes ☐ No If yes, is it vented outside? ☐ Yes ☐ No

Has there been a pesticide/herbicide application? ☐ Yes ☐ No

When: _____ Type: _____

Location: _____

Do any of the building occupants use solvents or volatile chemicals at work? ☐ Yes ☐ No

(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide applicator, cosmetologist, carpet installer)

If yes, what type of solvents are used? _____

_____

If yes, are their work clothes stored at or washed at home? ☐ Yes ☐ No

Do any of the building occupants regularly use or work at a dry cleaning service? (Check appropriate response below)

☐ Yes Use dry-cleaning regularly (weekly) ☐ No

☐ Yes Use dry-cleaning infrequently (monthly or less) ☐ Unknown

☐ Yes Work at a dry-cleaning service

Kitchen

Is there an exhaust fan? ☐ Yes ☐ No If yes, where is it vented: _____

Bathrooms

Is there an exhaust fan? ☐ Yes ☐ No If yes, where is it vented: _____

Garage

Is the garage attached? ☐ Yes ☐ No

Are petroleum-powered machines or vehicles stored in the garage? ☐ Yes ☐ No
(e.g., lawnmower, ATV, car)

Please Specify: _____

_____

LIST specific locations/items that need further inspection based on responses to these questions:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

BUILDING INSPECTION

General

Review the Occupant/Owner Questionnaire and inspect associated locations of interest (e.g., heaters, HVAC unit, hobby area, etc.)

Above grade construction: ☐ Wood frame ☐ Concrete ☐ Stone ☐ Masonry/bricks

Are there air distribution ducts present? ☐ Yes ☐ No

Describe the supply and cold air return ductwork; its condition where visible; whether there is a cold air return and tightness of duct joints. Indicate the locations on the floor plan diagram.

General use of each floor: (e.g., family room, bedroom, laundry, workshop, storage)

Basement: _____

1st Floor: _____

2nd Floor: _____

3rd Floor: _____

4th Floor: _____

Please describe any odors in the building: _____

Use air current tubes or tracer smoke to evaluate airflow patterns and qualitatively describe:

Airflow between floors: _____

Airflow near a potential preferential pathway: _____

Outdoor air infiltration: _____

Infiltration into air ducts: _____

Basement (Check all that apply):

Basement type:	☐ Full	☐ Slab	☐ Crawlspace	☐ Other: _____
Basement floor:	☐ Concrete	☐ Dirt	☐ Stone	☐ Other: _____
Basement floor:	☐ Unsealed	☐ Sealed	☐ Covered with: _____	
Foundation walls:	☐ Concrete	☐ Stone	☐ Other: _____	
Foundation walls:	☐ Unsealed	☐ Sealed	☐ Sealed with: _____	
The basement is:	☐ Wet	☐ Damp	☐ Dry	☐ Moldy
The basement is:	☐ Finished	☐ Unfinished	☐ Partially finished	

Is a sump present? ☐ Yes ☐ No Is there water in the sump? ☐ Yes ☐ No

Basement/Lowest level depth below grade: (in feet) _____

Identify potential soil vapor entry points and approximate size: (e.g., cracks, utility ports, drains)

_____

_____

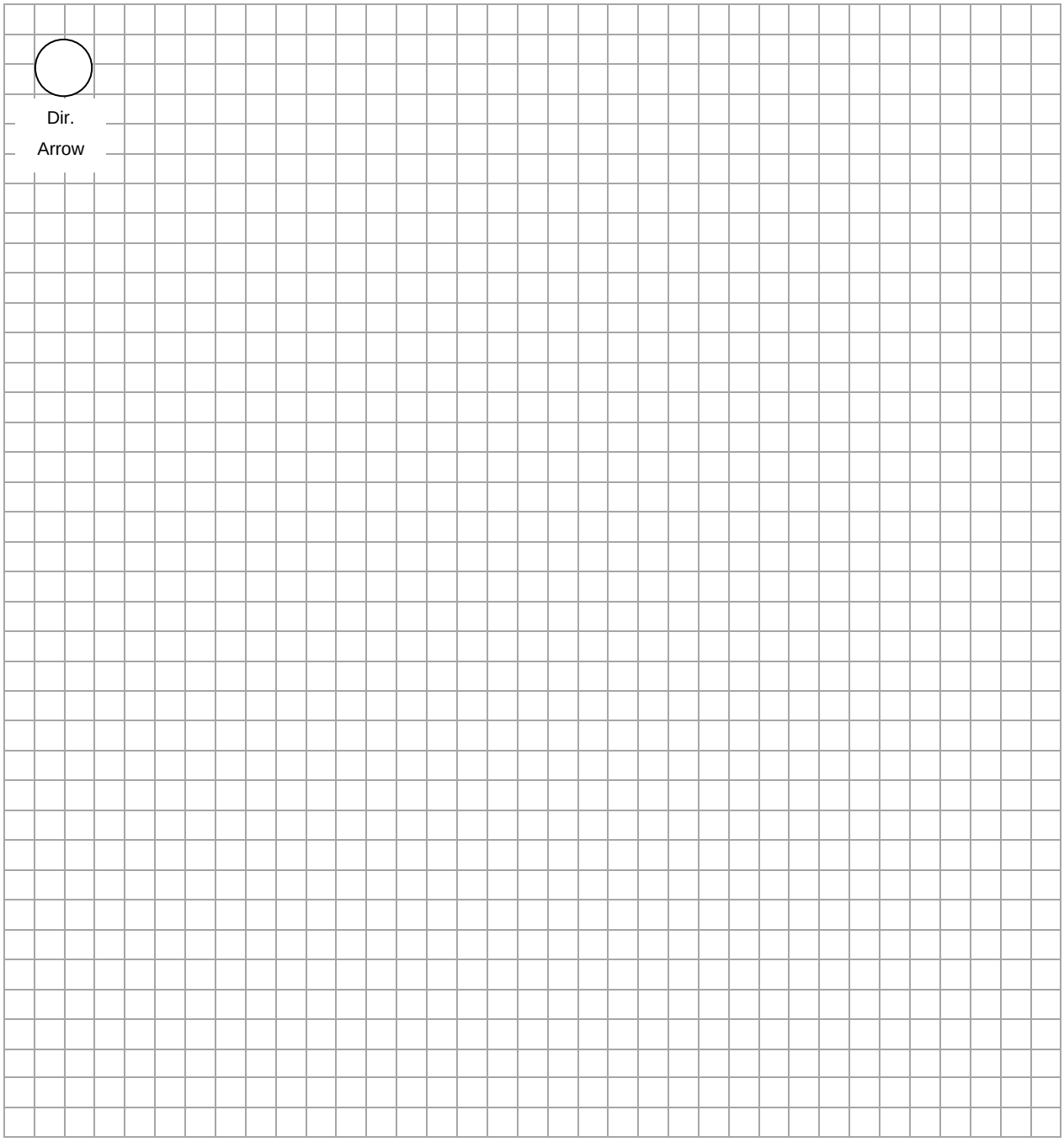
Note the general condition of the basement/crawlspace floor: _____

FLOOR PLANS

Draw a plan view sketches of the basement & upper floor(s) of the building (**use consistent orientation per plan)**.

Note any potential air sampling locations, preferential pathways, household chemicals, heating and ventilations elements, plumbing, doors, windows, and other items of interest.

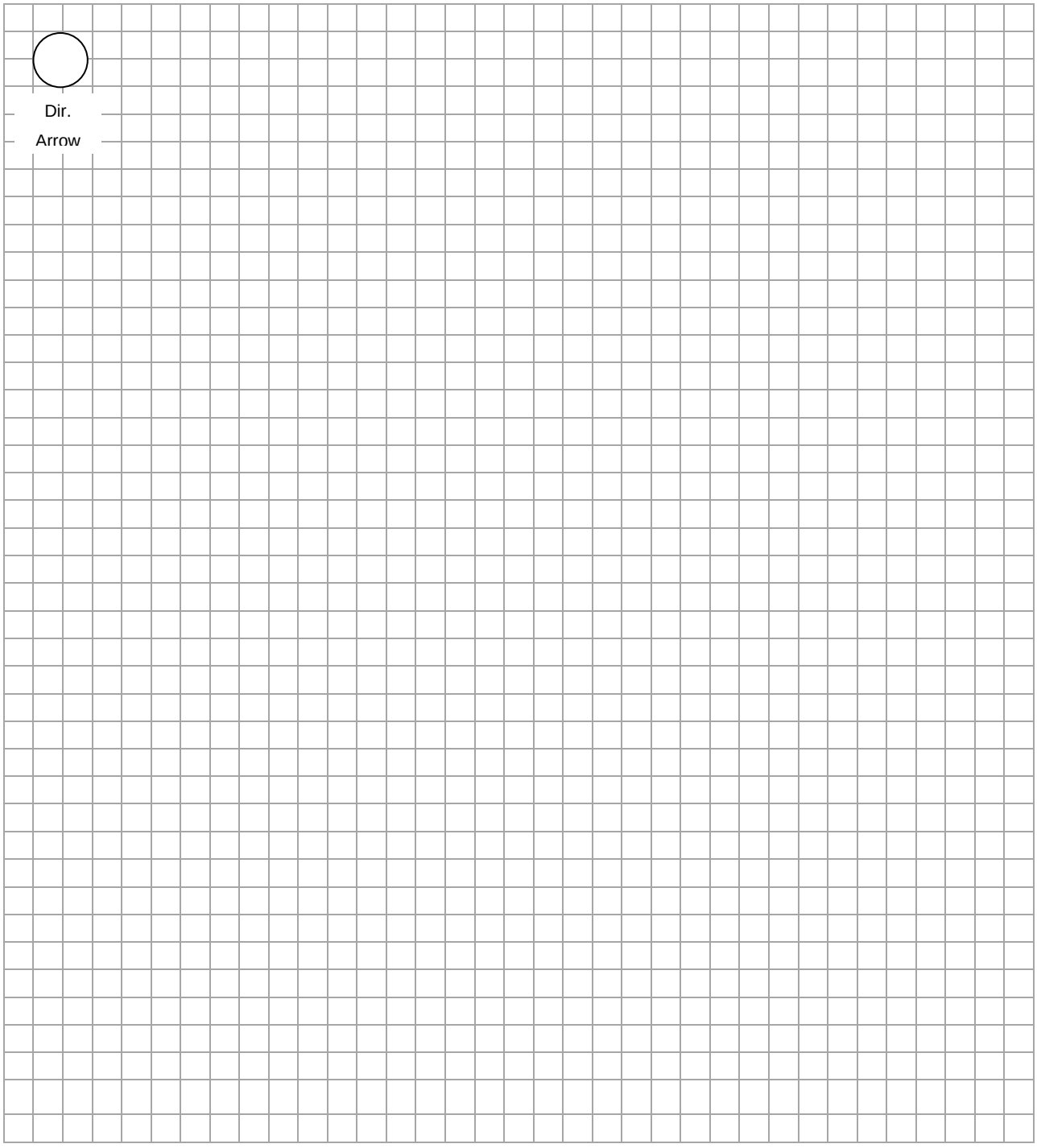
Basement:



Floor Plan: _____

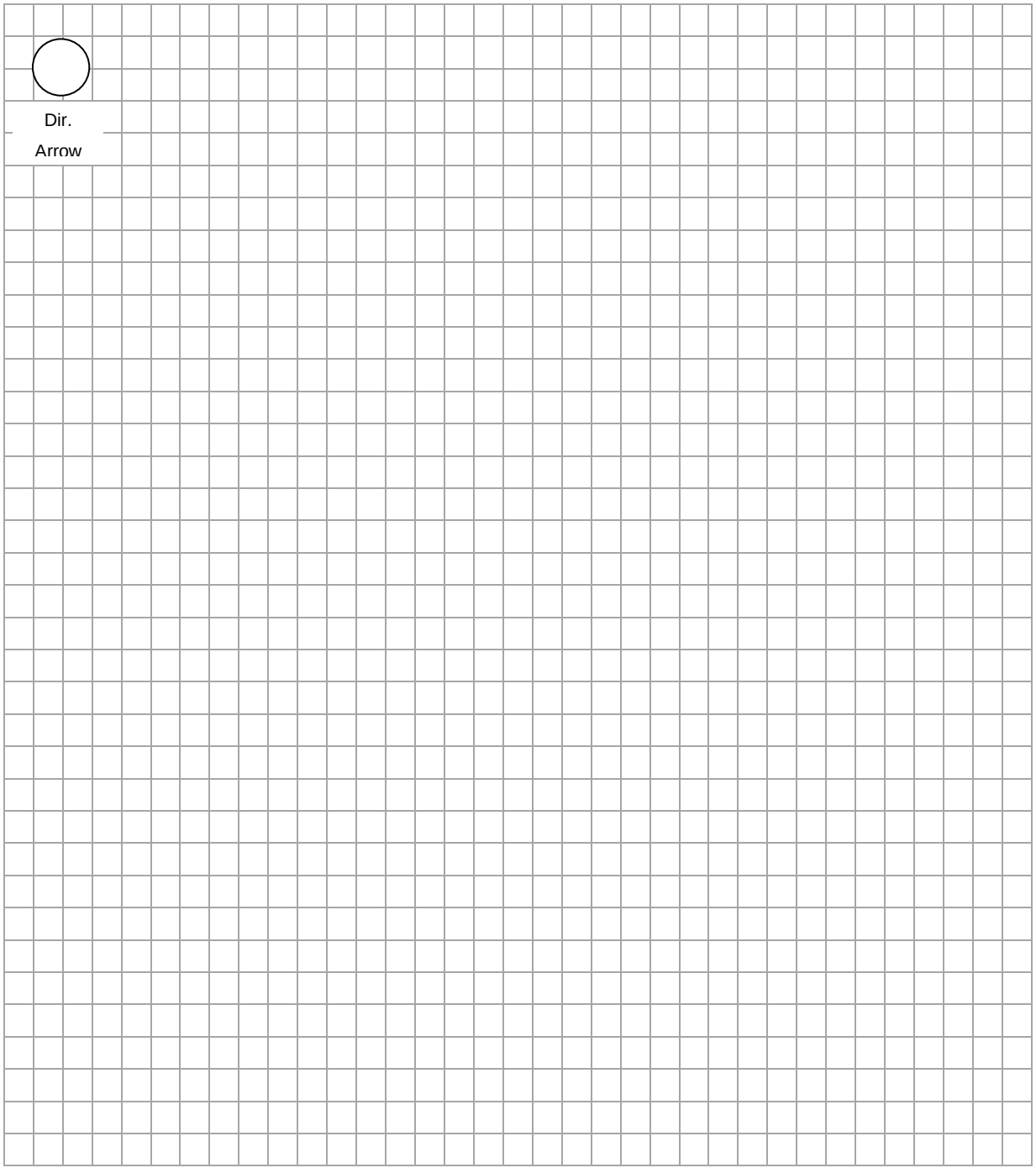
Note level of floor plan from the ground (i.e., first, second, third).

Note any potential air sampling locations, preferential pathways, household chemicals, heating and ventilations elements, plumbing, doors, windows, and other items of interest.



Outdoor Plot

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations; potential air contamination sources (industries, gas stations, repair shops, landfills, etc); outdoor air sampling location(s). Indicate the locations of the well, septic, and drainage systems; any known utilities; and a qualifying statement to help locate the site on a topographic map. **Note any standing water within the yard.**



PRODUCT INVENTORY LOG

Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D). Photographs of the front and back of the product containers can replace the hand written list of chemical ingredients; however, the photographs must be of good quality & ingredient labels must be legible.

Location	Product Description	Size (units)	Condition (UO, U, D)	Chemical Ingredients	Field Instrument Reading (units)	Photo Y / N

Additional Notes/Comments:

Attachments: _____

Signed: _____

LIST OF COMMON HOUSEHOLD CHEMICALS

- Adhesives (automotive, household, craft, plumbing)
- Household cleaners
- Lubricants
- Bonders
- Adhesive removers
- Antistatic aerosols
- Automotive parts cleaners
- Paint strippers
- “Spot removers” for fabrics
- Jewelry polish
- Water repellants
- Spray paints
- Dry-cleaned materials (e.g., clothes)
- Caulks and sealants
- Cosmetics including hair spray, nail polish, nail polish remover, and perfume/cologne
- Air fresheners and odor eliminators
- Inset repellants

PHOTOGRAPH LOG

Photo Identification	Comments

LANDAU ASSOCIATES

Air Sample Collection Form: Ambient / Indoor / Crawlspace

Project Name: _____ Project Number: _____

Client: _____ Sample Number: _____

Landau Rep: _____ Date/Time Collected: _____

Location Information: _____

SAMPLE TYPE

☐ Ambient Air ☐ Indoor Air ☐ Crawlspace ☐ Basement ☐ Other: _____

WEATHER DATA

Rainfall < 1" in 24 hrs.? (YES or **NO**) Irrigation not w/in 5 hrs.? (YES or **NO**) Standing water near sampling location? (YES or **NO**)

Air Temperature _____ °F or °C Wind Direction _____ Wind Speed _____ mph Humidity _____ %

Barometric Pressure_____ in Hg or mBar Is sampling occurring after frontal system during stable pressure? (**YES** or NO)

SAMPLE COLLECTION DATA

Sample Container: ☐ Summa Canister, Size (liters) _____ ☐ Tedlar Bag, Size (liters): _____

Canister number: _____

☐ Passive / Diffusive ☐ Other: _____

Manufacturer: _____

Sample Type: ☐ Grab ☐ Integrated (composite sample over time)

Height of Sample Above Floor/Ground: _____ feet (to nearest tenth)

Ground/Floor Type: Soil, Wood, Carpet, Tile, Concrete Other: _____

Sample Collection/Purge Pump (if used): _____

Summa Canister, Pre-Sampling and Post-Sampling

Initial Vacuum: _____ in Hg Vacuum After Sample Collection: _____ in Hg

LABORATORY ANALYSES:

_____

_____

Duplicate Sample Number(s): _____

Comments: _____

_____

Signature: _____ Date: _____

LANDAU ASSOCIATES

Sub Slab Vapor / Soil Gas Sample Collection Form

Project Name: _____ Project Number: _____

Client: _____ Sample Number: _____

Landau Rep: _____ Date/Time Collected: _____

Location Information: _____

SAMPLE TYPE

☐ Sub Slab Vapor ☐ Soil Gas ☐ Other: _____

WEATHER DATA

Rainfall < 1" in 24 hrs.? (YES or **NO**) Irrigation not w/in 5 hrs.? (YES or **NO**) Standing water near sampling location? (YES or **NO**)

Air Temperature _____ °F or °C Wind Direction _____ Wind Speed _____ mph Humidity _____ %

Barometric Pressure _____ in HG or mBar Is sampling occurring after frontal system during stable pressure? (**YES** or NO)

SOIL GAS AND SUB SLAB INFORMATION AND AND PURGE DATA

Nature of Location: PERMENANT or TEMPORARY (circle one) ☐ Post-Run Tubing (PRT) ☐ Soil Gas Monitoring Well ☐ Other: _____

Installation Method : ☐ Direct Push Drill Rig ☐ Hollow Stem Auger ☐ Rotosonic ☐ Other: _____

☐ Hand Driven ☐ Rotohammer ☐ Vapor Pin Manufacturer:_____

If Permanent, Is Well Secure? (YES or NO or NA) Damaged (YES or NO) YES-Describe: _____

Materials: ☐ PVC Pipe ☐ Stainless Steel ☐ Teflon ☐ Nylon or Polyethylene Tubing ☐ Other: _____

Well/Hole Diameter: _____ inches Total Depth of Well: _____ ft Depth to Groundwater: _____ ft

Vacuum/Pressure of source (in. H_2O): _____ Time: _____

Purge Volume Calculation: _____

Purge: Begin Time _____ End Time _____ Casing Volume (ft^3): _____

Flow Rate (liter or ml/min): _____ Volume Purged (ft^3): _____

VOLUME EXAMPLES

Diameter (in)	OD (in)	ID (in)	Vol (ft^3/ln ft)
0.25 (tubing)	0.250	0.170	0.00016
1 (sch. 40)	1.315	1.029	0.006
1.25 (sch. 40)	1.660	1.380	0.010
2 (sch. 40)	2.375	2.067	0.020

Vol. Purged (ft^3)	Temp. (°F/°C)	PID (ppm)	Other	Comments/Observations

LEAK TEST OPTIONS

☐ Shut-in Test Starting Vacuum: _____ in H2O *(target 100 inches H2O)* Test Duration: _____ minutes *(target > 1 min)*

Ending Vacuum: _____ in H2O *(target no noticable vacuum decrease)* Result: PASS FAIL (circle one)

☐ Helium Shroud Design: _____ Helium Source Concentration:_____

Shroud Tracer Concentration Fluctuation: _____ % *(target ± 10%)* Tracer Equilibration Time: _____*(target min. 5 min)*

Sample Air Tracer Concentration: _____ % of Shroud Conc. *(target <5%)*

☐ Water Bath (vapor pins only)

SAMPLE COLLECTION DATA

Sample Container: ☐ Summa Canister, Size (liters) _____ Canister #:_____ ☐ Tedlar Bag, Size (liters): _____

☐ Passive / Diffusive Manufacturer:_____ ☐ Other: _____

Sample Type: ☐ Grab ☐ Integrated (composite sample over time)

Sample Collection/Purge Pump (if used): _____

Summa Canister, Pre-Sampling and Post-Sampling: Initial Vacuum: _____ in Hg Vacuum After Sample Collection: _____ in Hg

LABORATORY ANALYSES: _____

Duplicate Sample Number(s) and Comments: _____

Signature: _____ Date: _____

LANDAU ASSOCIATES

Water & Product Level Measurements

Project Name _____ Project No. _____

Location _____ Date _____

_____ Landau Rep. _____

Client _____ Weather _____

Water Level Indicator No. _____ **Sensitivity Setting** _____

Well I.D.	Time	Depth to Product * (ft)	Depth to Water * (ft)	Well Casing Elevation**(ft)	Product Elevation (ft)	Water Elevation	Comments/Observations

* From top of well casing.

** Record relative positions of ground surface, well casing, and protective casing (monument cover) if elevation of well casing is unknown. Record Datum, if known.

LANDAU ASSOCIATES

As-Built Well Completion Form

Exploration No.: _____

Well No. (If different than Expl. No.): _____

Client/Owner: _____ Project No.: _____

Project Name: _____

Drilling Co.: _____

LAI Rep(s): _____

Installation Start Date: _____ Hour: _____

Installation Finish Date: _____ Hour: _____

Well Type: ☐ Single ☐ Nested ☐ Clustered

BORING AND WELL DIMENSIONS AND INSTALLATION DETAILS

DOE Unique Well No.: _____

Number of Pipes in Boring: _____

Boring Diameter at Top of Hole: _____

Does Diameter of Hole Change? _____

Boring Diameter at First Step Down: _____

Depth of First Step Down: _____

Boring Diameter at Second Step Down: _____

Depth of Second Step Down: _____

Well Completion Date: _____

Elevation of Well Cover: _____

Elevation of Top of Well Pipe: _____

Depth to Water: _____

Date: _____ Time: _____

_____

_____

MATERIALS USED

_____ Sacks of _____ Sand

_____ Sacks of _____ Concrete/Cement

_____ Sacks of _____ Grout Mix Used

_____ Sacks of Bentonite Chips

_____ Feet of _____-inch PVC Blank Casing

_____ Feet of _____-inch PVC Slotted Screen

_____ Threaded End Cap

_____ Waterproof Well Seal/Slip Cap

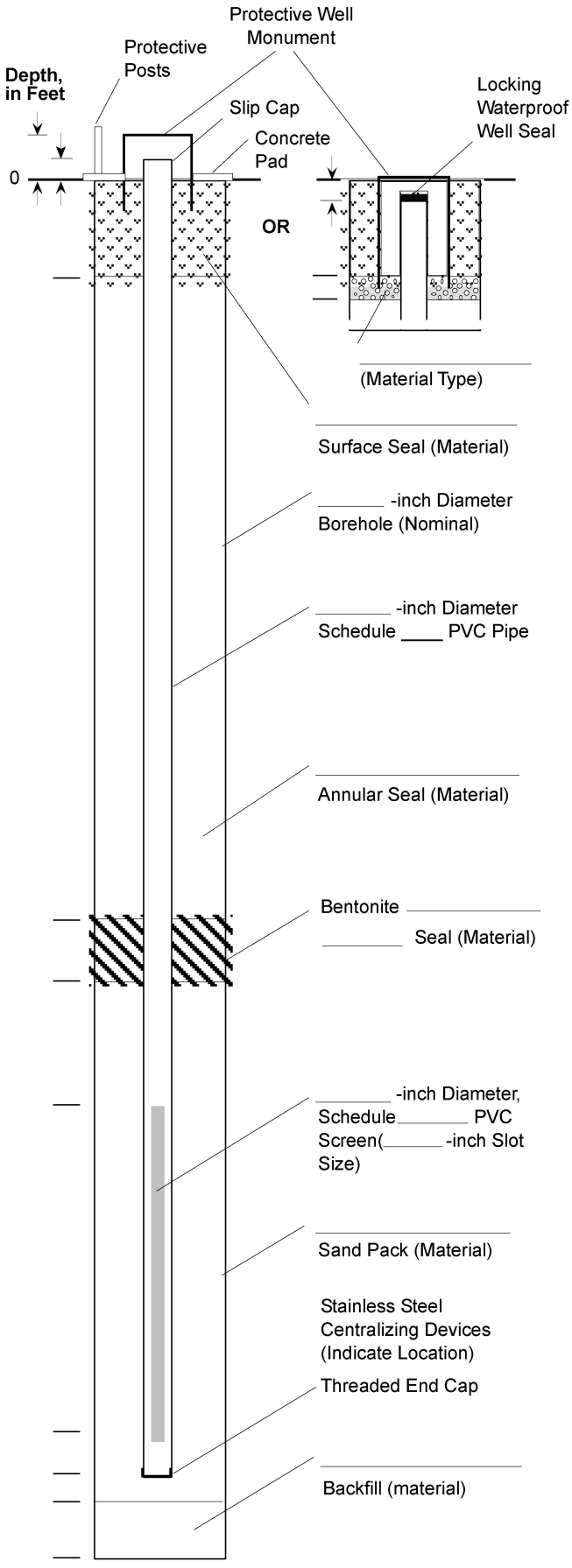
_____ Flush Mount/Aboveground Protective Monument

_____ Protective Posts

_____

_____

_____



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LANDAU ASSOCIATES

Well Development Record

Project Name: _____ Project No. _____
Location: _____ Date: _____
Client: _____ Landau Representative: _____

Well Number: _____ Time: _____

Depth to Water: _____
Well Depth: _____
Casing Diameter: _____
Casing Volume: _____

Volume of Schedule 40 PVC Pipe

Diameter (inch)	O.D. (inch)	I.D. (inch)	Volume (gal/ln ft)	Wt. Water (lbs/ln ft)
1.25	1.660	1.380	0.08	0.64
2	2.375	2.067	0.17	1.45
4	4.500	4.026	0.66	5.51
6			1.47	12.24

Est. Purge Volume: _____

Method of Development: _____ Surge Block: Yes ____ No ____

Begin Development: Time: Final Volume Purged: _____
Finish Development: Time: Water Disposal: ☐ 55-gal drum ☐ Storage Tank ☐ Ground ☐ Other _____

Initial Water Quality: (Turbidity, Color, Odor, Other) _____ Initial Yield: _____
pH: _____ Temp: _____ Conductivity: _____ Turbidity: ___
Notes: _____

Water Quality Notes: _____

Gallons	pH	Temperature	Conductivity	Turbidity	Comments

Final Water Quality: (Turbidity, Color, Odor, Other) _____
Final Yield: _____
pH: _____ Temperature: _____ Conductivity: _____ Turbidity: _____

Depth to Water After Development: _____ Well Depth After Development: _____

APPENDIX B

Quality Assurance Project Plan

Pre-Remedial Design Investigation Quality Assurance Project Plan Central Waterfront Cleanup Site Bellingham, Washington

October 14, 2020

Prepared for

Port of Bellingham
Bellingham, Washington

LANDAU ASSOCIATES

130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

TABLE OF CONTENTS

TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

ALS ..... Analytical Laboratory Services, Inc.
ARI ..... Analytical Resources, Inc.
CLP ..... EPA's Contract Laboratory Program
COC ..... chain of custody
DQI ..... data quality indicator
DQO ..... data quality objective
Ecology ..... Washington State Department of Ecology
EDD ..... electronic data deliverable
EIM ..... Ecology's Environmental Information Management database
EPA ..... US Environmental Protection Agency
FID ..... flame ionization detector
GC/MS ..... gas chromatography/mass spectrometry
HASP ..... health and safety plan
ICP ..... Inductively Coupled Plasma
LAI ..... Landau Associates, Inc.
LCS ..... laboratory control sample
LCSD ..... laboratory control sample duplicate
LFG ..... landfill gas
MS ..... matrix spike
MSD ..... matrix spike duplicate
MQO ..... measurement quality objective
PID ..... photoionization detector
PM ..... project manager
Port ..... Port of Bellingham
ppm ..... parts per million
PRDI ..... pre-remedial design investigation
QA ..... quality assurance
QAPP ..... quality assurance project plan
QC ..... quality control
RL ..... reporting limit
RPD ..... relative percent difference
SAP ..... sampling and analysis plan
Site ..... Central Waterfront Cleanup Site
SOP ..... standard operating procedure
TPH ..... total petroleum hydrocarbons

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1.0 INTRODUCTION AND BACKGROUND

Landau Associates, Inc. (LAI) prepared this Quality Assurance Project Plan (QAPP) for the Port of Bellingham (Port) in support of the Central Waterfront remedial design and permitting project. This QAPP presents the data quality objectives, laboratory activities, and quality assurance procedures to be implemented during execution of the Pre-Remedial Design Investigation (PRDI) sampling at the Central Waterfront Cleanup site (Site) in Bellingham, Washington. LAI prepared this QAPP following the Washington State Department of Ecology (Ecology) Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology 2016). Details related to the scope of work are available in the main body of the PRDI Project Plan (to which this QAPP is an appendix), while specifics of the project organization and sample collection methodology are provided in Appendix A, the Sampling and Analysis Plan (SAP). Future QAPP revisions will be addressed in addenda to the PRDI Project Plan.

The Site is listed under Ecology's Model Toxics Control Act as requiring remediation. The Site is part of a historical and active waterfront industrial property that is bordered to the north by I & J Waterway, the south by Whatcom Waterway, the east by Roeder Avenue, and the west by the Aerated Saturation Basin and Bellingham Bay (see Figure 1-1 of the PRDI Work Plan). The Site comprises approximately 51 acres of upland area. The adjacent intertidal and sediment areas are not included within the Site boundary. The upland area has been impacted by historical landfilling and industrial activity. Site contamination includes landfill refuse, total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons, metals, and landfill gas (LFG).

Ecology approved a Remedial Investigation/Feasibility Study of the Site, which had assessed a range of cleanup options. Subsequently, Ecology approved a Cleanup Action Plan with a selected cleanup action. The Port is conducting a PRDI to support effective implementation of Ecology's approved cleanup action. The purpose of this QAPP is to provide the quality assurance (QA) and quality control (QC) procedures that will be used in the collection of environmental data to support the PRDI.

The laboratories to be used for planned PRDI activities are Analytical Resources, Inc. (ARI) and Analytical Laboratory Services, Inc. (ALS). Analytical testing will be in accordance with the methodologies established in Test Methods for Evaluating Solid Waste: Physical/Chemical Methods (SW-846; EPA accessed July 27, 2020) and Standard Methods for the Examination of Water and Wastewater, 23rd edition (Baird et al. 2017). Validation of the data will be performed by a data validator with guidance from applicable portions of the National Functional Guidelines for Organic Superfund Methods Data Review (EPA 2017b) and the National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA 2017a).

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The specific roles, activities, and responsibilities of project participants are described in this section. The Port has the primary responsibility for managing the work completed at the Site. LAI is the primary consultant for management and execution of the PRDI and subsequent remedial design for planned Site cleanup. The daily management of the PRDI, along with validation of the data, will be completed by the LAI project team.

ARI will perform the laboratory chemical analysis of soil and groundwater. LFG samples will be analyzed by ALS. Environmental laboratories performing work under this QAPP will maintain current accreditation through Ecology for applicable methods and analytes. Geotechnical analysis will be managed by LAI at its soils laboratory. Contact information for the primary consultant and laboratories is provided below.

Contact	Responsibility
LAI 130 2nd Avenue South Edmonds, WA 98020 Telephone: (425) 778-0907	Coordinate laboratory analyses Geotechnical testing Data validation Reporting
ARI 4611 South 134th Place, Suite #100 Tukwila, WA 98168 Telephone: (206) 695-2600	Chemical analysis
ALS 2655 Park Center Drive, Suite A Simi Valley, CA 93065 Telephone: (805) 577-2086	Landfill gas testing

Key personnel and their roles and responsibilities are identified below.

Title/Role	Name	Organization	Responsibilities
Port Project Manager	Ben Howard	Port	Manages the project for Port of Bellingham.
Ecology Project Manager	John Guenther	Ecology	Oversees the project on behalf of the Washington State Department of Ecology.
Consultant Project Manager	Jeff Fellows	LAI	Supervises and coordinates all work for the project. These responsibilities include project planning and execution, scheduling, staffing, data evaluation, report preparation, subcontracts, and managing deliverables.
Quality Assurance Officer (QA)	Dani Jorgensen	LAI	Oversees and directs quality assurance reviews for the project, including laboratory procedures and actions. Coordinates and reviews data validation. Has oversight responsibility for management and integrity of the data.
Data Validator	Kristi Schultz	LAI	Reviews laboratory analytical data and provides data validation.

Title/Role	Name	Organization	Responsibilities
Field Lead	Kate Cleveland	LAI	Leads and coordinates field activities including documentation, sampling, and sample handling. Reports directly to the LAI project manager (PM).
Health and Safety Manager	Chris Kimmel	LAI	Responsible for review and implementation of the project Health and Safety Plan (HASP).
Field Equipment Manager	Devon Brandt	LAI	Ensures equipment is properly maintained and in good condition for project use.
Environmental Laboratory Project Manager(s)	Kelly Bottem Sue Anderson	ARI ALS	Manages laboratory analysis and reporting, including supervising in-house chain of custody, scheduling sample analyses within required holding times; oversees data review and preparation of laboratory reports and electronic data deliverables (EDDs).

3.0 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) reflect the overall degree of data quality or uncertainty that the decision-maker is willing to accept during decision-making. DQOs are used to specify the quality of the data, usually in terms of precision, bias, representativeness, comparability, and completeness. DQOs apply to the entire measurement system (e.g., sampling locations, methods of collection and handling, field analysis, laboratory analysis). DQOs are used to ensure that environmental data are scientifically valid, defensible, and of an appropriate level of quality given the intended use for the data (EPA 2000). QA objectives for the project data include the qualitative guidelines listed in the PRDI Project Plan, as well as quantitative determinations of the data quality indicators (DQIs), as described in this section.

3.1 Data Quality Indicators

DQIs are used to establish quality objectives and are discussed in detail below. A summary of DQIs and their associated measurement quality objectives (MQOs) is presented in Tables B-1a, B-1b, and B-1c.

3.1.1 Precision

Precision is a measure of variability in the results of replicate measurements due to random error (Ecology 2016). Precision is best expressed in terms of the standard deviation or relative percent difference (RPD). QC sample types that can be used to evaluate precision include field and laboratory duplicates, matrix spike duplicates (MSDs), and laboratory control sample duplicates (LCSDs). The precision of duplicate measurements will be expressed as an RPD, which is calculated by dividing the absolute value of the difference of the two measurements by the average of the two measurements, and expressing as a percentage. The formula for RPD calculation is shown below:

$$\text{RPD} = \left[\frac{|\text{D1} - \text{D2}|}{[(\text{D1} + \text{D2}) \div 2]}\right] \times 100\%$$

Where:

D1 = first measurement value

D2 = second measurement value (duplicate).

3.1.2 Accuracy

Accuracy is a combination of precision and bias (described in Section 3.1.7), in that it represents the degree to which a measured value represents the known value (Ecology 2016). Accuracy is expressed as the percent recovery of spiked samples (matrix spike [MS], laboratory control sample [LCS], and surrogate spike). The general formula used to calculate percent recovery is shown below (for MS/MSD percent recovery the result from the unspiked sample is taken into account in the formula):

$$\%R = \left[\frac{SSR}{C_s}\right] \times 100\%$$

Where:

%R = percent recovery

SSR = spiked sample result

C_s = concentration of the spike added.

3.1.3 Representativeness

Representativeness is an indicator of how accurately a result reflects the desired characteristic(s) of a defined population, accounting for both temporal and spatial variability (Ecology 2016). Representativeness qualitatively describes how well the analytical data characterize an area of concern. Representativeness is largely determined by the sampling design; analytical parameters for use in its evaluation include method-specified holding times and preservation requirements, and matrix heterogeneity. The sampling design for this project is presented in the SAP.

3.1.4 Comparability

Comparability is the "degree of confidence with which one data set can be compared to another" (Ecology 2016). QC procedures and MQOs, as stated in this QAPP, will provide for measurements that are consistent and representative of the media and conditions measured.

3.1.5 Completeness

Completeness is a measure of "the amount of valid data obtained from a measurement system compared to the amount that could be expected to be obtained under normal conditions" (EPA 2009). Field completeness is calculated as the number of actual samples collected divided by the number of planned samples. Analytical completeness is calculated as the number of valid data points divided by the total number of data points requested. Data points are considered invalid if they are rejected during data validation. The data validation approach for this project is provided in Section 9.0 and completeness objectives are provided in Tables B-1a, B-1b, and B-1c.

3.1.6 Sensitivity

Sensitivity is the capability of a method or an instrument to discern the difference between very small amounts of a substance. For the purposes of this project, sensitivity is the lowest concentration that can be accurately detected by the analytical method. Target reporting limits (RLs) are provided in Tables B-2.

3.1.7 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Bias of the laboratory results will be evaluated based on analysis of reference materials, method blanks, and MS samples, as presented in Tables B-1a, B-1b, and B-1c.

4.0 DATA GENERATION AND ACQUISITION

This section provides an overview of the data collecting and handling processes that will ensure data quality that meets project standards. More details about these processes are included in the SAP, as noted in subsections below.

4.1 Sampling Process Design

The sampling design, including selection of locations and development of the sampling program and procedures, is presented in the PRDI Project Plan and the SAP (Appendix A). Samples for chemical analysis will be collected from each location and analyzed for the constituents listed in the SAP.

4.2 Sampling Methods

A detailed description of the sampling methods for each matrix is presented in the SAP.

Sampling containers will be provided by the laboratory. Extra containers will be requested to ensure that clean containers are available to replace any broken or misused containers during sampling events. The laboratory will provide kits (e.g., plunger for Method 5035 soil sampling) to collect samples for analyses that require special methods to fill the sample container.

4.3 Sample Handling and Custody

Soil, groundwater, and LFG samples submitted to the analytical laboratories will be collected in the appropriate sample containers and preserved as specified in Table B-3. The storage temperatures and maximum holding times for physical/chemical analyses are also provided in Table B-3.

The transportation and handling of samples will be accomplished in a manner that not only protects the integrity of the sample, but also prevents any detrimental effects due to release of samples. Samples will be logged on a chain-of-custody (COC) form and will be kept in coolers on ice until delivery to the analytical laboratory. The COC form will accompany each shipment of samples to the laboratory. A sample is “in custody” if at least one of the following is true:

- It is in someone’s physical possession.
- It is in someone’s view.
- It is secured in a locked container or otherwise sealed so that tampering will be evident.
- It is kept in a secured area, restricted to authorized personnel only.

Sample control and COC in the field and during transportation to the laboratory will be conducted in general conformance with the procedures described below.

- As few persons as possible will handle samples.
- Sample bottles will be obtained new or pre-cleaned from the laboratory performing the analyses.

- The sample collector will be personally responsible for the completion of the COC record and the care and custody of samples collected until they are transferred to another person or dispatched properly under COC protocols.
- The onsite LAI team leader will oversee implementation of the field custody procedures during the field work and, in the event of non-compliance, will determine if corrective action is required.
- The coolers in which the samples are shipped will be accompanied by the COC record identifying their contents. The original record and laboratory copy will accompany the shipment (sealed inside the shipping container). The other copy will be distributed as appropriate to LAI's Quality Assurance Officer or designee.
- Shipping containers will be sealed with custody seals for shipment to the laboratory. The method of shipment, name of courier, and other pertinent information will be entered in the "remarks" section of the COC record.
- If sent by mail, the package will be registered with return receipt requested. If sent by common carrier, a bill of lading will be used. Freight bills, postal services receipts, and bills of lading will be retained as part of the permanent documentation.

When samples are transferred, the individuals relinquishing and receiving the samples will sign the COC form and record the date and time of transfer. The sample collector will sign the form in the first signature space. The only exception to this is the shipment of samples via commercial carriers. Because sample containers are sealed with the COC record inside prior to delivery to the carrier, the custody signature will be that of the individual taking possession of the samples from the carrier at its final destination. Each person taking custody will observe whether the shipping container is correctly sealed and in the same condition as noted by the previous custodian; deviations will be noted on the appropriate section of the COC record.

A designated sample custodian at the laboratory will accept custody of the shipped samples, verify the integrity of the custody seals, and certify that the sample identification numbers match those on the COC record. The custodian will then enter sample identification number data into a bound logbook, which is arranged by project code and station number. If containers arrive with broken custody seals, the laboratory will note this on the COC record and will immediately notify LAI.

Once the analytical work has been completed and the data report submitted by the laboratory, samples and extracts will be transferred from cold storage to a sample archiving area where they will be stored for 3 months, unless LAI provides other written instructions. Custody will be maintained in the long-term storage area and upon ultimate disposition, samples will be logged out, and the disposition recorded. Disposal will be in accordance with local, state, and federal landfill and wastewater regulations.

4.4 Analytical Methods

Chemical analyses will include TPH, including gasoline-, diesel- and motor oil-range TPH; benzene, toluene, ethylbenzene, and total xylenes; select metals (total and dissolved), bis(2-ethylhexyl) phthalate, polycyclic aromatic hydrocarbons, and natural attenuation conventional parameters with US Environmental Protection Agency (EPA) protocols or other methods as appropriate. Laboratory methods and target RLs for each matrix are provided in Tables B-2a and B-2b of this QAPP. Soil samples may also be collected for geotechnical analyses, including grain-size distribution, Atterberg limits, consolidation, and moisture content.

Dissolved metals will be field-filtered. Samples scheduled for analysis by Method NWTPH-Dx may undergo silica gel cleanup. For analysis of groundwater samples by Method 6020A, samples will be run with universal cell technology to reduce potential interference.

The contracted chemical laboratory will implement project-required standard operating procedures (SOPs) for sample preparation, cleanup, and analysis. These SOPs will be based on Method SW-846 (EPA; accessed July 29, 2020). Documentation of these SOPs will be kept on file at the contracted laboratory.

Documentation of appropriate method performance for the project target compounds will be available from the selected laboratory and will include the criteria for acceptance, rejection, or qualification of data. The laboratory is also required to periodically update method performance data such as control limits and method detection limits.

5.0 QUALITY CONTROL

This section details the measurement checks required to meet the DQIs for this program.

5.1 Field Quality Control

Field and analytical laboratory control samples will be collected to evaluate data precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity of the analytical results for this investigation. The field QC samples and the frequency at which they will be collected and/or analyzed by matrix and analysis is summarized in specified in the SAP; the evaluation of these samples is discussed in Section 10.0 and provided in Tables B-1a, B-1b, and B-1c.

The QC procedures for measuring field parameters such as pH, redox potential, conductance, dissolved oxygen, turbidity, and temperature in groundwater samples are discussed in the SAP and will include calibrating the instruments, measuring duplicate samples, and checking the reproducibility of the measurements by taking multiple readings on a single sample or reference standard. To ensure that field measurement is accomplished accurately, field equipment will undergo routine maintenance and calibration as described below.

5.1.1 Testing, Inspection, and Maintenance

LAI performs routine inspections and preventive maintenance (parts replacement and cleaning) for all pieces of field equipment in the supply and equipment room. Maintenance activities are conducted by field technicians, who are specifically trained in the use, operation, and maintenance of the equipment. Field equipment used during this project, including water level indicators, photoionization detectors (PIDs), flame ionization detectors (FIDs), and water field parameter meters (e.g., pH), will be cleaned and decontaminated prior to use. Each piece of equipment will be inspected and tested to ensure proper working function and facilitate replacement or repair of broken or non-operational components. Extra batteries will be included in the equipment cases or in field vehicles for replacing dead batteries during field work. Extra disposables will be packed for equipment requiring disposables for use, such as ferrous iron kits.

Field equipment is maintained by the Field Equipment Manager. Field staff continually notify the Field Equipment Manager when equipment maintenance is needed. This system ensures the equipment is maintained and working for the next field project.

Meters used to make field measurements will be further inspected and tested during calibration, as described below.

5.1.2 Calibration and Frequency

Field equipment is calibrated according to the manufacturer's guidelines and recommendations. If a FID or PID is used during this project, it will be calibrated on a daily basis according to the manufacturer's specifications.

Prior to use, the FID will be calibrated per the manufacturer's specifications and bump-tested to verify operation. These calibrations will be noted on field forms. The lower limit of detection for the FID will be 1 part per million (ppm). The FID will be used only for monitoring indoor air and other structures, as it is ineffective at detecting methane from subsurface probes due to the typically depleted levels of oxygen associated with LFG. The operation of the FID is based on the detection of ions formed during combustion of organic compounds in a hydrogen flame.

The PID preferred by LAI field personnel uses a 10.2 eV probe and is calibrated using a manufacturer-supplied standard gas (isobutylene, equivalent to 34 ppm benzene). Similarly, water field parameter meters will be calibrated at the start of each sampling day with laboratory-prepared calibration standards within the range of the anticipated measurement. An instrument will also be recalibrated at any time an anomalous reading suggests instrument imprecision or inaccuracy.

5.1.3 Inspection/Acceptance of Supplies and Consumables

Supplies are ordered and maintained by the LAI Field Equipment Manager. Disposables and consumables include nitrile gloves, Ziploc® bags for sample ice, field test kits, and polyethylene tubing, etc.

5.1.4 Laboratory Quality Control

Analytical procedures will be documented in writing as laboratory SOPs, with each SOP including a QA section that addresses the minimum QC requirements for the procedure. Certain QC requirements are matrix- or method-specific, but in general, the QA program must include the following:

- Instrument calibration
- Preparation and analysis of reagent/preparation blanks
- Analysis of instrument and/or method blanks
- Preparation and analysis of matrix spikes and matrix spike duplicates
- Preparation and analysis of surrogate spikes
- Analysis of laboratory duplicates for inorganics
- Preparation and analysis of laboratory control samples and standards
- Identification of internal standard areas and control limits, for gas chromatography/mass spectrometry (GC/MS) analysis
- System performance checks for both organic and total metals analyses.

5.1.4.1 Laboratory Quality Control Samples

An analytical batch is defined as 20 samples or less of the same type of matrix, prepared and analyzed as a group. The following analytical QC samples will be associated with each batch if the control procedure is applicable to the analysis.

Method Blank

A reagent or media blank will be analyzed as a check on laboratory contamination (glassware, reagents, analytical hardware) that might affect analytical results. A sample consisting of laboratory reagent-grade water (distilled and de-ionized water) or a solid matrix will be analyzed to monitor the analytical instrument for contamination. The method blank will be processed through the entire analytical procedure, including sample preparation. The results will be used in conjunction with other control data to validate overall system performance and identify bias that may impact data quality. Method blanks must be analyzed per Method SW-846 for applicable analyses, at least once with each analytical batch, with a 1 in 20 sample minimum.

Laboratory Control Samples

Independently prepared control samples will be processed through the entire analytical procedure. The purpose of these samples is to monitor and assure the accuracy of the procedure in the absence of matrix interference. Results of the LCSs will be charted and must meet acceptance criteria. Laboratory control samples must be analyzed per Method SW-846 for applicable analyses, at least once with each analytical batch, with a 1 in 20 sample minimum.

Laboratory Control Sample Duplicates

Independently prepared control sample duplicates will be processed through the entire analytical procedure. The purpose of the LCSD is to assure the precision of the procedure in the absence of matrix interference. Precision results in RPD will be tabulated and charted. The RPD equation is given below under Duplicate Samples or MSDs. LCSDs must be analyzed per Method SW-846 for applicable analyses, at least once with each analytical batch, with a 1 in 20 sample minimum.

Surrogates

Sample aliquots and laboratory QC samples scheduled for organic analysis will be spiked with surrogates. The surrogates to be added will be in compliance with the SW-846 analytical method referenced, and will be detailed in the laboratory method SOP. The purpose of the surrogates is to monitor and assure the accuracy of the analytical performance on individual samples and to indicate the presence of system bias, extraction inefficiencies, and/or matrix interferences. The recoveries of the surrogates will be charted and must meet acceptance criteria.

Internal Standards

Sample aliquots and laboratory QC samples scheduled for GC/MS analysis will be spiked with interval standards prior to extraction or analysis as applicable. The internal standards to be added will be in compliance with the SW-846 analytical method referenced, and will be detailed in the laboratory method SOP. The purpose of the internal standards is to ensure GC/MS instrument sensitivity and stability, and to provide for accurate target analyte quantitation. The internal standard area counts and retention times will be charted and must meet acceptance criteria.

Matrix Spike

An aliquot of a sample will be spiked with a known amount of the selected analyte(s). Percent recoveries of the selected spiked analytes will be tabulated by subtracting the non-spiked concentration from the spiked sample results. Results are used to assess accuracy in specific matrices. Matrix spikes must be analyzed per Method SW-846 for applicable analyses, at least once with each matrix-specific analytical batch, with a 1 in 20 sample minimum.

Percent recovery is calculated as follows:

$$\%R = \frac{(C_1 - C_0)}{C_2} \times 100$$

Where:

$\%R$	=	Percent recovery
C_1	=	Measured concentration in spiked sample aliquot
C_0	=	Measured concentration in unspiked sample aliquot
C_2	=	Actual concentration of spike added.

Duplicate Samples or Matrix Spike Duplicates

MSDs will be analyzed to monitor the method precision. Results in RPD will be tabulated and charted. The RPD calculation (for two samples, C_1 and C_2) is shown below. For analytical methods in which spiking is not applicable, sample duplicates will be used to assess precision. Duplicates or MSDs must be analyzed per Method SW-846 for applicable analyses, at least once with each matrix-specific analytical batch, and with a 1 in 20 sample minimum

$$RPD = \frac{C_1 - C_2}{\left(\frac{C_1 + C_2}{2}\right)} \times 100$$

Where:

RPD	=	Relative percent difference
C_1	=	Larger of the two observed values
C_2	=	Smaller of the two observed values.

The laboratory's QA program will be reviewed by the Quality Assurance Officer with specific emphasis on the acceptance criteria for QC samples, and on related corrective action should the QC criteria not be met. Acceptance criteria and corrective action consistent with Method SW-846 Update III method criteria will be deemed acceptable.

Data obtained will be properly recorded. The required QC summary package for organic and inorganic data and the EDD format is detailed in Section 6.0. The laboratory will reanalyze samples not handled or analyzed in conformance with the QC criteria, if sufficient sample volume is available. It is expected that sufficient volumes/weights of samples will be collected to allow for reanalysis when necessary.

Completed data reports from the laboratory will include a narrative outlining any problems, corrections, anomalies, and conclusions, as well as COC documentation and results for all analyses and laboratory QC.

6.0 DATA MANAGEMENT

Field data (groundwater field parameter data and water levels measurements) will be entered into an Excel spreadsheet and verified to determine that entered data are correct and without omissions and errors.

Laboratory analytical results, including QC data, will be submitted electronically. The electronic formats will include a PDF file of the laboratory report, and EDD files that will be uploaded by LAI to Ecology's Environmental Information Management (EIM) database. Laboratories will provide EDDs in EIM format and Level 2A reports.

Level 2A laboratory analytical reports will include the following:

- Case narrative, including adherence to prescribed protocols, non-conformity events, corrective measures, and/or data deficiencies (including initial and continuing instrument calibrations, and explanations for any missed target RLs)
- COC documentation
- Sample receipt and condition documentation
- Sample summary or equivalent
- Method summary or equivalent
- Sample results (with date, units, and RLs)
- Laboratory data qualifier definitions
- EPA Contract Laboratory Program (CLP)-equivalent forms
- Method/laboratory blank results
- Sample surrogate results
- Field QC results
- Laboratory control sample results
- Matrix spike results
- Duplicate and/or matrix spike duplicate results
- Post-digestion spike sample results
- Inductively coupled plasma (ICP) serial dilution results.

6.1 Data Reduction

This section summarizes the procedures for ensuring the accuracy of the data reduction process. Both field and laboratory data reduction procedures are summarized. Responsibilities for the data reduction process are delegated as follows:

- Technical personnel will document and review their own work and are responsible for the accuracy of the work.

- Calculations will receive a method and calculation check by a secondary reviewer prior to reporting (peer review).
- The Laboratory PM will be responsible for ensuring that data reduction is performed according to protocols discussed in this QAPP.

The laboratories will follow the data reduction and calculation procedures set forth in EPA-approved methods and 40 Code of Federal Regulations Part 136. Data reports and EDDs generated by the laboratory will undergo internal data approval in accordance with the laboratory's Quality Services Manual before being reported.

Automated data calculation and reduction, using instrument data system software or electronic spreadsheet software, will be utilized by the laboratory to the greatest extent practical. Analyses will be programmed to allow for raw data entry and editing at the keyboard, with integrated software performing calculations and permanent database generation. Data-entry errors will be checked by comparing the raw data printouts against the chemist's original work, minimizing the common sources of error in data reduction.

The Laboratory PM must ensure that the EDD matches the laboratory hard copy data report. This data review must be completed before deliverables are reported by the laboratory. Raw and final data will be stored electronically, with regularly scheduled backups performed and maintained at the laboratory.

Logbooks will be maintained for each instrument. Computer record file identification will readily allow retrieval by the client name. Worksheets and spreadsheets will be prepared using an electronic spreadsheet or related software package.

Raw data from the chemists' notebooks or bench sheets will include all analytical variables compiled for samples, replicates, blanks, standards, and matrix spikes. The Laboratory PM will approve submittal of the final data report and EDD after internal review.

7.0 DOCUMENTS AND RECORDS

This section describes the management requirements for production, distribution, and storage of documents and records associated with planned activities at the Site.

7.1 Document Distribution

Prior to beginning field activities, field staff will receive and have an opportunity to review plan-related documents pertinent to the field activities, including the Project Plan, SAP, and Health and Safety Plan (HASP), as appropriate to support the planned activities. The SAP, HASP, and Project Plan (and required future addenda) for each phase of the project will be finalized prior to commencement of field activities, and only the finalized versions will be distributed to field staff. Changes to procedures and plans after finalization will be documented as addenda and distributed along with the original finalized versions.

7.2 Field Documentation

Field equipment will have reference and related manuals stored in with the equipment. In addition, equipment that requires calibration will be accompanied by a calibration logbook. Field staff will record the calibration process in the logbook every time a calibration is performed.

A complete record of field activities will be maintained for the duration of the field phase of the work. Documentation will include the following:

- Daily recordkeeping by field personnel of field activities
- Recordkeeping of samples collected for analysis (field sampling forms)
- Use of sample labels and tracking forms for samples collected for analysis.

The field logs will provide a description of sampling activities completed, sampling personnel, daily weather conditions, and a record of modifications to the procedures and plans identified in the work plan or related documentation. The field logs are intended to provide sufficient data and observations to enable project staff to reconstruct events that occurred during the sampling period.

Field logs will be supplemented by sample collection forms, boring logs, and groundwater well logs completed by field staff, as applicable. The information that will be recorded in these forms is specified in the SAP.

Sample possession and handling will also be documented with COC forms so that it is traceable from the time of sample processing in the field, to delivery to the laboratory, and to the ultimate data analysis.

7.3 Analytical Data Records

Laboratory analytical data reports will be provided in electronic format by the laboratory. These reports will be included as appendices in documents where data are reported, and will be kept along with all other documents in the project files.

7.4 Storage

Documents and records associated with the project (i.e., final documents, billing and invoice records) and the documents described in Sections 7.2 and 7.3 will be stored in electronic form in project files on LAI's servers for the duration of the project.

8.0 AUDITS AND CORRECTIVE ACTIONS

Field and/or laboratory audits are not planned for this project.

Corrective action will be required if there are deviations from the methods or QA requirements established in this SAP/QAPP or if there are equipment or analytical malfunctions. Corrective action procedures will be implemented based on the type of unacceptable data and will be developed on a case-by-case basis. The following corrective actions may be included:

- Altering procedures in the field
- Using a different batch of sample containers
- Performing an audit of field or laboratory procedures
- Reanalyzing samples (if holding times allow)
- Resampling
- Evaluating sampling and analytical procedures to determine possible causes of the discrepancies
- Accepting the data with no action, acknowledging the level of uncertainty
- Qualification of the data
- Rejecting the data as unusable.

During field operations and sampling procedures, the field personnel will be responsible for conducting and reporting required corrective actions. A description of any corrective action taken will be entered in the daily field notebook. If field conditions do not allow for conformance with this SAP/QAPP, the LAI PM will be consulted immediately. For any corrective action or field condition resulting in a revision of this SAP/QAPP, the LAI PM will authorize changes or exceptions to this SAP/QAPP, as necessary and appropriate.

Incidents of QA failure and associated corrective action will be documented and reports will be placed in the appropriate project file. Also, corrective action will be taken promptly for deficiencies noted during spot-checks of raw data. As soon as sufficient time has elapsed for corrective action to be implemented, evidence of correction of deficiencies will be presented.

Corrective action in the analytical laboratory may be required due to equipment malfunction, failure of internal QA/QC checks, method blank contamination, non-compliance with QA requirements, or failure of performance or system audits. When measurement equipment or analytical methods fail QA/QC checks, the problem will be immediately brought to the attention of the appropriate persons in the laboratory, in accordance with the laboratory's SOPs. If failure is due to equipment malfunction, the equipment will be repaired, precision and accuracy will be reassessed, and the analysis will be rerun. Attempts will be made to reanalyze all affected parts of the analysis so that, in the end, results are not affected by failure of QA requirements.

During laboratory analysis, the Laboratory PM will be responsible for taking required corrective actions in response to equipment malfunctions. If an analysis does not meet the data quality goals outlined in this SAP/QAPP, corrective action generally will follow the guidelines in the EPA analytical methods noted in this SAP/QAPP and the EPA guidelines for data validation (EPA 2017a, b). If analytical conditions are such that non-conformance with this SAP/QAPP is indicated, the LAI PM will be notified as soon as possible so that any additional corrective actions can be taken.

The LAI PM is ultimately responsible for implementation of appropriate corrective actions and maintenance of a complete record of QC issues and corrective actions.

9.0 DATA VERIFICATION AND VALIDATION

The processes that will be used to verify and validate data are described in the subsections below.

9.1 Verification

Sample collection forms, field notes, and water level measurements will be reviewed by LAI and placed in the electronic project files. Field data (groundwater field parameter data and water level measurements) will be entered into an Excel spreadsheet and verified to determine all entered data are correct and without omissions and errors.

Technical verification requires comparison of QC and instrument performance standard results to required control limits. Technical verification is conducted throughout the analytical process, first by analysts, and finally by the Laboratory PM or designee and Laboratory PM. Laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.

9.2 Data Validation

Groundwater, soil, and LFG analytical data will undergo EPA Level 2A validation to determine that the results are acceptable and meet the quality objectives described in Section 3.0.

Validation of the data will be performed by an LAI data validator with guidance from applicable portions of the National Functional Guidelines for Organic Superfund Methods Data Review (EPA 2017b) and the National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA 2017a), analytical methods, and LAI SOPs.

The EPA Level 2A-equivalent validation and verification will include the following:

- Verification that the laboratory data package contains all necessary documentation (including COC records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related QC data, and QC acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were conducted.
- Verification that QC samples were analyzed as specified in the appropriate work plan.
- Evaluation of sample holding times.
- Evaluation of QC data compared to acceptance criteria, including method blanks, surrogate recoveries, laboratory duplicate and/or replicate results, and LCS results.
- Evaluation of RLs compared to target RLs specified in this QAPP.

Analytical data may be qualified based on the data validation review. Qualifiers will be consistent with applicable EPA national functional guidelines and will be used to provide data users with an estimate of the level of uncertainty associated with the qualified result. Data validation results will be evaluated with respect to assigned qualifiers to determine any data usability issues.

The following qualifiers may be assigned during the data validation process:

- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The result is an estimated quantity, but the result may be biased high.
- J– The result is an estimated quantity, but the result may be biased low.
- NJ The analyte has been "tentatively identified" or "presumptively identified" as present and the associated numerical value is the estimated concentration in the sample.
- R The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
- U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
- UJ The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

The objectives, evaluations, and actions employed during the data validation process will be guided by EPA national functional guidelines. Laboratories will be permitted to provide CLP-like forms in lieu of true CLP forms. The data validation criteria will not strictly adhere to national functional guidelines, but will also take into consideration method criteria for preservation and holding times; laboratory-specified criteria for surrogate, laboratory control samples, laboratory duplicates, and matrix spikes; and the data validator's professional judgment.

Data qualification arising from data validation activities will be documented in validation worksheets and as qualifiers in the EIM database.

10.0 DATA QUALITY ASSESSMENT

This section describes the steps required to reconcile project results with DQOs. Upon completion of data validation, the LAI PM will be provided a summary of qualified data. Data are considered valid and usable as long as they were not rejected during validation. The LAI PM or designee will review the data along with field documentation to ensure project DQOs were met.

Completeness of sampling will be determined by the number of samples collected divided by the number of samples to be collected as specified in the SAP, expressed as a percentage. The minimum requirement for sampling completeness is 90 percent.

Completeness for laboratory analyses will be determined by the number of valid results (results not qualified with a rejected [R] flag) divided by the number of possible individual analyte results, expressed as a percentage. The minimum requirement for analytical completeness is 90 percent.

11.0 REFERENCES

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Table B-1a
Measurement Quality Objectives for Soil
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Soil Samples Analyzed for Gasoline-Range Petroleum Hydrocarbons by Method NWTPH-Gx				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD and MS/MSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/MSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A
Bias/Contamination	Method Blank, Trip Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Soil Samples Analyzed for TPH-D and TPH-O by Method NWTPH-Dx				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD and MS/MSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/MSD	Recoveries within laboratory-specified control limits	0	S&A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A

Table B-1a
Measurement Quality Objectives for Soil
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Soil Samples Analyzed for Total Metals by EPA Methods 6010C and 7471B				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Accuracy	LCS	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS and MS/Laboratory Duplicate	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/Laboratory Duplicate	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Soil Samples Analyzed for BTEX by EPA Method 8260D				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD and MS/MSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/MSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A

Table B-1a
Measurement Quality Objectives for Soil
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Bias/Contamination	Method Blank, Trip Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S

Acronyms/Abbreviations:

°C = degrees Celsius
A = analytical
BTEX = benzene, toluene, ethylbenzene, xylene
DQI = data quality indicator
EPA = US Environmental Protection Agency
LCS = laboratory control spike
LCSD = laboratory control spike duplicate
MQO = measurement quality objective
MS = matrix spike
MSD = matrix spike duplicate
N/A = not applicable
NWTPH-Dx = Northwest Total Petroleum Hydrocarbon diesel extended
NWTPH-Gx = Northwest Total Petroleum Hydrocarbon gasoline extended
QA = quality assurance
QC = quality control
RL = reporting limit
RPD = relative percent difference
S = sampling
SIM = selected ion monitoring
TPH-D = diesel-range total petroleum hydrocarbons
TPH-O = oil-range total petroleum hydrocarbons

Table B-1b
Measurement Quality Objectives for Groundwater
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Groundwater Samples Analyzed for Gasoline-Range Petroleum Hydrocarbons by Method NWTPH-Gx				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD and MS/MSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/MSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A
Precision	Field Duplicates	RPD <20%	1 per 20 samples or one per analytical group	S&A
Bias/Contamination	Method Blank, Trip Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Representativeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Groundwater Samples Analyzed for TPH-D and TPH-O by Method NWTPH-Dx				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD and MS/MSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/MSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A
Precision	Field Duplicates	RPD <20%	1 per 20 samples or one per analytical group	S&A

Table B-1b
Measurement Quality Objectives for Groundwater
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Groundwater Samples Analyzed for SVOCs, PAHs by EPA 8270E, EPA 8270E SIM				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD and MS/MSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/MSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A
Precision	Field Duplicates	RPD <20%	1 per 20 samples or one per analytical group	S&A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Groundwater Samples Analyzed for Total or Dissolved Metals by EPA Methods 6020A UCT, 7470A, SM 3500				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Accuracy	LCS	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS and MS/Laboratory Duplicate	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/Laboratory Duplicate	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A

Table B-1b
Measurement Quality Objectives for Groundwater
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Precision	Field Duplicates	RPD <20%	1 per 20 samples or one per analytical group	S&A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Groundwater Samples Analyzed for Volatile Organic Compounds or BTEX by EPA Method 8260C				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD and MS/MSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/MSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A
Bias/Contamination	Method Blank, Trip Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Groundwater Samples Analyzed for Alkalinity by Method SM2320B				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Accuracy	LCS	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS and MS/Laboratory Duplicate	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/Laboratory Duplicate	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A

Table B-1b
Measurement Quality Objectives for Groundwater
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Precision	Field Duplicates	RPD <20%	1 per 20 samples or one per analytical group	S&A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Groundwater Samples Analyzed for Anions by EPA Method 300.0				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Accuracy	LCS	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS and MS/Laboratory Duplicate	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/Laboratory Duplicate	Recoveries within laboratory-specified control limits	1 per 10 samples or two per analytical batch	S&A
Precision	Field Duplicates	RPD <20%	1 per 20 samples or one per analytical group	S&A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Groundwater Samples Analyzed for Total Organic Carbon by Method SM 5310B				
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Accuracy	LCS	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS and MS/Laboratory Duplicate	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/Laboratory Duplicate	Recoveries within laboratory-specified control limits	1 per 10 samples or two per analytical batch	S&A
Precision	Field Duplicates	RPD <20%	1 per 20 samples or one per analytical group	S&A

Table B-1b
Measurement Quality Objectives for Groundwater
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S
Groundwater Samples Analyzed for Total Dissolved Solids by Method SM 2540C				
Accuracy	LCS	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS and MS/Laboratory Duplicate	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/Laboratory Duplicate	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A
Precision	Field Duplicates	RPD <20%	1 per 20 samples or one per analytical group	S&A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S

Acronyms/Abbreviations:

°C = degrees Celsius
A = analytical
BTEX = benzene, toluene, ethylbenzene, xylene
DQI = data quality indicator
EPA = US Environmental Protection Agency
LCS = laboratory control spike
LCSD = laboratory control spike duplicate
MQO = measurement quality objective
MS = matrix spike
MSD = matrix spike duplicate
N/A = not applicable
NWTPH-Dx = Northwest Total Petroleum Hydrocarbon diesel extended
NWTPH-Gx = Northwest Total Petroleum Hydrocarbon gasoline extended
QA = quality assurance
QC = quality control
RL = reporting limit
RPD = relative percent difference
S = sampling
SIM = selected ion monitoring
TPH-D = diesel-range total petroleum hydrocarbons
TPH-O = oil-range total petroleum hydrocarbons
UCT = universal cell technology

Table B-1c
Measurement Quality Objectives for Landfill Gas
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Landfill Gas Samples Analyzed for Volatile Organic Compounds by Method TO-15/TO-15 SIM				
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Bias/Contamination	Individual (100%) Canister Cleaning	Target analytes not detected at laboratory-specified SIM limits	1 for each canister	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	N/A	S&A
Field Completeness	Number of samples collected out of planned samples	90%	N/A	S

Acronyms/Abbreviations:

A = analytical
DQI = data quality indicator
LCS = laboratory control spike
LCSD = laboratory control spike duplicate
MQO = measurement quality objective
N/A = not applicable
QA = quality assurance
QC = quality control
RL = reporting limit
RPD = relative percent difference
S = Sampling
SIM = selected ion monitoring

Table B-2a
Target Reporting Limits for Soil and Groundwater
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

Analyte	CAS No.	Soil		Groundwater	
		Method	Reporting Limit (mg/kg)	Method	Reporting Limit (µg/L)
Volatile Organic Compounds					
Benzene	71-43-2	EPA 8260D	0.050	EPA 8260D	1.00
Toluene	108-88-3	EPA 8260D	0.050	EPA 8260D	1.00
Ethylbenzene	100-41-4	EPA 8260D	0.050	EPA 8260D	1.00
Total Xylenes	1330-20-7	EPA 8260D	0.100	EPA 8260D	2.00
Petroleum Hydrocarbons					
TPH-G (NWTPH-Gx)	N/A	NWTPH-Gx	5.00	NWTPH-Gx	100
TPH-D (NWTPH-Dx)	N/A	NWTPH-Dx	5.00	NWTPH-Dx	100
TPH-O (NWTPH-Dx)	N/A	NWTPH-Dx	10.0	NWTPH-Dx	200
TPH (calculation)	N/A	Calculation	(a)	Calculation	(a)
Semivolatile Organic Compounds					
bis(2-Ethylhexyl)phthalate	117-81-7	--	--	EPA 8270E	3.00
PAHs					
Naphthalene	91-20-3	--	--	EPA 8270E SIM	0.01
2-Methylnaphthalene	91-57-6	--	--	EPA 8270E SIM	0.01
1-Methylnaphthalene	90-12-0	--	--	EPA 8270E SIM	0.01
2-Chloronaphthalene	91-58-7	--	--	EPA 8270E SIM	0.01
Biphenyl	92-52-4	--	--	EPA 8270E SIM	0.01
2,6-Dimethylnaphthalene	581-42-0	--	--	EPA 8270E SIM	0.01
Acenaphthylene	208-96-8	--	--	EPA 8270E SIM	0.01
Acenaphthene	83-32-9	--	--	EPA 8270E SIM	0.01
Dibenzofuran	132-64-9	--	--	EPA 8270E SIM	0.01
2,3,5-Trimethylnaphthalene	2245-38-7	--	--	EPA 8270E SIM	0.01
Fluorene	86-73-7	--	--	EPA 8270E SIM	0.01
Dibenzothiophene	132-65-0	--	--	EPA 8270E SIM	0.01
Phenanthrene	85-01-8	--	--	EPA 8270E SIM	0.01
Anthracene	120-12-7	--	--	EPA 8270E SIM	0.01
Carbazole	86-74-8	--	--	EPA 8270E SIM	0.01
Fluoranthene	206-44-0	--	--	EPA 8270E SIM	0.01
Pyrene	129-00-0	--	--	EPA 8270E SIM	0.01
1-Methylphenanthrene	832-69-9	--	--	EPA 8270E SIM	0.01
Benzo(a)anthracene	56-55-3	--	--	EPA 8270E SIM	0.01
Chrysene	218-01-9	--	--	EPA 8270E SIM	0.01
Benzo(b)fluoranthene	205-99-2	--	--	EPA 8270E SIM	0.01
Benzo(k)fluoranthene	207-08-9	--	--	EPA 8270E SIM	0.01
Benzo(j)fluoranthene	205-82-3	--	--	EPA 8270E SIM	0.01
Benzofluoranthenes, Total	N/A	--	--	EPA 8270E SIM	0.01
Benzo(e)pyrene	197-97-2	--	--	EPA 8270E SIM	0.01
Benzo(a)pyrene	50-32-8	--	--	EPA 8270E SIM	0.01
Perylene	1985-5-0	--	--	EPA 8270E SIM	0.01
Indeno(1,2,3-cd)pyrene	193-39-5	--	--	EPA 8270E SIM	0.01
Dibenzo(a,h)anthracene	53-70-3	--	--	EPA 8270E SIM	0.01
Benzo(g,h,i)perylene	191-24-2	--	--	EPA 8270E SIM	0.01

Table B-2a
Target Reporting Limits for Soil and Groundwater
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

Analyte	CAS No.	Soil		Groundwater	
		Method	Reporting Limit (mg/kg)	Method	Reporting Limit (µg/L)
Conventionals					
Sulfate	14808-79-8	--	--	EPA 300.0	100
Nitrate	14797-55-8	--	--	EPA 300.0	100
Chloride	7647-14-5	--	--	EPA 300.0	100
Methane	74-82-8	--	--	RSK-175	0.654
Total Organic Carbon	N/A	--	--	SM 5310	500
Total Dissolved Solids	N/A	--	--	SM 2540	5,000
Alkalinity, Total (µg/L CaCO3)	N/A	--	--	SM 2320	1,000
Total/Dissolved Metals					
Arsenic	7440-38-2	EPA 6010C	5.00	EPA 6020A UCT	0.200
Barium	7440-39-3	EPA 6010C	0.300	N/A	--
Cadmium	7440-43-9	EPA 6010C	0.200	EPA 6020A UCT	0.100
Chromium, Total	7440-47-3	EPA 6010C	0.500	EPA 6020A UCT	0.500
Chromium, Hexavalent (SM 3500)	18540-29-9	--	--	SM 3500	10.0
Chromium, Trivalent (calculated)	16065-83-1	--	--	Calculation	N/A
Copper	7440-50-8	--	--	EPA 6020A UCT	0.500
Hardness (calculated)	N/A	--	--	EPA 6010C	N/A
Iron	7439-89-6	--	--	EPA 6020A UCT	20.0
Lead	7439-92-1	EPA 6010C	2.00	EPA 6020A UCT	0.100
Manganese	7439-96-5	--	--	EPA 6020A UCT	0.500
Mercury	7439-97-6	EPA 7471B	0.025	EPA 7470A	0.0200
Nickel	7440-02-0	--	--	EPA 6020A UCT	0.500
Selenium	7782-49-2	EPA 6010C	5.00	EPA 6020A UCT	0.500
Silver	7440-22-4	EPA 6010C	0.300	EPA 6020A UCT	0.200
Zinc	7440-66-6	--	--	EPA 6020A UCT	4.00

Notes:

(a) TPH will be calculated as the sum of detections.

Acronyms/Abbreviations:

CaCO3 = calcium carbonate
CAS = Chemical Abstracts Service
EPA = US Environmental Protection Agency
µg/L = micrograms per liter
mg/kg = miligrams per kilogram
N/A = not applicable
-- = not scheduled for analysis
NWTPH-Dx = Northwest Total Petroleum Hydrocarbon diesel extended
NWTPH-Gx = Northwest Total Petroleum Hydrocarbon gasoline extended
RL = reporting limit
SM = Standard Methods
TPH = total petroleum hydrocarbons
TPH-D = diesel-range total petroleum hydrocarbons
TPH-O = oil-range total petroleum hydrocarbons
UCT = universal cell technology

Table B-2b
Target Reporting Limits for Landfill Gas
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

Analyte	CAS No.	Target Reporting Limits
		Landfill Gas ($\mu g/m^3$)
Volatile Organic Compounds by EPA Method TO-15		
1,1,1-Trichloroethane	71-55-6	0.54
1,1,2,2-Tetrachloroethane	79-34-5	0.54
1,1,2-Trichloroethane	79-00-5	0.54
1,1-Dichloroethane	75-34-3	0.55
1,1-Dichloroethene	75-35-4	0.54
1,2,4-Trichlorobenzene	120-82-1	0.54
1,2,4-Trimethylbenzene	95-63-6	0.54
1,2-Dibromo-3-chloropropane	96-12-8	0.53
1,2-Dibromoethane	106-93-4	0.54
1,2-Dichloro-1,1,2,2-tetrafluoroethane (CFC 114)	76-14-2	0.53
1,2-Dichlorobenzene	95-50-1	0.54
1,2-Dichloroethane	107-06-2	0.54
1,2-Dichloropropane	78-87-5	0.54
1,3,5-Trimethylbenzene	108-67-8	0.53
1,3-Butadiene	106-99-0	0.53
1,3-Dichlorobenzene	541-73-1	0.54
1,4-Dichlorobenzene	106-46-7	0.54
1,4-Dioxane	123-91-1	0.54
2-Butanone (MEK)	78-93-3	1.1
2-Hexanone	591-78-6	0.54
2-Propanol (Isopropyl Alcohol)	67-63-0	2.1
3-Chloro-1-propene (Allyl Chloride)	107-05-1	0.54
4-Ethyltoluene	622-96-8	0.54
4-Methyl-2-pentanone	108-10-1	0.53
Acetone	67-64-1	5.3
Acetonitrile	75-05-8	0.53
Acrolein	107-02-8	1.0
Acrylonitrile	107-13-1	0.53
alpha-Pinene	80-56-8	0.54
Benzene	71-43-2	0.53
Benzyl Chloride	100-44-7	1.1
Bromodichloromethane	75-27-4	0.54
Bromoform	75-25-2	0.54
Bromomethane	74-83-9	0.54
Carbon Disulfide	75-15-0	1.1
Carbon Tetrachloride	56-23-5	0.53
Chlorobenzene	108-90-7	0.54
Chloroethane	75-00-3	0.54
Chloroform	67-66-3	0.54
Chloromethane	74-87-3	0.53
cis-1,2-Dichloroethene	156-59-2	0.53
cis-1,3-Dichloropropene	10061-01-5	0.52
Cumene	98-82-8	0.54
Cyclohexane	110-82-7	1.1
Dibromochloromethane	124-48-1	0.54

Table B-2b
Target Reporting Limits for Landfill Gas
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

Analyte	CAS No.	Target Reporting Limits Landfill Gas ($\mu g/m^3$)
Volatile Organic Compounds by EPA Method TO-15		
Dichlorodifluoromethane (CFC 12)	75-71-8	0.53
d-Limonene	5989-27-5	0.54
Ethanol	64-17-5	5.2
Ethyl Acetate	141-78-6	1.1
Ethylbenzene	100-41-4	0.54
Hexachlorobutadiene	87-68-3	0.53
m,p-Xylenes	179601-23-1	1.1
Methyl Methacrylate	80-62-6	1.1
Methyl tert-Butyl Ether	1634-04-4	0.54
Methylene Chloride	75-09-2	0.53
Naphthalene	91-20-3	0.52
n-Butyl Acetate	123-86-4	0.55
n-Heptane	142-82-5	0.54
n-Hexane	110-54-3	0.54
n-Nonane	111-84-2	0.54
n-Octane	111-65-9	0.54
n-Propylbenzene	103-65-1	0.54
o-Xylene	95-47-6	0.54
Propene	115-07-1	0.53
Styrene	100-42-5	0.53
Tetrachloroethene	127-18-4	0.52
Tetrahydrofuran (THF)	109-99-9	0.55
Toluene	108-88-3	0.54
trans-1,2-Dichloroethene	156-60-5	0.54
trans-1,3-Dichloropropene	10061-02-6	0.53
Trichloroethene	79-01-6	0.54
Trichlorofluoromethane	75-69-4	0.53
Trichlorotrifluoroethane	76-13-1	0.54
Vinyl Acetate	108-05-4	5.4
Vinyl Chloride	75-01-4	0.54
Volatile Organic Compounds by EPA Method TO-15 SIM		
Vinyl Chloride	75-01-4	0.025

Acronyms/Abbreviations:

CAS = Chemical Abstracts Service
EPA = US Environmental Protection Agency
SIM = selected ion monitoring
$\mu g/m^3$ = micrograms per cubic meter

Table B-3
Sample Containers, Preservatives, and Holding Times
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

Matrix	Analyte	Method	Container	Preservative	Holding Time (a)	Laboratory
Soil	TPH-G	NWTPH-Gx	2 x 40 mL vial	Cool to < 6°C, MeOH	14 days	ARI
Soil	TPH-D, TPH-O	NWTPH-Dx	4 oz jar (b)	Cool to < 6°C	14 days	ARI
Soil	BTEX	EPA 8260D	3 x 40 mL vial	Cool to < 6°C, 1 vial MeOH	14 days	ARI
Soil	Metals	EPA 6010C	4 oz jar (b)	Cool to < 6°C	6 months	ARI
Soil	Mercury	EPA 7471B	4 oz jar (b)	Cool to < 6°C	28 days	ARI
Soil	Grain Size/Hydrometer	ASTM D422	1 gallon plastic bag	N/A	N/A	LAI
Groundwater	TPH-G	NWTPH-Gx	2 x 40 mL vial	Cool to < 6°C, HCl	14 days preserved 7 days unpreserved	ARI
Groundwater	TPH-D, TPH-O	NWTPH-Dx	2 x 500 mL Amber	Cool to < 6°C	7 days	ARI
Groundwater	BTEX	EPA 8260D	2 x 40 mL vial	Cool to < 6°C, HCl	14 days preserved 7 days unpreserved	ARI
Groundwater	SVOCs	EPA 8270E	2 x 500 mL Amber	Cool to < 6°C, HCl	7 days/40 days	ARI
Groundwater	PAHs	EPA 8270E SIM	2 x 500 mL Amber	Cool to < 6°C, HCl	7 days/40 days	ARI
Groundwater	Total and Dissolved Metals	EPA 6020A UCT	500 mL HDPE	Cool to < 6°C HNO3 (c)	6 months	ARI
Groundwater	Total and Dissolved Mercury	EPA 7470A	500 mL HDPE	Cool to < 6°C HNO3 (c)	28 days	ARI
Groundwater	Hexavalent Chromium	SM 3500	500 mL HDPE	Cool to < 6°C, buffer to pH 9.3 to 9.7	28 days 24 hours (d)	ARI
Groundwater	Anions	EPA 300.0	500 mL HDPE	Cool to < 6°C	48 hrs (nitrate) 28 days (sulfate) (chloride)	ARI
Groundwater	Dissolved Gases	RSK-175	3 x 40 mL vial	Cool to < 6°C	14 days	ARI
Groundwater	Alkalinty	SM 2320B	500 mL HDPE	Cool to < 6°C	14 days	ARI
Groundwater	Total Organic Carbon	SM 5310B	250 mL glass	Cool to < 6°C, pH <2 H2SO4	28 days	ARI
Groundwater	Total Dissolved Solids	SM 2540C	1 Liter HDPE	Cool to < 6°C	7 days	ARI
Landfill Gas	VOCs	TO-15/TO-15 SIM	6-L Summa	N/A	30 days	ALS

Table B-3
Sample Containers, Preservatives, and Holding Times
Pre-Remedial Design Investigation Quality Assurance Project Plan
Central Waterfront Project – Bellingham, Washington

Notes:

(a) Time from sample collection to extraction/time from sample extraction to analysis.
(b) Combined analytical suite may be analyzed using 1-8 oz jar per sample.
(c) Total metals or field-filtered samples only.
(d) If buffer is not used.

Acronyms/Abbreviations:

°C = degrees Celsius
ASTM = ASTM International
ALS = Analytical Laboratory Services, Inc.
ARI = Analytical Resources, Inc.
BTEX = benzene, ethylbenzene, toluene, total xylenes
EPA = US Environmental Protection Agency
H2SO4 = sulfuric acid
HCl = hydrochloric acid
HDPE = high-density polyethylene
HNO3 = nitric acid
L = liter
LAI = Landau Associates, Inc.
MeOH = methanol
mL = milliliter
N/A = not applicable
NWTPH-Dx = Northwest Total Petroleum Hydrocarbon diesel extended
NWTPH-Gx = Northwest Total Petroleum Hydrocarbon gasoline extended
oz = ounces
SIM = selected ion monitoring
SM = Standard Methods
TPH-D = diesel-range total petroleum hydrocarbons
TPH-G = gasoline-range total petroleum hydrocarbons
TPH-O = oil-range total petroleum hydrocarbons
VOCs = volatile organic compounds
UCT = universal cell technology

APPENDIX C

Health and Safety Plan

Pre-Remedial Design Investigation
Health and Safety Plan
Central Waterfront Cleanup Site
Bellingham, Washington

October 14, 2020

Prepared for

Port of Bellingham
Bellingham, Washington

LANDAU ASSOCIATES

130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

Revision Log			
Submitted By	**Date**	**Version**	**Remarks**

Title	Name	Phone Number
EMERGENCY		
Ambulance		**911**
Police	Bellingham Police Dept.	**911** or (360) 778-8800
Fire	Bellingham Fire Dept. – Stations 1 & 3	**911** or (360) 778-8400
Local Hospital	PeaceHealth St. Joseph Medical Center	(360) 734-5400 (Main)
LANDAU ASSOCIATES PERSONNEL		
Project Manager	Jeff Fellows, PE	Cell: (206) 218-6501
Field Manager	Devan Brandt Jeovani Huerta-Avila	Cell: (425) 381-1160 Cell: (206) 650-1781
Site Safety Officer	Devan Brandt Jeovani Huerta-Avila	Cell: (425) 381-1160 Cell: (206) 650-1781
Corporate Health and Safety Manager	Chris Kimmel	Office: (425) 329-0254 Cell: (206) 786-3801
PORT OF BELLINGHAM		
Project Manager	Ben Howard	Office: (360) 715-7365
Project Engineer	Jennifer Allan	Office: (360) 676-2500 x382
SUBCONTRACTOR(S)		
Moffat & Nichols	Daryl English, PE	Cell: (206) 602-5319
Wilson Surveying	Tom Brewster, PLS	Office: (360) 733-6100 x231
Driller	Brian Gose	Office: (360) 577-9194
Utility Locate Service (APS)	Steve Brown	Cell: (425) 954-8436
Analytical Laboratory (ARI)	Kelly Bottem	Cell: (206) 695-6200
Caldera Archaeology, LLC	Ed Arthur	Cell: (360) 332-2600

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ATTACHMENTS

LIST OF ABBREVIATIONS AND ACRONYMS

°F ..... degrees Fahrenheit
AHA ..... Activity Hazard Analysis
BEHP ..... bis(2-ethyhexyl)phthalate
BTEX ..... benzene, toluene, ethylbenzene, xylene
CFR ..... Code of Federal Regulations
COPC ..... chemical of potential concern
CPR ..... cardiopulmonary resuscitation
Ecology ..... Washington State Department of Ecology
ft ..... foot/feet
HASP ..... health and safety plan
HAZWOPER ..... Hazardous Waste Operations & Emergency Response
HEPA ..... high-efficiency particulate air
HR ..... human resources
LAI ..... Landau Associates, Inc.
MTBE ..... methyl tert-butyl ether
NIOSH ..... National Institute for Occupational Safety and Health
OSHA ..... Occupational Safety and Health Administration
PAH ..... polycyclic aromatic hydrocarbon
PID ..... photoionization detector
PM ..... project manager
PPE ..... personal protective equipment
Port ..... Port of Bellingham
ppm ..... parts per million
SDS ..... safety data sheet
Site ..... Central Waterfront site
SOW ..... scope of work
SSHO ..... Site safety and health officer
SVOC ..... semivolatile organic compound
TPH ..... total petroleum hydrocarbons
TWA ..... time-weighted average
USACE ..... US Army Corps of Engineers
VOC ..... volatile organic compound

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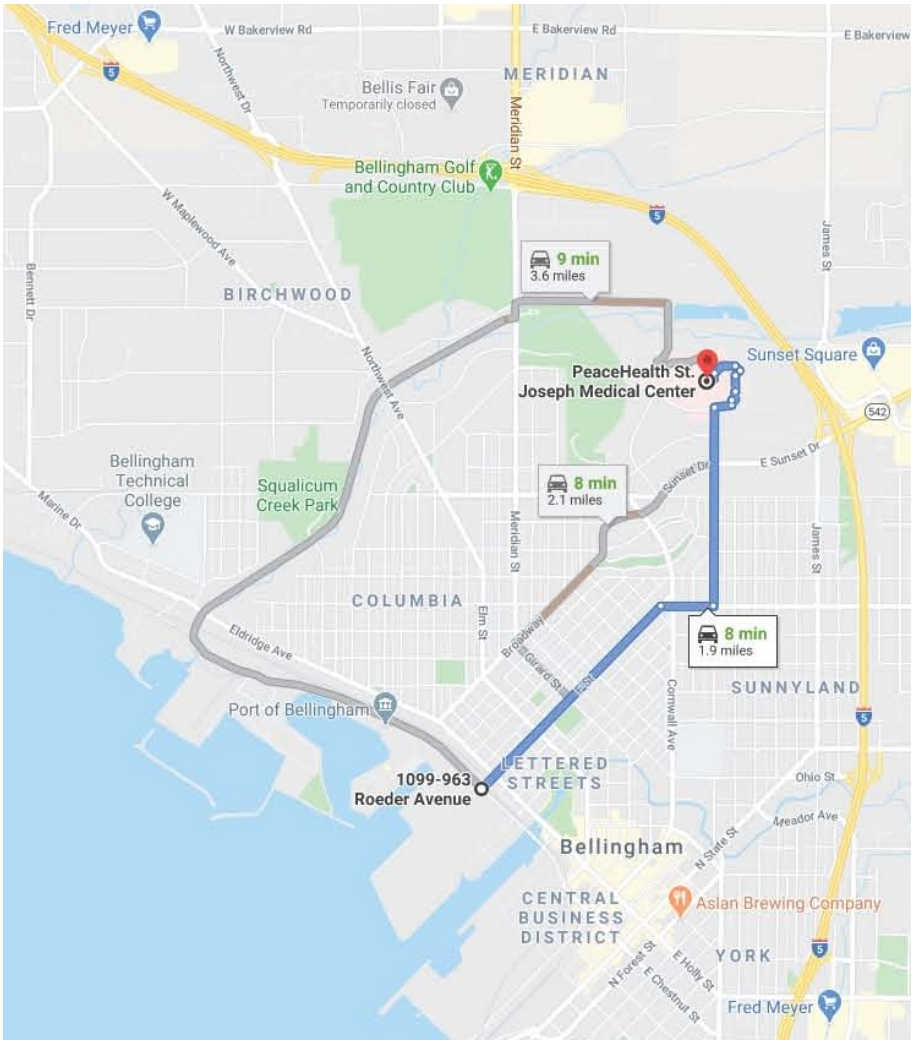
GENERAL PROJECT DATA

Consultant Name	Landau Associates, Inc.	
Project Number	0001024.010.012	
Project Name	**Central Waterfront Remedial Design and Permitting Program Bellingham, Washington**	
Brief Project Description	Hot spot investigation, soil boring advancement, monitoring well installation, test pit exploration, Site topographic surveys and condition reporting, surface condition evaluation, temporary and permanent landfill gas probe installation, multimedia sampling (soil, groundwater, sediment, indoor air), shoreline and infrastructure evaluation, and other remedial design-related investigation requirements.	
Site	Central Waterfront; Roeder Avenue	
Location Description	Bellingham, Washington	
Health and Safety Plan		
Prepared By:	Kate Cleveland	Task Manager
Preparation Date:	August 5, 2020	
Reviewed By:	Jeff Fellows, PE	Project Manager
Approved By:	Chris Kimmel	Corporate Health and Safety Manager

Task/Issue	Comments
Project work objective (brief)	Obtain further Site-specific information to support effective Site-wide remedial design and associated permitting.
Work Hours	07:00 to 18:00, Monday through Friday
Safety Meeting Frequency	Daily
Site Perimeter Marking	Unauthorized persons will be restricted from immediate work area when heavy equipment is being used. Work areas will be secured using a combination of fencing, protective barriers, traffic safety cones, etc., based on the specific aspect of work and location of activity.
Exclusion Zone Marking	Excavation and investigation areas will be demarcated with traffic cones and flagging, as necessary
Dust Control Methods	N/A
Excavations (including borings)?	Yes; boring advancement and test pit explorations (maximum 20 feet below ground surface)
Excavations over 5 ft Deep (excluding borings)?	No; maximum depth of test pit explorations is 5 feet (ft) below ground surface
Contact USA/Underground Alert	Applied Professional Services (APS) will perform a private utility locate; public utility locate will also be coordinated, as necessary.
OSHA Excavation Permit Required?	No
Other/Comments:	Port will be the main point-of-contact for tenants and owners in support of access and coordination of field activities.

HOSPITAL ROUTE MAP



Emergency Route from Site to PeaceHealth St. Joseph Medical Center

Directions	Distance
Head northeast on F Street toward West Holly Street	0.8 miles
F Street turns right and becomes Alabama Street	0.2 miles
Turn left onto Ellis Street	0.6 miles
Turn right onto Squalicum Parkway	499 feet
Turn left onto Levin Lane	446 feet
Turn left to stay on Levin Lane	331 feet
Turn left to stay on Levin Lane	404 feet
Destination is on the right, PeaceHealth St. Joseph Medical Center, 2901 Squalicum Parkway, Bellingham, WA 98225	
TOTAL TIME: 8 minutes	**TOTAL DISTANCE: 2.0 MILES**

SITE ACTIVITIES AND HAZARDS

Task Checklist					
☒	Mobilization and set-up	☒	Sample location marking	☒	Backfilling/compaction
☒	Excavation and trenching	☒	Manual handling of materials	☒	Site restoration
☒	Stockpiling soil management	☒	Sampling: soil, water, air, sediment	☒	Site cleanup
☒	Drilling and well installation	☒	Equipment decontamination	☐	Other:
☒	Hand augering	☒	Personnel decontamination	☐	Other:
☒	Well development	☒	Remove and load debris	☐	Other:
Comments:					
A variety of field activities are planned for the investigation phase. If new or additional activities are required, which are not listed above, the health and safety plan will be revised.					

Chemicals of Potential Concern			
Groundwater		**Soil/Sediment**	
☒	Volatile Organic Compounds (VOCs) – benzene	☒	VOCs – benzene
☒	Semivolatile organic compounds (SVOCs) – bis(2-ethyhexyl)phthalate (BEHP)	☒	SVOCs – BEHP
☒	Polycyclic aromatic hydrocarbons (PAHs)	☒	PAHs
☒	Metals	☒	Metals
☒	Total petroleum hydrocarbons (TPH)	☒	TPH
☐	Other (specify)	☐	Other (specify)
Air (Soil Vapor and Landfill Gas)			
☒	Hydrogen sulfide (H_2S) methane (CH_4)	☒	VOCs – benzene, toluene, ethylbenzene, xylenes (-m,p and –o) (BTEX), naphthalene, methyl tert-butyl ether (MTBE)
☒	PAHs – 1,3-butadiene, 2-methylnaphthalene	☒	Aliphatic hydrocarbons (C_5-C_8, C_9-C_{12}) and aromatic hydrocarbons (C_9-C_{12})
LIST OF SPECIFIC CHEMICALS OF CONCERN/CHEMICALS OF POTENTIAL CONCERN (COPCs):			
Site contamination includes landfill refuse, TPH, PAHs, VOCs, SVOCs, metals, and landfill gas from historical Site activities. If additional COPCs are identified, the health and safety plan will be revised.			

Chemicals of Potential Concern							
OTHER ANTICIPATED SITE HAZARDS							
Physical (Health)		**Ergonomic**		**Biological**		**General Safety**	
☒	Noise	☒	Materials handling	☒	Insects	☒	Trenching/excavation
☒	Weather stress	☒	Lifting	☒	Mammals/rodents	☒	Drill rig
☐	Ionizing radiation	☐	Shift-work (greater than 10-hour work day)	☒	Snakes	☒	Heavy construction equipment
☒	Chemical exposure	☒	Repetitive motion	☒	Spiders	☒	Hand tool use
☐		☒	Awkward postures	☒	Plants (e.g., poison oak)	☒	Vehicles/traffic
☐		☒	Pushing/pulling	☒	Blood-borne pathogens	☒	Elevated work (falls)
☐		☐		☒	COVID-19	☒	Welding/hot work
☐		☐		☐		☒	Utilities (above/underground)
☐		☐		☐		☒	Dredging
☐		☐		☐		☒	Working near water

Level of Protection Required					
Head:		**Foot:**		**Hand:**	
☒	Hardhat	☒	Composite-toed boots	☒	Leather/work gloves (conditional use)
☐	Other:	☐	Other:	☒	Nitrile gloves outer gloves (conditional use)
Eye:		**Respiratory:**		**Body:**	
☒	Safety glasses	☒	Dusk face mask	☒	High-visibility clothing
☒	Face shield (conditional use)	☒	Half-face or full-face Respirator with dust and high efficiency particulate air (HEPA) filter (conditional use)	☒	Tyvek suit (conditional use)
Ear:		**Other:**		**Cloth Overalls:**	
☒	Earplugs	☐		☒	Personal floatation device (conditional use)
☒	Earmuffs (conditional use)	☐		☒	Fall protection harness (conditional use)

Level of Protection Required							
Other Safety Equipment							
☒	First aid kit	☒	Traffic cones	☒	Personal dust monitor	☒	Ventilation blower/ fan
☒	Emergency eye wash	☒	Barrier tape	☒	Photoionization detector (PID)	☐	Warning line system
☒	Fire extinguisher	☒	Signage	☒	Landfill gas meter	☐	
☒	2-way radios	☐	Blast alarm	☒	FID meter	☐	
☒	Cell phones	☒	Lighting (conditional use)	☒	Ground fault circuit interrupter	☐	
☐	Other:	☐	Other:	☐	Other:	☐	Other:
Comments:							

Required Clearances			
Type	**Responsible Person**	**Date**	**Comments**
Utilities (above/ belowground)			
Confined spaces			
Excavations			
Drilling			
Traffic			
Elevated work			
Comments/Other:			

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1.0 INTRODUCTION

Landau Associates, Inc. (LAI) prepared this Site-specific Health and Safety Plan (HASP) and associated Activity Hazard Analyses (AHAs; Attachment C-1), for the Port of Bellingham (Port) in support of the Central Waterfront remedial design and permitting project. The purpose of this HASP is to identify, and inform field personnel and visitors of potential hazards and appropriate responses for work activities conducted at the Central Waterfront Project site (Site) located in Bellingham, Washington.

This HASP is a "working document" for use by Site personnel and may be modified at any time to address hazards and changing conditions encountered during project activities. This HASP will be maintained and located at the LAI Edmonds Office and on Site at all times.

This HASP conforms to the US Department of Labor, Occupational Safety and Health Administration (OSHA), Washington State Department of Ecology (Ecology), US Army Corps of Engineers (USACE), and other applicable federal, state, county, and local laws, ordinances and codes. Where requirements of different regulations noted herein are in conflict, the more stringent requirements will be followed and enforced.

1.1 Safety and Health Policy

LAI has a strong safety culture and has established policies and procedures meeting governing guidelines and requirements. LAI's Corporate Health and Safety Plan provides standard operating procedures for field and office activities that has been developed to meet or exceed the requirements listed in the documents referenced below.

1.2 References

The publications listed below provide guidance for implementation of the regulations and operational activities:

- Corporate Health and Safety Plan (LAI 2016)
- Occupational Safety and Health Standards, OSHA, 29 Code of Federal Regulations (CFR) 1910 (OSHA; accessed July 27, 2020)
- Occupational Safety and Health Regulations for Construction, 29 CFR 1926 (OSHA; accessed July 27, 2020)
- USACE Safety and Health Requirements Manual (USACE 2014)
- Chapter 296-843 Washington Administrative Code (WAC), Hazardous Waste Operations (Washington State Legislature 2018)
- Federal Acquisition Regulation Clause 52.236.13, Accident Prevention (DOD et al. 2012)
- National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), US Coast Guard, and US Environmental Protection Agency, Occupational Safety and Health Guidance (NIOSH et al. 1985)

- NIOSH Pocket Guide to Chemical Hazards (NIOSH 2007)
- American Conference of Governmental Industrial Hygienists, Threshold Limit Values and Biological Exposure Indices (ACGIH 2020).

1.3 Site Description and Location

The Central Waterfront Project Site (Site) is currently a 51-acre Marine Trade designation area, which includes a combination of industrial, commercial, and institutional mixed-uses. The Port owns and leases most of the land within the Site. Current tenants/operations include boat maintenance and storage (Landings at Colony Wharf), Technology Development Center for educational purposes (Bellingham Technical Institute) within the warehouse building, seafood processing (Bornstein Seafoods), boat storage and lift service (Hilton Harbor), concrete and shore-protection structures (Bellingham Marine Industries), and ship manufacturing (All American Marine). The street rights-of-way are owned by the City of Bellingham. Puget Sound Energy and Sanitary Services Company own and operate an electrical substation and refuse and recycling truck maintenance and storage area, respectively, along Roeder Avenue on the east side of the Site.

1.4 Project Description

The Third Amendment to the Central Waterfront Agreed Order (dated February 2020), requires the preparation and submittal, for Ecology's review and approval, of the documents necessary to complete the remedial design and permitting phase of the cleanup action described in the final Site Cleanup Action Plan. This HASP is one of the documents required for preparation, submittal to, and approval by Ecology in support of the additional Site investigation and field activities necessary to inform execution of the approved remedial design program.

1.4.1 Scope of Work

The scope of work (SOW) for the additional investigation and field activities at the Site will be conducted in phases. The results of the initial phase will inform the additional data needed for the subsequent phase(s) to continue to fine-tune Site-specific requirements for the remedial design.

In general, the SOW includes (but may not be limited to), the following activities:

- Site reconnaissance/condition evaluation
- Topographical surveys (traditional and UVA [drone] methods)
- Soil boring advancement
- Groundwater well installation; well development
- Exploratory test pitting
- Multimedia sampling and analysis (e.g., soil, groundwater, sediment, air)
- Shoreline and existing infrastructure evaluation

- Surface condition assessment
- Stormwater system evaluation
- Other activities specific to assessment of final design requirements.

1.4.2 Duration of Activities and Weather

Site investigation and field activities are anticipated to begin in fall 2020 and continue through 2021. Site work will be completed in a phased approach as detailed in the work plan and subsequent planning addenda.

The annual seasonal climate data for Bellingham, Washington is as follows:

	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March
Average high temperature (°F)	57	62	66	71	73	66	57	52	47	47	47	49
Average low temperature (°F)	41	46	51	54	57	55	42	39	39	36	35	36
Average precipitation (inches)	2.76	2.32	1.97	1.38	0.03	0.16	0.15	0.07	0.12	0.21	0.18	0.09

1.4.3 Subcontractors/Vendors

The following subcontractors/vendors will be involved with the project:

- Analytical Resources Inc. (ARI) will provide sampling containers, perform necessary multimedia sample analyses, and provide results.
    - 4611 South 134th Place, Suite 100
      Tukwila, WA
      Kelly Bottem; (206) 695-6200
- Applied Professional Services (APS) will provide utility locate services through the entirety of the Site. Utilities in public rights-of-way will be identified by a public locate service in advance of any field activities.
    - 43530 SE North Bend Way
      North Bend, WA
      Steve Brown; (425) 954-8436
- Caldera Archaeology, LLC will provide cultural resource and historical archaeology support if inadvertent discovery occurs.
    - 1155 North State, Suite 428
      Bellingham, WA
      Ed Arthur; (360) 332-2600
- Anderson Environmental Contracting LLC is a certified driller in Washington State and will provide labor, equipment, and materials necessary to advance soil borings and landfill gas probes.

  - 705 Colorado Street
    Kelso, WA
    Brian Gose; (360) 577-9194

- Moffat and Nichol will provide technical/engineering assistance including third-party document review, design review support services, and engineering evaluation.
  - 600 University Street, Suite 610
    Seattle, WA
    Daryl English; (206) 602-5319
- Wilson Engineering LLC will use an unmanned aerial vehicle drone to provide a 1-foot surface contour interval survey including utility marks for the 51-acre Site.
  - 805 Dupont Street, Suite 7
    Bellingham, WA
    Tom Brewster; (360) 733-6100

Ultimate identification of required subcontractors/vendors will be based on Ecology acceptance of the final planning documents and associated addenda. Subcontractors/vendors performing work at the Site will comply with the safety requirements of this HASP. LAI reserves the right to require subcontractors to provide activity-specific safety and health procedures (e.g., activity hazard analysis [AHA], job hazard analysis, job safety analysis, or similar).

2.0 PERSONNEL ORGANIZATION AND RESPONSIBILITIES

The **Project Manager (PM), Jeff Fellows,** has overall responsibility for management of this project. The PM will verify that adequate resources are provided to the field crews and safety and health staff to carry out their responsibilities as outlined herein. The PM will check that adequate personnel and equipment resources are available to complete the project assignments safely. The PM will have the overall responsibility to see that the project activities are completed according to the approved plans and guidance documentation.

The **Task Manager, Kate Cleveland,** will work with the PM throughout the duration of the project, including supporting preparation of documents and submittals, coordinating with subcontractors and vendors, performing quality control checks, and working with the LAI field staff and supporting contractors so that they remain on schedule and the elements of the SOW are completed appropriately. The Task Manager will also be on Site periodically to direct and oversee the fieldwork activities.

The **Site Safety and Health Officer (SSHO), TBD,** will be responsible for Site safety and health activities and documentation in the field, as appropriate to the activities being conducted. The SSHO is Red Cross-certified in cardiopulmonary resuscitation (CPR) and first aid. The SSHO is responsible for implementing this HASP and initiating changes to the plan, with the concurrence of the PM. The SSHO has stop-work authority for specific activities, which will be executed only upon determination of an imminent safety hazard or potentially dangerous situation. The SSHO will be present for project operations, when necessary.

The **Corporate Health and Safety Officer (Safety Professional), Chris Kimmel,** will be responsible for reviewing and approving the Site-specific HASP and for performing a safety review in accordance with LAI's Health and Safety Policy. Ms. Kimmel will not be on Site unless necessary and she will be available for consultation regarding safety and health concerns throughout the duration of project activities.

3.0 PROJECT HAZARD ANALYSIS

Potential hazards associated with planned Site activities include chemical, biological, and physical (including ergonomic) hazards. The following sections discuss these anticipated hazards or those that have some potential to occur during Site operations and the measures to be implemented by LAI to eliminate or minimize these hazards, to the extent practicable. Personal protective equipment (PPE) will be provided by LAI or contractors and will be modified based on Site-specific safety monitoring program data.

3.1 Chemical Hazards

Safety Data Sheets (SDSs; Attachment C-2) and generic safety and health information about the chemicals that may be present on Site will be maintained on Site at all times. The SDSs indicate the appropriate protective measures and first aid steps if exposed to the chemical.

The following list of chemicals of potential concern (COPCs) in Site soil and groundwater includes exposure pathways, symptoms of acute exposure, and instruments used to monitor contaminants.

- Petroleum hydrocarbons are located in soil and groundwater at the Site. The exposure pathways include inhalation, ingestion, and dermal contact. Acute exposure symptoms include headaches, nausea, dizziness, nervous excitation, insomnia, gastrointestinal symptoms, encephalopathy, anxiety, delirium, delusions, convulsions, and acute psychosis. LAI will conduct ambient air monitoring using a photoionization detector (PID), implement measures to manage dust generation, and wear appropriate PPE.
- VOCs have been identified as a COPC for the Site. Monitoring for VOCs will be compared to benzene as this compound has the lowest action criteria for upgrade of PPE. VOC (benzene) exposure pathways include inhalation, ingestion, and dermal contact. Acute exposure symptoms include irritated eyes, skin, nose, and respiratory system; giddiness; headache; nausea; staggered gait; dermatitis; fatigue; anorexia (carcinogenic); insomnia; abdominal pain; and ultimately kidney disease. LAI will monitor and manage potential benzene exposure using a PID, implement dust control measures, and wear appropriate PPE.
- SVOCs have been identified as a COPC in soil and groundwater at the Site. SVOC (BEHP) exposure pathways include inhalation, skin absorption, ingestion, and dermal contact. Acute exposure symptoms include a potential endocrine disruption. LAI will monitor SVOCs using a PID, implement dust control measures, and wear appropriate PPE.
- PAHs have been identified as COPCs for soil and groundwater at the Site. PAHs [benzo(a)pyrene and carcinogenic PAH] exposure pathways include inhalation, ingestion, and dermal contact. PAHs have a low acute toxicity and acute symptoms are unclear. Acute exposure symptoms often attributed to PAHs are headache, nausea, and respiratory and dermal irritation. Chronic exposure is linked to cancer. LAI will control potential exposure to PAHs by implementing dust control measures and wearing PPE.
- Lead and other metals have been identified as COPCs for soil and groundwater at the Site. Lead has a low exposure criteria and will be used to characterize worker protection from metals in this plan. Lead's exposure pathways include inhalation, and ingestion. Acute exposure symptoms include lassitude, insomnia, anorexia, constipation, and ultimately kidney

disease. LAI will manage potential lead exposure by implementing dust control measures and wearing PPE.

- Arsenic has been identified as a COPC for soil and groundwater at the Site. Arsenic's exposure pathways include inhalation, ingestion, and dermal contact. Acute exposure symptoms include dermatitis, gastrointestinal disturbances, and respiratory irritation. LAI will manage potential arsenic exposure by implementing dust control measures and wearing PPE.

Hydrogen sulfide, methane, landfill emission gas, aliphatic and aromatic hydrocarbons, VOCs, and PAHs have been identified as COPCs with respect to landfill gas emissions and indoor air quality at the Site. The following includes information on the exposure pathways, symptoms of acute exposure, and instruments used to monitor these contaminants:

- Exposure pathways for landfill gas, which contains hydrogen sulfide and methane gas generated from refuse, include inhalation. Acute exposure symptoms include asphyxiation. LAI will monitor for potential methane gas using a 4-gas meter, and minimize inhalation risk by working upwind of potential sources, and wearing PPE, as necessary.
- Exposure pathways for aliphatic (C5-C8 and C9-C12) and aromatic hydrocarbons (C9-C12) include inhalation and dermal contact. Acute vapor exposure symptoms include skin irritation, fever, and respiratory irritation (asthma-like), which can lead to chemical pneumonia. LAI will monitor for potential methane gas using a 4-gas meter, and minimize inhalation risk by working upwind of potential sources, and wearing PPE, as necessary.
- Exposure pathways for VOCs (BTEX, MTBE, and naphthalene) include inhalation, ingestion, and dermal contact. Acute vapor exposure symptoms include eye, nose, and skin irritation, and effects on the central nervous system such as headache, tiredness, drowsiness, dizziness, and even death (BTEX); respiratory irritation, dizziness, and disorientation (MTBE); and confusion, listlessness, lethargy, vertigo, muscle twitching, convulsions, decreased responses to painful stimuli, coma, and cerebral edema (naphthalene). LAI will monitor for potential VOCs using a PID meter or 4-gas meter, and minimize inhalation risk by working upwind of potential sources, and wearing PPE, as necessary.
- Exposure pathways for PAHs (1,3-butadiene and 2-methylnaphthalene) include inhalation, ingestion, and dermal contact. Acute vapor exposure symptoms include irritation of the skin, eyes, mucus membranes, and upper respiratory tract; headaches; nausea; vomiting; diarrhea; anemia; jaundice; euphoria; dermatitis; visual disturbances; convulsions; decreased pulse rate; fainting; and coma. LAI will monitor for potential PAHs using a 4-gas meter, and minimize inhalation risk by working upwind of potential sources, and wearing PPE, as necessary.

The ambient air monitoring program for COPCs and target levels for PPE upgrades are summarized in Table 1 below.

Table C-1: Action Levels for Respiratory Protection

Monitoring Parameter	Reading	Level of Protection
VOC ACTION – Level 1		
PID Screening		
VOCs	PID reading 1 to 2 parts per million (ppm) in breathing zone for more than 1 minute	Employ fans or engineering controls to reduce VOC concentrations in work area if possible. Collect colorimetric tube benzene readings.
Colorimetric Tubes		
Benzene	Benzene reading 0.1 to 0.5 ppm	Establish 25-ft diameter exclusion zone around work area and upgrade to Level C-half face respirator with organic vapor/HEPA cartridge.
Benzene	Benzene reading > 0.5 ppm	Evacuate area and move upwind. Establish 50-ft diameter exclusion zone around work area. Notify onsite contact and LAI PM. Do not return to area of detection until benzene < 0.1 ppm.
VOC ACTION – Level 2		
PID Screening		
VOCs	PID reading > 25 ppm in breathing zone for more than 1 minute	Establish 25-ft diameter exclusion zone around work area and upgrade to Level C-half face respirator with organic vapor/HEPA cartridge. Collect colorimetric tube benzene and refer to action levels below.
Colorimetric Tubes		
Benzene	Follow ACTION LEVEL #1	Follow ACTION LEVEL #1
VOC ACTION – Level 3		
VOCs (PID)	PID reading > 25 ppm instantaneous reading	Evacuate area and move upwind. Establish 50-ft diameter exclusion zone around work area. Notify onsite contact and LAI PM. Do not return to area of detection until VOCs < 25 ppm.
Contaminated Particulates	Visible Dust	Stop work and control dust with water, resume work. If dust persists, upgrade to Level C-half-faced respirator with organic vapor/HEPA combination cartridges.
Combustible Vapors	> 10% lower explosive limit	Discontinue work immediately and allow vapors to reduce to background prior to resuming work. Verify proper grounding of exploration equipment.

3.2 Biological Hazards

The possibility exists for exposure to small mammals (i.e., raccoons, skunks, squirrels, mice, and dogs) and insects (i.e., spiders, bees, wasps) during the course of Site project activities. If mammals are observed, employees are to immediately contact the SSHO. The SSHO will then assess the situation and instruct employees on further safety procedures including possible summoning of animal control personnel, if appropriate.

The COVID-19 viral pandemic continues to be evolving and is anticipated to be of concern during the planned timeframe of this project. People infected with COVID-19 may have little to no symptoms and in some cases, symptoms (when they appear) can take up to 14 days to present after exposure to COVID-19. Symptoms can include the following: fever (greater than 100.4°F), cough, and difficulty breathing. LAI employees will conduct a daily personal health check, which will be reported to LAI's Human Resources (HR) department electronically. If an LAI staff member has COVID-19-like symptoms, or has been exposed to someone testing positive for the virus, they are required to stay home and immediately contact their doctor and LAI's HR department. LAI will notify contractors and clients if medical test results indicate that the LAI staff member tested positive for the virus. COVID-19 protective measures are listed below and will be included in the daily onsite safety meetings:

- Wear a face mask at all times while on Site.
- Practice physical distancing by keeping at least 6 feet away from other people.
- Wash your hands with soap and water for at least 20 seconds after using toilet facilities, before and after eating, after handling potentially contaminated or infectious materials, after removing hand PPE, and after sneezing, coughing, or touching your face. When soap and water are not available, use an alcohol-based hand sanitizer.
- Avoid touching your eyes, nose, and mouth with unwashed hands.
- Cover your mouth and nose when coughing or sneezing with a tissue or the crook of your elbow. Throw the used tissue in the trash and wash your hands.
- Maintain vehicles and field equipment through regular cleaning and disinfecting of surfaces.
- Do not share tools or equipment (e.g., cell phones, shovels, etc.) between employees without disinfecting them first.
- Avoid handling common-use items such as pens and clipboards; equip each worker with their own. If it is necessary to have common-use items, include them in the cleaning and disinfecting cycle outlined below.
- Get adequate rest, eat a healthy and balanced diet, and stay hydrated.

3.3 Physical Hazards

Potential physical hazards at the Site principally include slips/trips/falls and strain and sprains from awkward postures and body positions. Specifically, it is anticipated that working around heavy

equipment including excavators and drill rigs will be a focused interest. Various other potential physical hazards are described in the sections below.

3.3.1 Slips, Trips, or Falls

Many of the planned Site activities can expose workers to slip, trip, or fall hazards. Work areas will be maintained in as neat and orderly state as practical to prevent slips, trips, or falls. Equipment will not be stored in foot-traffic routes. Tools and materials will not be left lying around when not in direct use.

LAI field staff will ensure work areas are clean and orderly. The practice of "Clean as You Go" (procedure requiring each employee to keep his/her work area clean and debris free as work proceeds) will be maintained on this project. Care will be taken when walking through or working in uneven terrain (e.g., berms, vegetation, ditches, etc.) or on wet surfaces. Good footwear and constant awareness will help reduce slips, trips, and falls. Prior to initiating Site activities, work areas shall be inspected to identify pre-existing slip, trip, and fall hazards. Pre-existing slip, trip and fall hazards shall be marked, barricaded, or removed prior to the initiation of Site activities.

3.3.2 General Debris

Trash and generated debris (i.e., garbage or waste) will be first placed in dedicated "debris piles" and removed from the Site daily to reduce hazards to workers. The daily safety meeting will cover potential debris hazards at the Site.

3.3.3 Vehicle and Equipment Safety

Vehicles and equipment will be inspected before use at the Site. Only licensed and LAI-authorized drivers are to operate LAI-owned vehicles. Other vehicles and onsite equipment must be operated by a licensed and certified driver/operator.

- Seat belts and shoulder harnesses shall be worn by drivers and passengers in vehicles, whenever the vehicle is in motion on public or private thoroughfares and roads including employees who drive their personal vehicles or rental vehicles.
- Drivers shall be properly licensed.
- Drivers shall perform a pre-operational check of their vehicle. Be familiar with the operator's manual.
- No vehicle shall be operated in an unsafe condition. Damages and worn conditions will be reported for prompt repair.
- Load will be secured in the vehicle to minimize movement during traveling.
- Drive defensively, observe speed limits, and obey all traffic laws when operating vehicles.
- Plan ahead to minimize or eliminate the need for backing. Always check to the rear before backing.

- Choose the safest location possible to park vehicles. Avoid parking in other vehicle's blind spots.
- Keep windshield, windshield wipers, side windows and mirrors clean.
- No cell phone use (including texting) of any kind is permitted while vehicle is running regardless if the vehicle is moving.

3.3.4 Ladder Safety

No ladder use is anticipated for this project.

3.3.5 Elevated Work

No elevated work is anticipated for this project.

3.3.6 Utilities

The Site has multiple owners and tenants currently operating with multiple utilities per operation. A public and private utility locate will be conducted in advance of planned earth-disturbing activities and extreme care and proper planning will be used to avoid contact with underground and/or overhead power lines, water and sanitary sewer lines, storm drains, and other utilities at the Site. Prior to any drilling, excavating, or trenching, locates will be reviewed to prevent encounters with subsurface utilities. Safe distances of at least 10 ft will be maintained from overhead power lines to booms, masts, and other such equipment extensions, if applicable. If underground utilities are present or suspected to be present, hand excavation, probing, or other suitable means shall be used to locate the utilities when intrusive activities are within 3 ft of the expected utility location.

3.3.7 Excessive Noise

If an activity is conducted that could expose workers to adverse noise levels, steps will be taken to either minimize the noise source, the time of exposure, or both. Adverse noise levels are defined as equal to or greater than an 8-hour time-weighted average (TWA) of 85 decibels (A-scale, slow response) as measured with a Type 2 sound level meter and/or noise dosimeter.

Personnel who must work near loud equipment (exposure at or above 85 decibels TWA) will be required to wear hearing protection (earplugs or muffs) to reduce their exposure to excessive noise. The use of ear plugs or ear muffs is mandatory when noise prevents conversation in a normal voice at a distance of 3 ft. This "general rule" is an indication that noise levels may exceed the OSHA action level of 85 decibels TWA. Personnel required to wear hearing protection will be in a Hearing Conservation Program in compliance with 29 CFR 1910.95.

3.3.8 Lifting Heavy Objects

Many activities may require lifting heavy objects or heavy physical labor. For manual material handling tasks, personnel will be trained in proper lifting techniques. When heavy objects must be

lifted manually, workers will keep the load close to the body, use their legs to lift, and avoid any twisting or turning motions to minimize stress on the lower back. Care should be taken whenever lifts above shoulder level are anticipated. An adequate number of personnel or an appropriate mechanical device will be used to lift or handle heavy objects whenever feasible.

3.3.9 Using Tools and Equipment

Hazards that are present during the use of tools and equipment are generally associated with improper tool handling, using the wrong tool for the job, not wearing PPE, or inadequate maintenance. Management of these hazards will involve rigorous maintenance of tools and equipment and employee training in the proper use of various tools prior to use to ensure safe working condition. Defective tools and equipment shall be immediately removed from service for repair or replacement.

3.3.10 Electrical Safety

Electrical work is not anticipated for this project.

3.3.11 Lock-out/Tag-out (Control of Hazardous Energy)

Lock-out/tag-out work is not anticipated for this project.

3.3.12 Confined Space

Entry into confined space is not anticipated for this project.

3.3.13 Inclement Weather

Weather is an important consideration when working at the Site. Extremely hot or cold weather, high winds, or heavy rains can cause physical discomfort, loss of efficiency, and increase the potential for stress and personal injury. At the direction of the SSHO, work will be stopped in the event of high winds (over 30 miles per hour), heavy rain, lightning, snow, or hail. The H&S Manager will have radio or cell phone access for Site works during inclement weather for first-aid response.

3.3.13.1 Heat Stress

If the ambient temperature exceeds 70°F when wearing impermeable clothing (e.g., Tyvek) or when the heat index reaches 80°F, workers will be observed for signs of heat stress, and physiological monitoring (temperature or pulse) will be done during breaks. Break durations will be increased if workers exhibit symptoms of heat stress. The breaks will last until symptoms are relieved and/or the pulse of the worker is less than 110 beats per minute.

The following basic requirements apply to outdoor work activities and to all employees while working where “environmental risk factors” and “personal risk factors” for heat illness are present:

- Drinking water in the quantity of 1 quart per hour shall be available at all times for each employee for the duration of the entire shift while working outdoors in the heat. It is important that the drinking water be fresh, pure, suitably cool, and provided to employees free of charge. The water shall be located as close as practicable to the areas where employees are working. Supervisors shall remind employees to drink frequently and this topic must be addressed at tailgate safety meetings.
- Employees must have access to a shaded area to prevent or recover from heat illness symptoms and where they can take their rest breaks anytime when the temperature exceeds 80°F. The shaded area must be located as close as practicable to the areas where employees are working. An employee who takes a preventive cool-down rest: (A) shall be monitored and asked if they are experiencing symptoms of heat illness; (B) shall be encouraged to remain in the shade; and, (C) shall not be returned to work until signs or symptoms of heat illness have abated, but in no event less than 5 minutes in addition to the time needed to access the shade. (The supervisor shall provide appropriate first aid or emergency response, as needed, to promote worker safety and health.
- High-heat procedures shall be implemented when the temperature equals or exceeds 95°F. These high-heat procedures include:
  - Confirming that effective communication is maintained so that employees at the work Site can contact a supervisor when necessary.
  - Observing employees for alertness and signs or symptoms of heat illness. The supervisor shall confirm effective employee observation/monitoring by implementing one or more of the following: (A) Supervisor or designee observation of 20 or fewer employees, or (B) Mandatory buddy system, or (C) Regular communication with sole employee, such as by radio or cellular phone, or (D) Other effective means of observation.
  - Designating one or more employees on each work site to call for emergency medical services, and allowing other employees to call for emergency services when no designated employee is available.
  - Reminding employees throughout the work shift to drink plenty of water.
  - Close supervision by a supervisor or designee for the first 14 days of a new hire exposed to 80°F or more.
- Responding to signs and symptoms of possible heat illness, including, but not limited to, first aid measures and how emergency medical services will be provided:
  - If a supervisor observes, or an employee reports, signs or symptoms of heat illness in any employee, the supervisor shall take immediate action commensurate with the severity of the illness.
  - If the signs or symptoms are indicators of severe heat illness (such as, but not limited to, decreased level of consciousness, staggering, vomiting, disorientation, irrational behavior or convulsions), the supervisor must implement emergency response procedures.
  - An employee exhibiting signs or symptoms of heat illness shall be monitored and shall not be left alone or sent home without being offered onsite first aid and/or being provided with emergency medical services in accordance with LAI's procedures.

- Contacting emergency medical services and, if necessary, transporting the employee exhibiting symptoms of illness to the nearest hospital.

3.3.13.2 Cold Stress

- Prolonged exposure to cold air, cold water, or wind at temperatures below freezing may lead to hypothermia. The early signs of cold stress are shivering, numbness, and pain in the extremities. The SSHO (or authorized designee) will verify that workers are properly clothed in insulated dry clothing whenever air temperatures are below 40° F. If work is to be performed continuously at temperatures below 40° F, heated warming shelters or vehicles with functioning heaters will be available. Workers will be required to use the shelters at regular intervals; frequency of use will depend on the severity of the conditions. If a worker's clothing becomes wet, the worker will put on dry clothing before returning to work. Warm, decaffeinated beverages will be provided at the work Site to provide calories and fluid volume.
- A worker with hypothermia will be moved to a warm, dry area. Cold or wet clothing will be removed and warm, dry clothing and/or blankets will be provided. For severe cold stress, workers will be examined by a licensed health-care professional as soon as possible. Employees will have to specifically know how to summon emergency medical support.

3.3.14 Material Handling

Pinch points and crush by/struck by hazards are present when personnel are required to work in close proximity to material handling equipment. The following procedures shall be implemented when handling field equipment and materials:

- LAI personnel will notify the material handling operator prior to advancing near the work area.
- Personnel shall keep their fingers out of pinch points such as between rigging material and forks on equipment or the sides of containers.
- Personnel shall not position themselves between material handling equipment and the containers or be permitted to walk or stand under a suspended load.
- Spotters shall be provided when ground personnel are working near material handling equipment.

Ground personnel shall wear reflective, high-visibility vests when working near heavy equipment.

4.0 PERSONAL PROTECTIVE EQUIPMENT AND HYGIENE

The use of PPE and personal hygiene are engineered controls to minimize the potential exposure to environmentally impacted media and reduce acute exposure.

4.1 Personal Protective Equipment

This project anticipates that Level D PPE will be appropriate for most of this project's activities. The typical equipment necessary for Level D PPE is as follows:

- Hard hat
- Safety glasses
- Steel-toed work shoes or boots
- Leather gloves when working with equipment
- Nitrile gloves for sampling activities
- Hearing protection (muffs or plugs), as needed
- Long pants and long-sleeved shirts or cloth coveralls
- High-visibility safety vests
- Personal floatation device (when working near or over waterways)
- Face mask (when working inside or unable to keep 10-ft distance outside).

If required, Level D PPE may be upgraded to Modified Level C. Modified Level C PPE includes the above-noted items plus Tyvek® coveralls and a half-face air purifying respirator fitted with organic vapor cartridges. Ambient air monitoring data will be used to evaluate the target levels for PPE upgrade. Each worker will be responsible for maintaining his or her own PPE.

4.2 General Hygiene

Workers will complete the following personal hygiene procedures before leaving the work Site.

- Toilet and hand washing facilities will be located on Site or an alternate sanitary facility and their specific location identified prior to beginning work activities.
- Potable drinking water will be available on Site for use by Site personnel.
- PPE shall be kept clean and in good repair. Safety devices, including protective clothing worn by the employee, shall not be shared among employees until properly cleaned.
- PPE shall be replaced on a frequent basis to minimize cross contamination and for worker protection.
- Equipment leaving the Site will be free of gross hazardous and non-hazardous waste (i.e., mud and/or soil).
- Minimize hand-to-mouth actions and maintain good hygiene practices.

4.3 Personnel Decontamination

Decontamination for personnel wearing Level D PPE will consist of Site personnel washing their hands, arms, face, and neck prior to eating, drinking/smoking, and at the end of the work shift. Decontamination for personnel wearing Modified Level D and Level C PPE will be as follows:

- If gross contamination is present, wash PPE in detergent or other appropriate solution and rinse in clean water.
- Remove hard hat.
- Remove disposable over-boots (if used).
- Remove outer gloves.
- Wash chemical-resistant boots with detergent solution and rinse with clean water.
- Remove Tyvek coveralls or upgrade to Modified Level C PPE. Starting at the neck, roll the coveralls off from the inside out and down past the boots. Take care to prevent the release and dispersion of dusts and/or prevent contact with decontamination water that may have accumulated on the coveralls. Do not contaminate clothing inside the coveralls during removal.
- Place disposable PPE in an appropriate container for disposal.
- If wearing a respirator, remove the respirator. Dispose of cartridges in PPE disposal container. Clean and disinfect the respirators and place into a plastic bag for storage.
- Remove liner gloves.
- Thoroughly wash hands and face with soap and water or hand sanitizer stored on Site.

Disposable protective clothing shall be removed during decontamination and shall be disposed of in a lidded container lined with a labeled drum liner. Waste generated at the Site shall be disposed of according to the hazard classification of the debris.

4.4 Equipment Decontamination

Equipment shall be decontaminated prior to demobilization from a specific area and/or the Site. Gross contamination and adhered dirt will be cleaned from large pieces of equipment with shovels and brooms. If necessary, an Alconox® soap solution and brushes will be used to remove remaining residues of contamination and adhered dirt. Equipment will be decontaminated as previously described prior to mobilization to the Site if the equipment appears to be contaminated.

Downhole drilling equipment will be decontaminated between sampling intervals and prior to mobilizing to the next boring, and prior to leaving the Site using a high-pressure, hot-water steam cleaner. Decontamination material (soil from equipment and cleaning water) will be collected to minimize runoff to the environment.

Environmental sampling equipment will be decontaminated between sampling intervals using a three-step process; tap water rinse, Alconox soap and tap water mixture wash, followed by a distilled water rinse.

Generated decontamination water will be collected and stored in Washington State Department of Transportation-approved containers for disposal upon receipt of analytical testing results.

5.0 SITE CONTROL

The SSHO will be responsible for establishing Site-specific work zones and for developing barriers between the immediate work area and the general public. People wishing to enter the designated work area will check in with the SSHO, who will review the HASP and request the visitor to sign the HASP acknowledgment page indicating they understood the risk of entering into the immediate work area.

5.1 Hazard Control

Control of potential hazards involves the entire Site crew understanding and implementing the provisions of this HASP. Employees are ultimately responsible for their own safety and the safety of those working around them. Each employee has the right to stop work if unsafe conditions are noted and report the issue to the SSHO. Employees will be required to follow safe work practices, use appropriate PPE correctly, and follow emergency procedures when required. The PM has the overall responsibility for ensuring that the means are available to supply Site personnel with the appropriate equipment, tools, material, and PPE when required. The SSHO shall be responsible for ensuring the implementation and enforcement of this HASP during project activities.

5.2 Training Requirements

LAI field personnel have received 29 CFR 1926 (OSHA's Construction Safety Orders)-required training for conducting work on environmentally impacted sites. Specific training includes the following:

- 40 hours of Hazardous Waste Operations & Emergency Response (HAZWOPER) initial training along with annual 8-hour refresher training.
- Baseline and annual occupational physical exams.
- Respiratory fitness testing and respiratory use training.
- At least one member of each field crew has received training on first aid, CPR, and the use of an automated external defibrillator.

In addition to the OSHA-required training, selected field personnel have received specialized training on various field components such as confined space training, asbestos testing certification, and underground storage tank removal training. Specialized field activities will be conducted only by trained personnel.

Hazard Communication training is required for workers assigned to this project. The SDSs for substances for which there may be a concern shall be reviewed in tailgate toolbox meetings with special attention paid to the substance hazards, signs and symptoms of exposure, and safe work practices (e.g., hazard control). Copies of the SDSs for Site COPCs are provided in Attachment C-2.

Although confined space entry is not expected, workers who might enter confined spaces will have had training specific to their assigned duties. Documentation of training can be made available for review.

If elevated construction-related work (greater than 6 ft above the work surface) is required, personnel will be trained in the fall protection system to be used such as personal fall arrest systems or personnel lift equipment.

Visitors to the project Site work areas, including regulatory agency personnel, must first receive a Site-specific briefing by the SSHO.

6.0 COMMUNICATION AND MEETINGS

6.1 General

Communication is the key to maintaining a safe work space and all personnel play a role. The hierarchy of plans and procedures must be communicated in training before arrival to the Site as well as communicated to onsite employees before an activity or task begins. The hierarchy of plans required is listed below.

- LAI Corporate Health and Safety Program: Employees arriving at the Site must be familiar with their company's health and safety policies.
- Site-Specific HASP: Employees must be familiar with the HASP covering planned project activities.
- Activity Hazard Analysis: The AHA specific to the activity/task for the project will be communicated to employees at the initiation of a particular activity (see Attachment C-1).

Additionally, hazard communication for this project must be reviewed as described below.

6.2 Hazard Communication

Site-specific hazard communication information will be posted at the identified work area at the Site to enhance employee and subcontractor safety and health. The purpose of the hazard communication program is to provide information about COPCs and manufactured hazardous substances, and establish safe work practices and procedures to control those chemicals. The program involves training on worker protection, container labeling, use of SDSs, and personnel information and training. Site-specific training will include a daily tailgate safety meeting, and task-specific training as determined by the SSHO. All SDSs for onsite hazardous substance products will be maintained on Site. Employees shall avoid exposure to hazardous substances, whenever possible. No one is to bring hazardous substances or chemicals onto the job Site without express authorization from the SSHO. All hazardous substances brought onto the Site will be accompanied by an SDS.

Designated work areas will be identified and segregated from the general public by the use of traffic cones and barrier tape. Only trained personnel who have been made aware of the hazard communication by meeting with the SSHO, reviewing the Site-specific HASP, and signing the acknowledgment card will be allowed within the designated work area.

6.3 Daily Safety Meetings

Each morning prior to the start of operations, Site personnel will receive project work activity-specific, safety briefings. Daily safety meetings will be used to complete required onsite training requirements and to review Site hazards and controls that will be implemented to manage those hazards (e.g., review of AHA information). Attendance at the daily safety meetings shall be mandatory for project Site personnel, and attendance shall be documented. A copy of LAI's Daily Tailgate/Toolbox Meeting

Sign-in Sheet will be included. At a minimum, project safety and health orientations shall include the following topics:

- Names of personnel and alternates responsible for Site safety and health
- Physical and chemical hazards anticipated during planned project activities
- Symptoms of overexposure to chemicals of concern
- Emergency response procedures and location of emergency equipment
- Prevention, symptoms, and treatment for heat/cold stress
- COVID-19 protective measures
- PPE (initial PPE levels, action levels)
- Location of emergency numbers and route to hospital
- Review of the appropriate AHA to be used for the pending day's scope of work.

7.0 EMERGENCY PROCEDURES

7.1 Emergency Equipment

Emergency equipment will be stored at appropriate onsite locations selected during Site mobilization. Emergency response equipment shall be stored in the direct vicinity of the designated work area. The following is a list of emergency equipment that will be on Site:

- Fire extinguisher (A/B/C type): located in all LAI field vehicles
- First aid kit
- Portable eye wash station (or bottle wash station with proper solution)
- Drinking water
- Absorbent pads
- Miscellaneous hand tools
- Communications equipment (cell phone, radio, or walkie-talkie)
- SDSs for chemicals stored on Site for the field activities described in this HASP.

7.2 Local Emergency Information

Emergency telephone numbers are provided at the beginning of this HASP. The emergency telephone numbers should be posted by Site telephones and in a common area within the direct vicinity of the designated work area for easy reference in the event of an emergency.

Personnel with any injury (including minor injuries) that need medical attention will be transported to the nearest hospital.

7.3 Emergency Response Procedures

The SSHO has the responsibility and authority for coordinating emergency response activities until proper authorities arrive and assume control. In addition, the SSHO has the responsibility of alerting emergency services personnel (see emergency telephone numbers listed above) of the need and/or arrival of emergency medical transport and ensuring that such transport has full access to injured personnel.

When calling for assistance in an emergency situation, the following information should be provided:

- Name of caller
- Caller's location
- Name(s) of person(s) exposed or injured
- Nature of emergency
- Actions taken

The recipient of the call should hang-up first – **not** the caller.

7.4 Fire and Explosion

In the event of a fire, the Port PM will be notified immediately. If the area is not safe, evacuate the area immediately. If it is safe to do so, trained Site personnel may:

- Use fire-fighting equipment available on Site to control or extinguish the fire
- Remove or isolate flammable or other hazardous materials that may contribute to the fire.

In the event of an explosion, all personnel will be evacuated, and the local fire department will be notified immediately. No one will re-enter the area until it has been cleared by the fire department or other safety personnel.

7.5 Reporting of Accidents and Injuries

All incidents (injury, illness, accidents) must be reported to the PM and the Corporate Health and Safety Manager immediately.

The LAI PM will be immediately notified in writing in the event of a serious incident, including those requiring a physician's treatment. The Port PM shall be notified immediately of any incident requiring notification of the LAI PM. An incident report will be filed with Corporate Health and Safety Manager, which will be evaluated within 48 hours of the incident. The incident report will include the details of the incident, resulting injury to personnel or environment, and root cause of the incident. The LAI PM will be responsible for following up on recommendations from the investigation. Necessary corrective actions will be taken to prevent recurrence of similar incidents. The Incident Report will be completed as soon as possible (within 8 hours) and forwarded to ckimmel@landauinc.com.

Near-misses and accidents, without regard to their severity, will be reported in writing to the LAI PM within 24 hours. The SSHO will complete this documentation. The near-misses will be reported via email. The Port will also be notified.

The following types of incidents are considered reportable:

- Physical injury (a log of first aid administered on Site will be kept)
- Fire, explosions, or flashes
- Serious infractions of safety rules and requirements
- Unexpected chemical exposures
- Near-misses
- Vehicular accidents
- Property damage
- Injuries to the public

- Damage to private property
- Animal bites or stings.

Work will be suspended to correct the cause of the incident and to modify this HASP, if necessary.

8.0 REFERENCES

ACGIH. 2020. 2020 TLVs and BEIs Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices American Conference of Governmental Industrial Hygienists.

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LAI. 2016. Corporate Health and Safety Plan. Landau Associates, Inc. August 3.

NIOSH. 2007. NIOSH Pocket Guide to Chemical Hazards. Publication No. 2005-149. National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, US Department of Health and Human Services. September. https://www.cdc.gov/niosh/npg/.

NIOSH, OSHA, USCG, and EPA. 1985. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. Publication No. 115. National Institute for Occupational Safety and Health, Occupational Safety and Health Administration, US Coast Guard, and US Environmental Protection Agency. October. https://www.osha.gov/Publications/complinks/OSHG-HazWaste/all-in-one.pdf.

OSHA. Occupational Safety and Health Standards. 29 CFR Part 1910. Occupational Safety and Health Administration, US Department of Labor. https://www.osha.gov/laws-regs/regulations/standardnumber/1910.

OSHA. Safety and Health Regulations for Construction. 29 CFR 1926. Occupational Safety and Health Administration, US Department of Labor. https://www.osha.gov/laws-regs/regulations/standardnumber/1926.

USACE. 2014. Safety and Health Requirements Manual. Publication No. 385-1-1. US Army Corps of Engineers. November 30. https://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_385-1-1.pdf.

Washington State Legislature. 2018. Chapter 296-843 WAC: Hazardous Waste Operations. Washington Administrative Code. November 6. https://apps.leg.wa.gov/wac/default.aspx?cite=296-843.

ATTACHMENT C-1

Activity Hazard Analysis Forms

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

Activity/Work Task: **General Work Activities**	Overall Risk Assessment Code (RAC) (Use highest code)	**M**
Project Location: Central Waterfront, Bellingham, WA		
Contract Number:		
Date Prepared: April, 2020		
Prepared by (Name, Title): Kate Cleveland, Task Manager		
Reviewed by (Name, Title): Chris Kimmel, Corporate H&S Officer		

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	**E**	**E**	**H**	**H**	**M**
Critical	**E**	**H**	**H**	**M**	**L**
Marginal	**H**	**M**	**M**	**L**	**L**
Negligible	**M**	**L**	**L**	**L**	**L**

Notes: (Field Notes, Review Comments, etc.)

This AHA is generic to site mobilization and demobilization activities surrounding construction related operations.

Recommended controls specified by EM385-1-1 Sections 2, 3, 5, 8, 13, and 14.

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk

H = High Risk

M = Moderate Risk

L = Low Risk

Job Steps	Hazards	Controls	RAC
See Below	Generally physical hazards in nature.	Engineering, Work Practices / Administrative, PPE	See Below

Equipment to be Used	Competent or Qualified Personnel name(s)	Inspection Requirements
Company vehicles and equipment	Lead Field Technician	Inspect new equipment brought on site. Daily safety meeting of activities and more comprehensive evaluation by site safety and health officer when and where necessary.

TRAINING REQUIREMENTS	PROHIBITED ITEMS
HASP / AHA review and orientation, Daily tailgate meeting Emergency Actions and Fire Prevention First Aid / CPR (at least 1 employee's current on site.)	Certain items are prohibited at all times when working in or around Site: Personal devices such as radios, music players, headphones. Firearms, weapons, drugs. Jewelry, any other personal items or tool not directly involved or required for the task outlined. Cell phone use must take place in safe and supported areas. Cell phone use in areas of potential hazard (e.g. mobile equipment, contamination) is prohibited.

The AHA shall be reviewed and modified as necessary to address changing site conditions, operations, or change of competent/qualified person's

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

ACTIVITY: General Work Activities **ANALYZED BY: Kate Cleveland** **DATE: April, 2020**

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
Review AHA with employees	Training	Review this AHA with all applicable employees. Review any manufacture's supplied information for equipment intended for use.	L
General Work Activities	COVID-19 Virus Protection	Conduct daily health screen for symptoms (fever greater than 100.4ºF, fatigue, and cough. Wear a face mask at all times and maintain 6 foot social separation, when appropriate. Stay home if personnel is exposed to person testing positive for virus or if symptomatic-contact doctor for follow-up activities. Notify SSHO immediately if changes in personnel health.	M
General Work Activities	Strains and Sprains	Site personnel will be instructed on proper lifting techniques (keep back straight, lift with legs, limit twisting, etc.). Mechanical devices should be used to reduce manual handling of materials whenever possible. Team lifting should be utilized if mechanical devices are not available. Utilize two-man lift for loads greater than 50 pounds.	L
General Work Activities	Crushing, struck by, and pinch points.	Ensure that the equipment manufacturers' instructions and recommendations are followed consistently. All equipment will be initially inspected to certify safe to use onsite and before each days use. Unsafe equipment will be taken out of service and will not be used until repaired. Only operators trained, experienced and certified with the specific equipment will operate that equipment. Equipment is to have and maintain manufacturer's guards. Ensure work area is assessed for overhead and underground utilities and obstacles prior to the start of operations. Equipment will not be approached on blind sides and eye contact with operators will be made before approaching	M

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
		equipment. Operators need to acknowledge your presence before you approach. - Define equipment swing areas with high visibility markings or barriers. - Establish and know hand signals between ground spotters and operators. - All equipment will be equipped with backup alarms. - A spotter will be used for backing up equipment in congested areas. - Inspect area for stability prior to off-loading equipment. Designate one person to provide signals when offloading equipment. - Personnel shall stay a sufficient distance away in case equipment rolls to the side.	
General Work Activities	Expose to temperature extremes	- Review site-specific HASP and follow requirements for physiological monitoring. - Acclimatize to work in hot weather by working in heat and taking more frequent breaks, systematically building up tolerance to heat. - Conduct field activities in the early morning if possible to avoid heat or inclement weather. - Site personnel will be trained about signs and symptoms of heat stress and cold stress. - Adequate shade, water, and breaks will be taken. - Wear adequate clothing for the weather. - Workers shall be allowed to take a work-free cool down rest/recovery period in the shade for a minimum of five minutes at any time when they feel the need to do so to protect themselves from overheating, or at the first sign of heat illness-related symptoms.	M

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
	Slips, trips and falls	□ Maintain appropriate housekeeping. □ Identify immovable trip hazards with high visible warnings. □ Visually inspect work areas and mark (e.g. high viz paint), barricade, or eliminate slip, trip and fall hazards if feasible. Maintain work areas safe and orderly. □ Unloading areas should be on even terrain. □ Watch and prepare for uneven terrain, stumps, and vegetation in walk areas. □ Tools and supplies/equipment will be properly stored. □ Step slowly and tentatively in tall grass where the ground can't be seen to avoid depressions or other obstacles that could cause ankle/knees sprains. □ Be on the lookout for biological hazards; including poisonous plants, snakes. Do not begin field work unless you have the means to implement the controls in the safety plan for biological hazards. □ Do not use mobile device or perform other activities while walking to ensure you can keep focused on shifts in terrain, biological hazards, or other slip/trip/fall hazards.	M
General Work Activities	Struck by Vehicular Traffic	□ Establish and abide by safe travel and parking planning. □ Spotters will be used as necessary when backing up. □ Heavy equipment will be equipped with back up alarms. □ Traffic cones and orange traffic vests will be used when working in areas of traffic, construction vehicles and near roadways. □ Employees will need to pay attention to operations around and adjacent to their work and continually evaluate the need for Traffic Safety measures. □ Pedestrian traffic will be eliminated through the work zone using a combination of barricades, signage, and human spotters.	L

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
	Struck by Dropped Objects	☐ Composite or steel toe boots will be worn in all construction areas.	L
	Noise Injury	☐ Hearing protection will be worn during any other operations that are deemed appropriate (greater than 85 dBA).	L
	Punctures/Cuts from Sharp Objects	☐ Leather (minimum) or cut resistant gloves will be worn depending on the material working with. ☐ All hand and power tools will be maintained in a safe condition. ☐ When possible and appropriate, blunt all sharp objects. ☐ ALL impalement hazards will be removed or capped / covered to prevent puncture.	L
General Work Activities	Damage/burns from Fire	☐ Only use approved fuel cans with a pouring spout or funnel. ☐ Smoking and open flames are not permitted in fueling areas. ☐ A minimum 10 lb. BC type fire extinguisher will be located adjacent to work areas and refueling points and immediately available.	L
	Spills	☐ Spill and absorbent materials will be readily available. ☐ Contain, control and clean up the spill and affected area. ☐ Manage and dispose of spill material appropriately per local standards.	L
	Struck by/Damage from Hand and Power Tools	☐ The proper tools will be used for each task. ☐ All tools will be inspected before each use. ☐ Damaged tools will be removed from service and tagged.	M
	Exposure to Chemicals brought on site	☐ Identify all chemical hazards and receive training regarding safe handling and storage of chemicals. ☐ Wear PPE in accordance with Manufacturers recommendations. ☐ Have all applicable SDSs available for immediate reference.	L

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
	Adverse Weather: Struck by Lightning	□ Follow the 30-second rule (time between lightning strike and thunder) for shutdown of operations. □ Seek shelter in building (preferred) or vehicle. □ Immediately suspend operations when lightning is in the immediate vicinity and seek shelter.	L
	Adverse Weather: Struck by materials from High Wind	□ Ensure that all debris/materials are secured. □ Revaluate operations when wind speed is greater than 30 MPH sustained.	L
General Work Activities	Rattlesnakes, bees/ wasps, ticks	□ Exercise vigilance when working in vegetated areas, even urban ones. Being poisoned by a venomous snake is a medical emergency. It requires immediate attention in a medical facility. First-aid measures include immobilizing the entire affected limb with splints and placing a firm (but not tight) bandage around the whole limb. This will limit the toxin's spread through the body as well as the amount of local tissue damage. □ Incisions and suction, tourniquets and compression are all harmful to the patient. Antivenin treatment should be administered only in a medical facility. □ Precautions: Wear closed shoes and long trousers in terrain where venomous snakes, scorpions or spiders may be present. □ Inspect areas prior to reaching into them to inspect for biological hazards such as rattlesnakes. Always wear gloves when opening wells, handling materials that have been stored outside. □ Examine clothing and shoes before you put them on, checking for hidden animals/insects. □ Use wasp/bee spray if necessary in accordance with manufacturer's labeling and direction for use. When using spray, wear leather gloves and safety glasses.	L

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
		▯ "Recon" locations when possible to plan where wasp spray may be needed to be used so that wasps can be sprayed when least active—i.e., early mornings, evenings to reduce being exposed to a "swarm". Wasps have been observed on gates and equipment that haven't been operated. If bees or other stinging insects are known to be present, determine whether additional protective clothing should be donned before entering/working in those areas. ▯ Persons susceptible to anaphylactic shock resulting from allergic reactions should carry an epinephrine pen with them at all times and shall notify coworkers and SSHO of the location of the epi-pen.	
General Work Activities	Feral Animals	▯ Avoid all contact with dogs, cats and other animals. ▯ If bitten or scratched by an animal: ▯ Immediately cleanse the wound with soap and water and a povidone-iodine solution if available. ▯ Let the wound bleed freely. ▯ Seek medical advice, and notify local health authorities immediately to assess the need for rabies post-exposure vaccination, even if you have had pre-exposure vaccination.	M
	Rodents	▯ Be on the lookout for signs of rodents when performing work. Rodent signs include: droppings, live/dead rodents, rodent odors, urine stains, tracks, gnawing damage, burrows, runways (commonly travelled paths) and rodent sounds. ▯ Rodents are a health concern due to their potential role in transmission of diseases.	M

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
	Falls from Ladders	□ Inspect prior to use to ensure good integrity and weight limits are not exceeded. □ Set ladder on sturdy even ground. □ Ensure ladder is no more than 1/4 of the height of the ladder from the support (building) edge. □ Ensure work area is protected from accidental contact with ladder from vehicles or equipment. □ If going from one level to another ladder must extend at least three feet over top edge of support. □ If working on ladder top must be tied off or supported by appropriate means. □ Always face ladder while working. □ Tools and materials should be raised and lowered not carried up ladder. □ Do not use metal ladders for electrical work.	L

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

EQUIPMENT TO BE USED/ TRAINING REQUIRED:

EQUIPMENT	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
General operations	Daily by the competent person and SSHO. Inspection procedures as recommended by manufacturer of tools and equipment used on-site.	☐ Elements of the HASP ☐ Elements of this AHA ☐ All site crew must have completed 40-hour HAZWOPER training and annual 8-hour refresher, HAZWOPER medical clearance ☐ At least one crewmember must have current first-aid/CPR training ☐ Perform hazard communication training when chemicals are used including fuels, oils, adhesives ☐ Training on signs and symptoms of heat stress ☐ Respiratory training
Company vehicles and equipment	Following manufacturer's instructions.	
PPE and related equipment (e.g. portable fire extinguisher, first aid supplies, emergency eye wash, spill control materials).	Initial and at least weekly	On site by the SSHO

Note:

AHA = Activity Hazard Analysis

PPE = Personal protective equipment

ACTIVITY HAZARD ANALYSIS # 1: General Work Activities

ACTIVITY HAZARD ANALYSIS ACKNOWLEDGMENT – General Work Activities

I have been trained and informed on the hazards and safe work practices associated with this Activity Hazard Analysis to include training and protective equipment requirements. I have also been given the opportunity to ask questions and receive informed answers.

NAME	DATE	COMPANY	SIGNATURE

Note: It is critically important to recognize that "NOT" all hazards can be recognized and addressed in the documented Activity Hazard Analysis, as site conditions may be different than anticipated. The on-site team member(s) are responsible to survey the area to recognize site hazards, report identified and potential hazards to the Health and Safety Manager, evaluate those hazards, and document those hazards and controls on the field copy of the AHA.

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

Activity/Work Task: **Heavy Equipment**	AHA # 2	Overall Risk Assessment Code (RAC) (Use highest code)	M
Project Location: Central Waterfront, Bellingham, WA			
Contract Number:			
Date Prepared: April, 2020	Latest Revision: NA		
Prepared by (Name, Title): Kate Cleveland, Task Manager Reviewed by (Name, Title): Chris Kimmel, Corporate H&S Officer			

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Notes: (Field Notes, Review Comments, etc.)
AHA is developed for those employees doing any work with heavy equipment.
Recommended controls specified by EM 385-1-1 Sections 5 & 13.

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
See Below	Generally physical hazards in nature. Additional safety requirements in SSHP.	Engineering, Work Practices / Administrative, PPE	See Below

Equipment to be Used	Competent or Qualified Personnel name(s)	Inspection Requirements
Excavator Drill Rig	[Subcontractor work only]	Inspect new equipment brought on site. Daily safety meeting of activities and more comprehensive evaluation by site safety and health officer when and where necessary.

TRAINING REQUIREMENTS	PROHIBITED ITEMS
HASP / AHA review and orientation, Daily tailgate meeting HAZWOPER Training Manufacturers safety instructions All operators trained and qualified as appropriate. Emergency Actions and Fire Prevention First Aid / CPR (at least 1 employee's current on site.)	Certain items are prohibited at all times when working in or around Site: Personal devices such as radios, music players, headphones. Firearms, weapons, drugs. Jewelry, any other personal items or tool not directly involved or required for the task outlined. Cell phone use must take place in safe and support areas. Cell phone use in areas of potential hazard (e.g. mobile equipment, air contamination) is prohibited.

The AHA shall be reviewed and modified as necessary to address changing site conditions, operations, or change of competent/qualified person's

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

ACTIVITY: Heavy Equipment **ANALYZED BY: Kate Cleveland** **DATE: April, 2020**

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
Review AHA with employees	Training	□ Review this AHA with all affected employees. □ Review any manufacturer's supplied information	L
General Work Activities	Being struck by vehicles	□ Park in designated and safe areas or park vehicle in such a manner as to serve as a barrier for worker protection when working near task. □ Wear appropriate PPE (e.g. hard hat, high-visibility vest). □ Always face traffic making eye and verbal contact with equipment and vehicle operators. □ Place signs, barricades/cones, and vehicles in such a way to protect field personnel.	L
	COVID-19 Virus Protection	□ Conduct daily health screen for symptoms (fever greater than 100.4ºF, fatigue, and cough. □ Wear a face mask at all times and maintain 6 foot social separation, when appropriate. □ Stay home if personnel is exposed to person testing positive for virus or if symptomatic-contact doctor for follow-up activities. □ Notify SSHO immediately if changes in personnel health.	M
	Cuts and scrapes from handling and moving materials	□ Ensure materials/equipment to be handled are free of sharp edges and points. □ Wear leather gloves and long-sleeved shirts.	M
	Slips and trips from uneven or obstructed walking surfaces in the work area	□ Clear work area and walkways of debris. □ Cover holes, pits, or other openings in walking surface. □ Wear high-traction, safety-toe boots.	M
	Back strain from lifting and moving materials in the work area	□ Use mechanical lifting devices when possible. □ Do not lift more than 50 lbs. per individual. Have others help lift excessively heavy loads. □ When lifting, maintain ergonomic posture, with head up, knees bent.	L

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
Heavy Equipment Operations	Various slips, trips, falls, strain, sprains, struck by, stuck against	□ Supervisors and operators will ensure that the equipment manufacturers' instructions and recommendations are followed consistently. □ All equipment will be initially inspected to certify safe to use onsite and before each day's use. Unsafe equipment will be taken out of service, tagged and not be used until repaired. □ Only operators trained, experienced and certified (when feasible) with the specific equipment will operate that equipment. □ Do not operate equipment on grades, which exceed manufacturer's recommendations. □ Equipment is to have and maintain manufacturer's guards. □ Plan travel route when moving equipment from one site to the next to avoid low over-hangs and power lines. □ Ensure work area is assessed for overhead and underground utilities and obstacles prior to the start of operations. □ Equipment will not be approached on blind sides and eye contact with operators will be made before approaching equipment. □ Define equipment swing areas with high visibility markings or barriers. □ Establish and know hand signals between ground spotters and operators. □ All equipment will be equipped with backup alarms. □ The use of headphones, cell phones and texting devices for entertainment purposes is prohibited when any exposure to or operation of heavy equipment. □ Equipment parked on an incline shall have the wheels chocked or track mechanisms blocked and the parking brake set.	L
Heavy Equipment Operations	Various slips, trips, falls, strain, sprains, struck by, stuck against		L

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
		Equipment will be shut down before and during fueling operations. A spotter will be used for backing up equipment in congested areas. Stay away from foundation holes, backfill holes at the end of each day. Slope all excavated area to prevent collapse of excavated pits while taking out foundations.	
Heavy Equipment Operations	Emergency	Radios or cellular phones will be used for communication. Dial 911 in case of emergency	L
Drill Rig Inspection	Faulty or damaged equipment being utilized to perform work	All machinery or mechanized equipment will be inspected by a competent mechanic and be certified to be in safe operating condition. Equipment will be inspected before being put to use and at the beginning of each shift. Faulty/unsafe equipment will be tagged and if possible locked out. Earth drilling equipment will be equipped with two	L

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
		easily-accessible emergency shutdown devices, one for the operator and one for the assistant.	
Drill Rig Staging	Uneven terrain, poor ground support, inadequate clearances, contact with utilities	□ Earth drilling equipment will not be transported with the mast up with the following exceptions: □ Movement over level, smooth terrain □ The path of travel has been inspected for stability and the absence of holes, other ground hazards, and electrical hazards □ The travel distance is limited to a short, safe distance □ The equipment operator will ascertain proper clearance prior to moving equipment. □ Clearance will be monitored by a spotter or by the use of an electrical proximity warning device. □ Machinery and mechanized equipment will be operated only by designated personnel. □ Above and below ground utilities will be located prior to staging equipment. □ Inspect brakes and tire pressure on drill rig.	M
Drill Rig Operation	Inexperienced operator	□ Machinery and mechanized equipment will be operated only by designated personnel. □ The operator will verbally alert employees and visually ensure employees are clear from dangerous parts of equipment prior to starting or engaging equipment.	M
	Falling objects	□ Hard hats are required to be worn when there is a possibility of falling objects. □ Remove unsecured tools and materials before raising and lowering the derrick. □ Stay alert and clear of materials suspended overhead.	M
	Pinch points	□ Keep feet and hands clear of moving/suspended materials and equipment. □ Inspect for pinch points.	M

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
		□ Stay alert at all times.	
	Jack/Outriggers	□ Outriggers will be extended per the manufacturer's specifications. □ Ensure proper footing and cribbing.	M
	Hoists	□ Hoists will be used only for their designated intent and will not be loaded beyond their rates capacity. □ Steps will be taken to prevent two-blocking hoists. □ The equipment manufacturer's procedures will be followed if rope becomes caught in, or objects pulled into the cathead. □ Drill rods will be neither run nor rotated through rod slipping devices. □ No more than 1-foot of drilling rod column will be hoisted above the top of the drill mast. □ Drill road tool joints will not be made up, tightened, or loosened while the rod column is supported by a rod slipping device.	M
	Whip lines and cables	□ Stand clear when under tension	M
Drill Rig Operation	Fire	□ Keep areas adjacent to derricks reasonably free from accumulation of oil, fuel, or other materials (good house-keeping). □ Have fire extinguishers inspected and readily available.	M
	Noise	□ Hearing protection is mandatory above 85 dbA.	L
	Contact with rotating or reciprocating machine parts	□ Machine guards will not be tampered with or removed. □ Long-handled shovels will be used to remove auger cuttings. □ Safe lockout procedures for maintenance work will be used.	M

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
	Slip, trip, and fall hazards	□ Maintain good house-keeping and keep work area picked up and clean, as feasible. □ Continually inspect work areas for slip, trip, and fall hazards. □ Assure no holes in walkways exist that are greater than 12-inches by 12-inches.	M
	Contact with potentially contaminated materials	□ Real-time air monitoring will take place. If necessary, proper PPE will be utilized.	M
	Auger binding or breaking	□ Auger guides will be used on hard surfaces.	M
	Special conditions	□ Climbing booms or any hazardous operations out of the normal use of drilling will not be conducted.	M
	Contact with utility lines and buried drums	□ Conduct a utility locate prior to drilling activities. □ Observe surroundings for overhead utilities and obstacles, and buried utility indicators (asphalt patches along trench lines, etc.). □ Use a metal detector or similar to check for buried drum and tanks.	M
	Inclement weather, lightning	□ Weather conditions will be monitored. Operations will cease during electrical storms or when electrical storms are imminent.	M
Drill Rig Operation	Fall hazards	□ Us safety full-body harness, shock absorbing lanyard and double locking hooks, and lifeline when working above 6-feet. □ Open boreholes will be capped and flagged. □ Open excavations will be barricaded.	M
Well Construction and Abandonment	Bentonite dust	□ Level C PPE (respiratory protection) is required.	M
	Heavy lifting	□ Use proper lifting techniques. Use mechanical means or the buddy system if weight is greater than 50 lbs.	M
	Work on elevated surfaces	□ Utilize appropriate fall protection.	M

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
	Contact with potential contaminated materials	□ Use appropriate PPE.	M
	Flammable or hazardous atmosphere	□ Monitor atmosphere with LEL/O2 device.	M

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

EQUIPMENT TO BE USED/ TRAINING REQUIRED:

EQUIPMENT	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
General operations	Daily by the competent person and Site Safety Coordinator.	Elements of this AHA Elements of the HASP
Excavator Drill Rig	Operators must inspect their equipment daily per manufacturer's instructions.	Elements of this AHA Elements of the HASP
PPE and related equipment (e.g. portable fire extinguisher, first aid supplies, emergency eye wash, spill control materials).	Initial and at least weekly.	On site by the SSHO.

Note:

AHA = Activity Hazard Analysis

PPE = Personal protective equipment

ACTIVITY HAZARD ANALYSIS # 2: Heavy Equipment

ACTIVITY HAZARD ANALYSIS ACKNOWLEDGMENT – General Mobilization / Demobilization Construction

I have been trained and informed on the hazards and safe work practices associated with this Activity Hazard Analysis to include training and protective equipment requirements. I have also been given the opportunity to ask questions and receive informed answers.

NAME	DATE	COMPANY	SIGNATURE

Note: It is critically important to recognize that "NOT" all hazards can be recognized and addressed in the documented Activity Hazard Analysis, as site conditions may be different than anticipated. The on-site team member(s) are responsible to survey the area to recognize site hazards, report identified and potential hazards to the Health and Safety Manager, evaluate those hazards, and document those hazards and controls on the field copy of the AHA.

ACTIVITY HAZARD ANALYSIS # 3: Sampling

Activity/Work Task: **Sampling**	AHA # 3	Overall Risk Assessment Code (RAC) (Use highest code)	L
Project Location: Central Waterfront, Bellingham, WA			
Contract Number:			
Date Prepared: April, 2020	Latest Revision: NA		
Prepared by (Name, Title): Kate Cleveland, Task Manager Reviewed by (Name, Title): Chris Kimmel, Corporate H&S Officer			
Recommended controls specified by EM 385-1-1.			

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	**E**	**E**	**H**	**H**	**M**
Critical	**E**	**H**	**H**	**M**	**L**
Marginal	**H**	**M**	**M**	**L**	**L**
Negligible	**M**	**L**	**L**	**L**	**L**

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk

H = High Risk

M = Moderate Risk

L = Low Risk

Job Steps	Hazards	Controls	RAC
See Below	Generally physical hazards in nature. Additional safety requirements in SSHP.	Engineering, Work Practices / Administrative, PPE	See Below

Equipment to be Used	Competent or Qualified Personnel name(s)	Inspection Requirements
Drill Rig Excavator	TBD, Lead Field Technician	New equipment brought on site. Daily of activities and more comprehensive by site safety and health officers.

TRAINING REQUIREMENTS	PROHIBITED ITEMS
HASP / AHA review and orientation, Daily tailgate and toolbox HAZWOPER Training Respirator Training Emergency Actions and Fire Prevention First Aid / CPR (at least 1 employee's current on site.)	Certain items are prohibited at all times when working in or around Site: Personal devices such as radios, music players, headphones. Firearms, weapons, drugs. Jewelry, any other personal items or tool not directly involved or required for the task outlined. Cell phone use must take place in safe and support areas. Cell phone use in areas of potential hazard (e.g. mobile equipment, air contamination) is prohibited.

The AHA shall be reviewed and modified as necessary to address changing site conditions, operations, or change of competent/qualified person's

ACTIVITY HAZARD ANALYSIS # 3: Sampling

ACTIVITY: Sampling **ANALYZED BY: Kate Cleveland** **DATE: April, 2016**

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
Review AHA with employees	Training	☐ Review this AHA with all affected employees.	L
General Site Activities	Being struck by vehicles	☐ Park in designated and safe areas or park vehicle in such a manner as to serve as a barrier for worker protection when working near task. ☐ Wear appropriate PPE (e.g. hard hat, high-visibility vest). ☐ Always face traffic making eye and verbal contact with equipment and vehicle operators. ☐ Place signs, barricades/cones, vehicles in such a way to protect field personnel. ☐ Evaluate the effectiveness of the work-zone.	L
	Cuts and scrapes from handling and moving materials	☐ Ensure materials/equipment to be handled are free of sharp edges and points. ☐ Wear leather gloves and long-sleeved shirts (e. g. gutters).	L
	COVID-19 Virus Protection	☐ Conduct daily health screen for symptoms (fever greater than 100.4ºF, fatigue, and cough. ☐ Wear a face mask at all times and maintain 6 foot social separation, when appropriate. ☐ Stay home if personnel is exposed to person testing positive for virus or if symptomatic-contact doctor for follow-up activities. ☐ Notify SSHO immediately if changes in personnel health.	M
	Slips and trips from uneven or obstructed walking surfaces in the work area	☐ Clear work area and walkways of debris. ☐ Cover holes, pits, or other openings in walking surface. ☐ Wear high-traction, safety-toed boots. ☐ Adapt “Clean as you Go” work practices. ☐ Be aware of surroundings (e.g., footing, equipment, personnel, tools, etc.). Inspect work area, remove slip, trip, fall hazards where possible or mark them so they can be avoided. ☐ Avoid areas of unstable ground; do not walk on stockpile.	L

ACTIVITY HAZARD ANALYSIS # 3: Sampling

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
		□ Use good housekeeping techniques to keep the workplace free of slip, trip, and fall hazards. □ Store tools and any materials out of walkways and travel path of equipment. □ Do not use mobile device or perform other activities while walking to ensure you can keep focused on shifts in terrain, biological hazards, or other slip/trip/fall hazards.	
	Back strain from lifting and moving materials in the work area	□ Use mechanical lifting devices when possible. □ Do not lift more than 50 lbs. per individual. Have others help lift excessively heavy loads. □ When lifting, maintain ergonomic posture, with head up, knees bent.	L
Collecting Subsurface Soil Samples and Groundwater Samples	Contact with contaminated material/personal injury	□ Use proper PPE. □ Ensure no other work is performed in immediate area. □ Verify with operator that excavator bucket is resting on ground and their hands are off the controls. □ Use proper bending techniques to scoop soil.	L
	Contact with sample preservation substances and agents	□ Review SDS for any chemical substances that pose potential exposure. □ Follow safe work practices and wear the assigned PPE □ Know exactly where emergency equipment is located (e.g. eye-wash station w/in easy access).	L
	Emergency	□ Radios or cellular phones will be used for communications. □ Dial 911 in case of emergency.	L
Sample packaging and Shipment	Contact with contaminated material/personal injury	□ Proper labeling, packaging, and handling. □ Proper lifting techniques or team lifting when moving heavy coolers filled with soil samples.	L

ACTIVITY HAZARD ANALYSIS # 3: Sampling

EQUIPMENT TO BE USED/ TRAINING REQUIRED:

EQUIPMENT	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
General operations	Daily by the competent person and Site Safety Coordinator.	Elements of this AHA Elements of the HASP
Drill Rig and excavator, laboratory containers/preservatives	Operators must inspect their equipment daily per manufacturer's instructions.	Elements of this AHA Elements of the HASP
PPE and related equipment (e.g. portable fire extinguisher, first aid supplies, emergency eye wash, spill control materials).	PPE daily and before use by the wearer. Other safety equipment daily and otherwise appropriate as determined by the SSHO.	On site by the SSHO

Additional Notes / Comments:

ACTIVITY HAZARD ANALYSIS # 3: Sampling

ACTIVITY HAZARD ANALYSIS ACKNOWLEDGMENT – Sampling

I have been trained and informed on the hazards and safe work practices associated with this Activity Hazard Analysis to include training and protective equipment requirements. I have also been given the opportunity to ask questions and receive informed answers.

NAME	DATE	COMPANY	SIGNATURE

Note: It is critically important to recognize that "NOT" all hazards can be recognized and addressed in the documented Activity Hazard Analysis, as site conditions may be different than anticipated. The on-site team member(s) are responsible to survey the area to recognize site hazards, report identified and potential hazards to the Health and Safety Manager, evaluate those hazards, and document those hazards and controls on the field copy of the AHA.

ACTIVITY HAZARD ANALYSIS # 4: Landfill Gas Monitoring and Sampling

Activity/Work Task: **LFG Monitoring and Sampling**	AHA # 4	Overall Risk Assessment Code (RAC) (Use highest code)	L

Project Location: Central Waterfront, Bellingham, WA

Contract Number:

Date Prepared: April, 2020 | Latest Revision: NA

Prepared by (Name, Title): Kate Cleveland, Task Manager
Reviewed by (Name, Title): Chris Kimmel, Corporate H&S Officer

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Recommended controls specified by EM 385-1-1.

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	Hazards	Controls	RAC
See Below	Generally physical hazards in nature. Additional safety requirements in SSHP.	Engineering, Work Practices / Administrative, PPE	See Below

Equipment to be Used	Competent or Qualified Personnel name(s)	Inspection Requirements
Drill Rig	TBD, Lead Field Technician	New equipment brought on site. Daily of activities and more comprehensive by site safety and health officers.

TRAINING REQUIREMENTS	PROHIBITED ITEMS
HASP / AHA review and orientation, Daily tailgate and toolbox HAZWOPER Training Respiratory Training Emergency Actions and Fire Prevention First Aid / CPR (at least 1 employee's current on site.)	Certain items are prohibited at all times when working in or around Site: Personal devices such as radios, music players, headphones. Firearms, weapons, drugs. Jewelry, any other personal items or tool not directly involved or required for the task outlined. Cell phone use must take place in safe and support areas. Cell phone use in areas of potential hazard (e.g. mobile equipment, air contamination) is prohibited.

The AHA shall be reviewed and modified as necessary to address changing site conditions, operations, or change of competent/qualified person's

ACTIVITY HAZARD ANALYSIS # 4: Landfill Gas Monitoring and Sampling

ACTIVITY: LFG Monitoring & Sampling **ANALYZED BY: Kate Cleveland** **DATE: April, 2016**

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
Review AHA with employees	Training	☐ Review this AHA with all affected employees.	L
General Site Activities	Being struck by vehicles	☐ Park in designated and safe areas or park vehicle in such a manner as to serve as a barrier for worker protection when working near task. ☐ Wear appropriate PPE (e.g. hard hat, high-visibility vest). ☐ Always face traffic making eye and verbal contact with equipment and vehicle operators. ☐ Place signs, barricades/cones, vehicles in such a way to protect field personnel. ☐ Evaluate the effectiveness of the work-zone.	L
	COVID-19 Virus Protection	☐ Conduct daily health screen for symptoms (fever greater than 100.4^{o}F, fatigue, and cough. ☐ Wear a face mask at all times and maintain 6 foot social separation, when appropriate. ☐ Stay home if personnel is exposed to person testing positive for virus or if symptomatic-contact doctor for follow-up activities. ☐ Notify SSHO immediately if changes in personnel health.	M
	Cuts and scrapes from handling and moving materials	☐ Ensure materials/equipment to be handled are free of sharp edges and points. ☐ Wear leather gloves and long-sleeved shirts (e. g. gutters).	L
	Slips and trips from uneven or obstructed walking surfaces in the work area	☐ Clear work area and walkways of debris. ☐ Cover holes, pits, or other openings in walking surface. ☐ Wear high-traction, safety-toed boots. ☐ Adapt “Clean as you Go” work practices. ☐ Be aware of surroundings (e.g., footing, equipment, personnel, tools, etc.). Inspect work area, remove slip, trip,	L

ACTIVITY HAZARD ANALYSIS # 4: Landfill Gas Monitoring and Sampling

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
		fall hazards where possible or mark them so they can be avoided. Avoid areas of unstable ground; do not walk on stockpile. Use good housekeeping techniques to keep the workplace free of slip, trip, and fall hazards. Store tools and any materials out of walkways and travel path of equipment. Do not use mobile device or perform other activities while walking to ensure you can keep focused on shifts in terrain, biological hazards, or other slip/trip/fall hazards.	
	Back strain from lifting and moving materials in the work area	Use mechanical lifting devices when possible. Do not lift more than 50 lbs. per individual. Have others help lift excessively heavy loads. When lifting, maintain ergonomic posture, with head up, knees bent.	L
Purging and Sampling	Inhalation exposure to VOCs and other gases	Stay upward when opening protective casing and vaults. Test the atmosphere before purging and sampling to make sure vapors are not at unsafe levels. Use proper PPE. Perform remote venting during purging and sampling. Proper decontamination procedures shall be followed.	L
	Contact with potentially contaminated materials and gas	Review SDS for any chemical substances that pose potential exposure. Follow safe work practices and wear the assigned PPE Know exactly where emergency equipment is located (e.g. eye-wash station w/in 10 seconds of work area).	L
	Emergency	Radios or cellular phones will be used for communications. Dial 911 in case of emergency.	L

ACTIVITY HAZARD ANALYSIS # 4: Landfill Gas Monitoring and Sampling

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROL	RISK ASSESSMENT CODE
Sample packaging and Shipment	Contact with contaminated material/personal injury	□ Proper labeling, packaging, and handling. □ Proper lifting techniques or team lifting when moving heavy coolers filled with soil samples.	L

ACTIVITY HAZARD ANALYSIS # 4: Landfill Gas Monitoring and Sampling

EQUIPMENT TO BE USED/ TRAINING REQUIRED:

EQUIPMENT	INSPECTION REQUIREMENTS	TRAINING REQUIREMENTS
General operations	Daily by the competent person and Site Safety Coordinator.	Elements of this AHA Elements of the HASP
Drill Rig, laboratory containers/preservatives	Operators must inspect their equipment daily per manufacturer's instructions.	Elements of this AHA Elements of the HASP
PPE and related equipment (e.g. portable fire extinguisher, first aid supplies, emergency eye wash, spill control materials).	PPE daily and before use by the wearer. Other safety equipment daily and otherwise appropriate as determined by the SSHO.	On site by the SSHO

Additional Notes / Comments:

ACTIVITY HAZARD ANALYSIS # 4: Landfill Gas Monitoring and Sampling

ACTIVITY HAZARD ANALYSIS ACKNOWLEDGMENT – Landfill Gas Monitoring and Sampling

I have been trained and informed on the hazards and safe work practices associated with this Activity Hazard Analysis to include training and protective equipment requirements. I have also been given the opportunity to ask questions and receive informed answers.

NAME	DATE	COMPANY	SIGNATURE

Note: It is critically important to recognize that "NOT" all hazards can be recognized and addressed in the documented Activity Hazard Analysis, as site conditions may be different than anticipated. The on-site team member(s) are responsible to survey the area to recognize site hazards, report identified and potential hazards to the Health and Safety Manager, evaluate those hazards, and document those hazards and controls on the field copy of the AHA.

ATTACHMENT C-2

Safety Data Sheets

SAFETY DATA SHEET

Creation Date 24-Aug-2009 **Revision Date** 25-Apr-2019 **Revision Number** 6

1. Identification

Product Name **Hydrochloric Acid**

Cat No. : **A144-212; A144-212LC; A144-500; A144-500LB; A144-500LC; A144-612GAL; A144C-212; A144C-212EA; A144P-19; A144P-20; A144S-212; A144S-212EA; A144S-500; A144SI-212**

Synonyms Muriatic acid

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Fisher Scientific UK
Bishop Meadow Rd
Loughborough, Leicestershire, LE11 5RG
Great Britain
Tel: 01509 231166

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Corrosive to metals	Category 1
Skin Corrosion/irritation	Category 1 B
Serious Eye Damage/Eye Irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	

Label Elements

Signal Word
Danger

Hazard Statements
May be corrosive to metals
Causes severe skin burns and eye damage
May cause respiratory irritation

Precautionary Statements
Prevention
Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Keep only in original container
Response
Immediately call a POISON CENTER or doctor/physician
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Ingestion
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting
Spills
Absorb spillage to prevent material damage
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Store in corrosive resistant polypropylene container with a resistant inliner
Store in a dry place
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
None identified

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Water	7732-18-5	62-65
Hydrochloric acid	7647-01-0	35-38

4. First-aid measures

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.

Ingestion	Do not induce vomiting. Call a physician or Poison Control Center immediately.
Most important symptoms and effects	Causes burns by all exposure routes. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Substance is nonflammable; use agent most appropriate to extinguish surrounding fire.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Corrosive Material. Causes burns by all exposure routes. Thermal decomposition can lead to release of irritating gases and vapors.

Hazardous Combustion Products
Hydrogen chloride gas
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
3	0	0	N/A

6. Accidental release measures

Personal Precautions	Use personal protective equipment. Ensure adequate ventilation. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Do not get in eyes, on skin, or on clothing.
Environmental Precautions	Should not be released into the environment. See Section 12 for additional ecological information.
Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling	Wear personal protective equipment. Do not breathe vapors or spray mist. Do not get in eyes, on skin, or on clothing. Do not ingest.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place. Corrosives area.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Hydrochloric acid	Ceiling: 2 ppm	Ceiling: 5 ppm Ceiling: 7 mg/m³ (Vacated) Ceiling: 5 ppm (Vacated) Ceiling: 7 mg/m³	IDLH: 50 ppm Ceiling: 5 ppm Ceiling: 7 mg/m³	Ceiling: 2 ppm

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	pungent
Odor Threshold	No information available
pH	< 1
Melting Point/Range	-35 °C / -31 °F
Boiling Point/Range	57 °C / 135 °F @ 760 mmHg
Flash Point	No information available
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	125 mbar @ 20 °C
Vapor Density	1.27
Specific Gravity	1.18
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	1.8 mPa.s @ 15°C
Molecular Formula	HCl
Molecular Weight	36.46

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Stable under normal conditions.

Conditions to Avoid Incompatible products. Excess heat.

Incompatible Materials Metals, Strong oxidizing agents, Bases, sodium hypochlorite, Amines, Fluorine, Cyanides, Alkaline

Hazardous Decomposition Products Hydrogen chloride gas

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions Contact with metals may evolve flammable hydrogen gas.

11. Toxicological information

Acute Toxicity

Product Information
Oral LD50 Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Dermal LD50 Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Vapor LC50 Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Water	-	Not listed	Not listed
Hydrochloric acid	238 - 277 mg/kg (Rat)	> 5010 mg/kg (Rabbit)	1.68 mg/L (Rat) 1 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Causes burns by all exposure routes

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed
Hydrochloric acid	7647-01-0	Not listed	Not listed	Not listed	Not listed	Not listed

IARC: (International Agency for Research on Cancer)

IARC: (International Agency for Research on Cancer)
Group 1 - Carcinogenic to Humans
Group 2A - Probably Carcinogenic to Humans
Group 2B - Possibly Carcinogenic to Humans

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure Respiratory system
STOT - repeated exposure None known

Aspiration hazard No information available

Symptoms / effects,both acute and delayed Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains. Large amounts will affect pH and harm aquatic organisms.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Hydrochloric acid	-	282 mg/L LC50 96 h Gambusia affinis mg/L LC50 48 h Leucscus idus	-	56mg/L EC50 72h Daphnia

Persistence and Degradability Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its water solubility.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No UN1789
Proper Shipping Name HYDROCHLORIC ACID
Hazard Class 8
Packing Group II

TDG

UN-No UN1789
Proper Shipping Name HYDROCHLORIC ACID
Hazard Class 8
Packing Group II

IATA

UN-No UN1789
Proper Shipping Name Hydrochloric acid
Hazard Class 8
Packing Group II

IMDG/IMO

UN-No UN1789
Proper Shipping Name Hydrochloric acid
Hazard Class 8
Packing Group II

15. Regulatory information

United States of America Inventory

Component	CAS-No	TSCA	TSCA Inventory notification - Active/Inactive	TSCA - EPA Regulatory Flags
Water	7732-18-5	X	ACTIVE	-
Hydrochloric acid	7647-01-0	X	ACTIVE	-

Legend:
TSCA - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories

Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Australia (AICS), China (IECSC), Korea (ECL).

Component	CAS-No	DSL	NDSL	EINECS	PICCS	ENCS	AICS	IECSC	KECL
Water	7732-18-5	X	-	231-791-2	X	-	X	X	KE-35400
Hydrochloric acid	7647-01-0	X	-	231-595-7	X	X	X	X	KE-20189

U.S. Federal Regulations

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Hydrochloric acid	7647-01-0	35-38	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Hydrochloric acid	X	5000 lb	-	-

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Hydrochloric acid	X		-

OSHA - Occupational Safety and Health Administration Not applicable

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Hydrochloric acid	-	TQ: 5000 lb

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Hydrochloric acid	5000 lb	5000 lb

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Water	-	-	X	-	-
Hydrochloric acid	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ): Y
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security This product contains the following DHS chemicals:
Legend - STQs = Screening Threshold Quantities, APA = A placarded amount

Component	DHS Chemical Facility Anti-Terrorism Standard
Hydrochloric acid	Release STQs - 15000lb (concentration >=37%) Release STQs - 5000lb (anhydrous) Theft STQs - 500lb (anhydrous)

Other International Regulations

Mexico - Grade	No information available

16. Other information

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Creation Date	24-Aug-2009
Revision Date	25-Apr-2019
Print Date	25-Apr-2019
Revision Summary	SDS sections updated. 2. 3. 11.

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

Methanol (230, 232, 233)

000000011383

Version 3.1 Revision Date 03/26/2015 Print Date 03/08/2016

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Methanol (230, 232, 233)
MSDS Number	:	000000011383
Product Use Description	:	Solvent
Manufacturer or supplier's details	:	Honeywell International Inc. 115 Tabor Road Morris Plains, NJ 07950-2546
For more information call	:	1-800-368-0050 +1-231-726-3171 (Monday-Friday, 9:00am-5:00pm)
In case of emergency call	:	**Medical: 1-800-498-5701 or +1-303-389-1414**
	:	**Transportation (CHEMTREC): 1-800-424-9300 or +1-703-527-3887**
	:	
	:	(24 hours/day, 7 days/week)

SECTION 2. HAZARDS IDENTIFICATION

Emergency Overview

Form	:	liquid, clear
Color	:	colourless
Odor	:	slight alcohol-like

Classification of the substance or mixture

Classification of the substance or mixture	:	Flammable liquids, Category 2 Eye irritation, Category 2A Reproductive toxicity, Category 2 Specific target organ toxicity - single exposure, Category 1, Eyes, Nervous system, Systemic toxicity

GHS Label elements, including precautionary statements

Symbol(s) :

Signal word : Danger

Hazard statements : Highly flammable liquid and vapour.
Causes serious eye irritation.
Suspected of damaging fertility or the unborn child.
Causes damage to organs.

Precautionary statements : **Prevention:**
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
Keep container tightly closed.
Ground/bond container and receiving equipment.
Use explosion-proof electrical/ ventilating/ lighting/ equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
Wash skin thoroughly after handling.
Do not eat, drink or smoke when using this product.
Wear protective gloves/ eye protection/ face protection.

Response:
IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
IF exposed: Call a POISON CENTER or doctor/ physician.
If eye irritation persists: Get medical advice/ attention.
In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.

Storage:
Store in a well-ventilated place. Keep cool.

Store locked up.

Disposal:
Dispose of contents/ container to an approved waste disposal plant.

Carcinogenicity

No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP, IARC, or OSHA.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Formula : CH4O

Chemical nature : Substance

Chemical Name	CAS-No.	Concentration
Methanol	67-56-1	100.00 %

SECTION 4. FIRST AID MEASURES

Inhalation : Call a physician immediately. Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Use oxygen as required, provided a qualified operator is present.

Skin contact : Wash off immediately with plenty of water for at least 15 minutes. Take off contaminated clothing and shoes immediately. Wash contaminated clothing before re-use. Call a physician.

Eye contact : Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Call a physician.

Ingestion : Call a physician immediately. Do NOT induce vomiting. Immediate medical attention is required. Never give anything by mouth to an unconscious person.

Notes to physician

Treatment : Treat symptomatically.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media : Alcohol-resistant foam
Carbon dioxide (CO2)
Dry chemical
Cool closed containers exposed to fire with water spray.

Unsuitable extinguishing media : Do not use a solid water stream as it may scatter and spread fire.

Specific hazards during firefighting : Flammable.
Vapours may form explosive mixtures with air.
Vapours are heavier than air and may spread along floors.
Vapors may travel to areas away from work site before igniting/flashing back to vapor source.
In case of fire hazardous decomposition products may be produced such as:
Carbon monoxide
Carbon dioxide (CO2)
Formaldehyde

Special protective equipment for firefighters : Wear self-contained breathing apparatus and protective suit.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions : Wear personal protective equipment.
Immediately evacuate personnel to safe areas.
Keep people away from and upwind of spill/leak.
Ensure adequate ventilation.
Remove all sources of ignition.
Do not swallow.
Do not breathe vapours or spray mist.
Avoid contact with skin, eyes and clothing.

Environmental precautions : Prevent further leakage or spillage if safe to do so.

Prevent product from entering drains.
Discharge into the environment must be avoided.
Do not flush into surface water or sanitary sewer system.
Do not allow run-off from fire fighting to enter drains or water courses.

Methods for cleaning up : Ventilate the area.
No sparking tools should be used.
Use explosion-proof equipment.
Contain spillage, soak up with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and transfer to a container for disposal according to local / national regulations (see section 13).

SECTION 7. HANDLING AND STORAGE

Handling

Handling : Wear personal protective equipment.
Use only in well-ventilated areas.
Keep container tightly closed.
Do not smoke.
Do not swallow.
Do not breathe vapours or spray mist.
Avoid contact with skin, eyes and clothing.

Advice on protection against fire and explosion : Keep away from fire, sparks and heated surfaces.
Take precautionary measures against static discharges.
Ensure all equipment is electrically grounded before beginning transfer operations.
Use explosion-proof equipment.
Keep product and empty container away from heat and sources of ignition.
No sparking tools should be used.
No smoking.

Storage

Requirements for storage areas and containers : Store in area designed for storage of flammable liquids.
Protect from physical damage.
Keep containers tightly closed in a dry, cool and well-ventilated place.
Containers which are opened must be carefully resealed and

kept upright to prevent leakage.
Keep away from heat and sources of ignition.
Keep away from direct sunlight.
Store away from incompatible substances.
Container hazardous when empty.
Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Protective measures	:	Ensure that eyewash stations and safety showers are close to the workstation location.
Engineering measures	:	Use with local exhaust ventilation. Prevent vapour buildup by providing adequate ventilation during and after use.
Eye protection	:	Do not wear contact lenses. Wear as appropriate: Safety glasses with side-shields If splashes are likely to occur, wear: Goggles or face shield, giving complete protection to eyes
Hand protection	:	Solvent-resistant gloves Gloves must be inspected prior to use. Replace when worn.
Skin and body protection	:	Wear as appropriate: Solvent-resistant apron Flame retardant antistatic protective clothing. If splashes are likely to occur, wear: Protective suit
Respiratory protection	:	In case of insufficient ventilation, wear suitable respiratory equipment. For rescue and maintenance work in storage tanks use self-contained breathing apparatus. Use NIOSH approved respiratory protection.
Hygiene measures	:	When using do not eat, drink or smoke. Wash hands before breaks and immediately after handling the product. Keep working clothes separately.

Do not swallow.
Do not breathe vapours or spray mist.
Avoid contact with skin, eyes and clothing.
This material has an established AIHA ERPG exposure limit.
The current list of ERPG exposure limits can be found at http://www.aiha.org/insideaiha/GuidelineDevelopment/ERPG/Documents/2011erpgweelhandbook_table-only.pdf.

Exposure Guidelines

Components	CAS-No.	Value	Control parameters	Update	Basis
Methanol	67-56-1	TWA : time weighted average	(200 ppm)	2008	ACGIH:US. ACGIH Threshold Limit Values
Methanol	67-56-1	STEL : Short term exposure limit	(250 ppm)	2008	ACGIH:US. ACGIH Threshold Limit Values
Methanol	67-56-1	SKIN_DES : Skin designation:	Can be absorbed through the skin.	2008	ACGIH:US. ACGIH Threshold Limit Values
Methanol	67-56-1	REL : Recommended exposure limit (REL):	260 mg/m3 (200 ppm)	2005	NIOSH/GUIDE:US. NIOSH: Pocket Guide to Chemical Hazards
Methanol	67-56-1	SKIN_DES : Skin designation:	Can be absorbed through the skin.	2005	NIOSH/GUIDE:US. NIOSH: Pocket Guide to Chemical Hazards

Methanol	67-56-1	STEL : Short term exposure limit	325 mg/m3 (250 ppm)	2005	NIOSH/GUIDE:US. NIOSH: Pocket Guide to Chemical Hazards
Methanol	67-56-1	PEL : Permissible exposure limit	260 mg/m3 (200 ppm)	02 2006	OSHA_TRANS:US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)
Methanol	67-56-1	TWA : time weighted average	260 mg/m3 (200 ppm)	1989	Z1A:US. OSHA Table Z-1-A (29 CFR 1910.1000)
Methanol	67-56-1	STEL : Short term exposure limit	325 mg/m3 (250 ppm)	1989	Z1A:US. OSHA Table Z-1-A (29 CFR 1910.1000)
Methanol	67-56-1	SKIN_FINAL : Skin designation (Final Rule Limit applies):	Can be absorbed through the skin.	1989	Z1A:US. OSHA Table Z-1-A (29 CFR 1910.1000)

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state	:	liquid, clear
Color	:	colourless
Odor	:	slight alcohol-like
pH	:	Note: Not applicable

Melting point/freezing point	:	Note: Not applicable
Boiling point/boiling range	:	64.7 °C
Flash point	:	52 °F (11 °C) Method: closed cup
Evaporation rate	:	ca. 5 Method: Compared to Butyl acetate.
Lower explosion limit	:	6 %(V)
Upper explosion limit	:	36 %(V)
Vapor pressure	:	129.32 hPa at 20 °C(68 °F)
Vapor density	:	1.11 Note: (Air = 1.0)
Density	:	0.792 g/cm3 at 20 °C
Water solubility	:	Note: completely soluble
Ignition temperature	:	464 °C
Molecular weight	:	32.04 g/mol

SECTION 10. STABILITY AND REACTIVITY

Chemical stability	:	Stable under recommended storage conditions.
Possibility of hazardous reactions	:	Hazardous polymerisation does not occur.
Conditions to avoid	:	Heat, flames and sparks. Keep away from direct sunlight.
Incompatible materials to avoid	:	Strong oxidizing agents Aluminium Magnesium May attack many plastics, rubbers and coatings.
Hazardous decomposition products	:	In case of fire hazardous decomposition products may be produced such as: Carbon monoxide Carbon dioxide (CO2) Formaldehyde

SECTION 11. TOXICOLOGICAL INFORMATION

Acute oral toxicity	:	LD50: 5,628 mg/kg Species: Rat
Acute inhalation toxicity	:	LC50: 64000 ppm Exposure time: 4 h Species: Rat
Acute dermal toxicity	:	LD50: 15,800 mg/kg Species: Rabbit
Skin irritation	:	Species: Rabbit Classification: irritating Exposure time: 24 h

Eye irritation	:	Species: rabbit eye Classification: irritating
Repeated dose toxicity	:	Species: Rat Application Route: Inhalation Test substance: Methanol Note: Developmental Toxicity NOAEL (maternal toxicity) 10,000 ppm NOAEL (developmental toxicity) 5,000 ppm Skeletal and visceral malformations.
Genotoxicity in vitro	:	Note: In vitro tests did not show mutagenic effects
Genotoxicity in vivo	:	Note: In vivo tests did not show mutagenic effects

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity effects

Toxicity to fish	:	LC50: 29,400 mg/l Exposure time: 96 h Species: Fathead minnow
Toxicity to daphnia and other aquatic invertebrates	:	LC50: 10,000 mg/l Exposure time: 24 h Species: Daphnia (water flea)
Toxicity to bacteria	:	EC50: 43,000 mg/l Exposure time: 5 min Species: Photobacterium phosphoreum
	:	EC50: 40,000 mg/l Exposure time: 15 min Species: Photobacterium phosphoreum
	:	EC50: 39,000 mg/l Exposure time: 25 min Species: Photobacterium phosphoreum

Further information on ecology

Additional ecological information	:	Accumulation in aquatic organisms is unlikely. The product is readily degradable in the environment.

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods	:	Observe all Federal, State, and Local Environmental regulations.

SECTION 14. TRANSPORT INFORMATION

DOT	UN/ID No.	:	UN 1230
	Proper shipping name	:	METHANOL
	Class		3
	Packing group		II
	Hazard Labels		3

IATA	UN/ID No.	:	UN 1230
	Description of the goods	:	METHANOL
	Class	:	3
	Packaging group	:	II
	Hazard Labels	:	3 (6.1)
	Packing instruction (cargo aircraft)	:	364
	Packing instruction (passenger aircraft)	:	352
	Packing instruction (passenger aircraft)	:	Y341

IMDG	UN/ID No.	:	UN 1230
	Description of the goods	:	METHANOL
	Class	:	3
	Packaging group	:	II
	Hazard Labels	:	3 (6.1)
	EmS Number	:	F-E, S-D
	Marine pollutant	:	no

SECTION 15. REGULATORY INFORMATION

Inventories

US. Toxic Substances Control Act	:	On TSCA Inventory
Australia. Industrial Chemical (Notification and Assessment) Act	:	On the inventory, or in compliance with the inventory
Canada. Canadian Environmental Protection Act (CEPA). Domestic Substances List (DSL)	:	All components of this product are on the Canadian DSL.
Japan. Kashin-Hou Law List	:	On the inventory, or in compliance with the inventory
Korea. Toxic Chemical Control Law (TCCL) List	:	On the inventory, or in compliance with the inventory
Philippines. The Toxic Substances and Hazardous and Nuclear Waste Control Act	:	On the inventory, or in compliance with the inventory
China. Inventory of Existing Chemical Substances	:	On the inventory, or in compliance with the inventory
New Zealand. Inventory of Chemicals (NZIoC), as published by ERMA New Zealand	:	On the inventory, or in compliance with the inventory

National regulatory information

US. EPA CERCLA Hazardous Substances (40 CFR 302)	:	The following component(s) of this product is/are subject to release reporting under 40 CFR 302 when release exceeds the Reportable Quantity (RQ): Reportable quantity: 5000 lbs

	:	Methanol	67-56-1
SARA 302 Components	:	No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.	
SARA 313 Components	:	The following components are subject to reporting levels established by SARA Title III, Section 313:	
	:	Methanol	67-56-1
SARA 311/312 Hazards	:	Fire Hazard Acute Health Hazard Chronic Health Hazard	
CERCLA Reportable Quantity	:	5000 lbs	
California Prop. 65	:	WARNING: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.	
		Methanol	67-56-1
Massachusetts RTK	:	Methanol	67-56-1
New Jersey RTK	:	Methanol	67-56-1
Pennsylvania RTK	:	Methanol	67-56-1
WHMIS Classification	:	B2: Flammable liquid D1B: Toxic Material Causing Immediate and Serious Toxic Effects D2A: Very Toxic Material Causing Other Toxic Effects D2B: Toxic Material Causing Other Toxic Effects This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.	

SECTION 16. OTHER INFORMATION

		HMIS III	NFPA
Health hazard	:	2*	1
Flammability	:	3	3
Physical Hazard	:	0	
Instability	:		0

* - Chronic health hazard

Hazard rating and rating systems (e.g. HMIS® III, NFPA): This information is intended solely for the use of individuals trained in the particular system.

Further information

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Changes since the last version are highlighted in the margin. This version replaces all previous versions.
Previous Issue Date: 03/19/2014
Prepared by Honeywell Performance Materials and Technologies Product Stewardship Group

SAFETY DATA SHEET

Creation Date 12-Mar-2009 **Revision Date** 25-Apr-2019 **Revision Number** 10

1. Identification

Product Name **Nitric acid (65 - 70%)**

Cat No. : **A198C-212, A200-212, A200-212LC, A200-500, A200-500LC, A200-612GAL, A200C-212, A200S-212, A200S-212LC, A200S-500, A200SI-212, A467-1, A467-2, A467-250, A467-500, A483-212; S719721**

CAS-No 7697-37-2
Synonyms Azotic acid; Engraver's acid; Aqua fortis

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Oxidizing liquids	Category 3
Corrosive to metals	Category 1
Acute Inhalation Toxicity - Dusts and Mists	Category 3
Skin Corrosion/irritation	Category 1 A
Serious Eye Damage/Eye Irritation	Category 1

Label Elements

Signal Word
Danger

Hazard Statements
May intensify fire; oxidizer
May be corrosive to metals
Causes severe skin burns and eye damage

Toxic if inhaled

Precautionary Statements
Prevention
Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep/Store away from clothing/ other combustible materials
Take any precaution to avoid mixing with combustibles
Keep only in original container
Wear respiratory protection
Response
Immediately call a POISON CENTER or doctor/physician
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician
Skin
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Ingestion
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting
Fire
In case of fire: Use CO2, dry chemical, or foam for extinction
Spills
Absorb spillage to prevent material damage
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Store in corrosive resistant polypropylene container with a resistant inliner
Store in a dry place
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Corrosive to the respiratory tract

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Nitric acid	7697-37-2	65 - 70
Water	7732-18-5	30 - 35

4. First-aid measures

General Advice Immediate medical attention is required. Show this safety data sheet to the doctor in

attendance.

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Remove and wash contaminated clothing before re-use. Call a physician immediately.

Inhalation If breathing is difficult, give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Remove from exposure, lie down. Call a physician immediately.

Ingestion Do not induce vomiting. Never give anything by mouth to an unconscious person. Clean mouth with water. Call a physician immediately.

Most important symptoms and effects Causes burns by all exposure routes. Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation: Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated

Notes to Physician Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media CO_2, dry chemical, dry sand, alcohol-resistant foam.

Unsuitable Extinguishing Media No information available

Flash Point Not applicable
Method - No information available

Autoignition Temperature No information available

Explosion Limits
Upper No data available
Lower No data available

Oxidizing Properties Oxidizer

Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors. The product causes burns of eyes, skin and mucous membranes. Oxidizer: Contact with combustible/organic material may cause fire. May ignite combustibles (wood paper, oil, clothing, etc.).

Hazardous Combustion Products
Nitrogen oxides (NOx) Thermal decomposition can lead to release of irritating gases and vapors
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
4	0	0	OX

6. Accidental release measures

Personal Precautions Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Ensure adequate ventilation. Use personal protective equipment.

Environmental Precautions Should not be released into the environment. Do not flush into surface water or sanitary sewer system. See Section 12 for additional ecological information.

Methods for Containment and Clean Up Soak up with inert absorbent material. Keep in suitable, closed containers for disposal. Sweep up and shovel into suitable containers for disposal. Wear self-contained breathing apparatus and protective suit.

7. Handling and storage

Handling Use only under a chemical fume hood. Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Do not ingest. Do not breathe vapors or spray mist. Keep away from clothing and other combustible materials.

Storage Keep containers tightly closed in a cool, well-ventilated place. Do not store near combustible materials.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Nitric acid	TWA: 2 ppm STEL: 4 ppm	(Vacated) TWA: 2 ppm (Vacated) TWA: 5 mg/m³ (Vacated) STEL: 4 ppm (Vacated) STEL: 10 mg/m³ TWA: 2 ppm TWA: 5 mg/m³	IDLH: 25 ppm TWA: 2 ppm TWA: 5 mg/m³ STEL: 4 ppm STEL: 10 mg/m³	TWA: 2 ppm STEL: 4 ppm

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location. Ensure adequate ventilation, especially in confined areas.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. Tightly fitting safety goggles. Face-shield.

Skin and body protection Long sleeved clothing.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Keep away from food, drink and animal feeding stuffs. When using, do not eat, drink or smoke. Contaminated work clothing should not be allowed out of the workplace. Provide regular cleaning of equipment, work area and clothing. Avoid contact with skin, eyes and clothing. For environmental protection remove and wash all contaminated protective equipment before re-use. Wear suitable gloves and eye/face protection.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Clear Colorless, Light yellow
Odor	Strong Acrid
Odor Threshold	No information available
pH	< 1.0 (0.1M)
Melting Point/Range	-41 °C / -41.8 °F

Boiling Point/Range	Not applicable
Flash Point	Not applicable
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	0.94 kPa (20°C)
Vapor Density	No information available
Specific Gravity	1.40
Solubility	miscible
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	No information available
Molecular Formula	HNO3
Molecular Weight	63.01

10. Stability and reactivity

Reactive Hazard Yes

Stability Oxidizer: Contact with combustible/organic material may cause fire.

Conditions to Avoid Incompatible products. Combustible material. Excess heat. Exposure to air or moisture over prolonged periods.

Incompatible Materials Combustible material, Strong bases, Reducing agents, Metals, Powdered metals, Organic materials, Aldehydes, Alcohols, Cyanides, Ammonia, Strong reducing agents

Hazardous Decomposition Products Nitrogen oxides (NOx), Thermal decomposition can lead to release of irritating gases and vapors

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Oral LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Dermal LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Mist LC50	Category 3. ATE = 1 - 5 mg/l. Category 4.
Vapor LC50	Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Nitric acid	Not listed	Not listed	LC50 = 2500 ppm. (Rat) 1h
Water	-	Not listed	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Causes severe burns by all exposure routes

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico

Nitric acid	7697-37-2	Not listed	Not listed	Not listed	Not listed	Not listed
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure None known
STOT - repeated exposure None known

Aspiration hazard No information available

Symptoms / effects,both acute and delayed Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation: Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains. Large amounts will affect pH and harm aquatic organisms.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Nitric acid	Not listed	LC50: = 72 mg/L, 96h (Gambusia affinis)	Not listed	Not listed

Persistence and Degradability Miscible with water Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its water solubility.

Component	log Pow
Nitric acid	-2.3

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No UN2031
Proper Shipping Name NITRIC ACID
Hazard Class 8
Subsidiary Hazard Class 5.1
Packing Group II

TDG

UN-No UN2031
Proper Shipping Name NITRIC ACID
Hazard Class 8
Subsidiary Hazard Class 5.1
Packing Group II

IATA

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

IMDG/IMO

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

15. Regulatory information

United States of America Inventory

Component	CAS-No	TSCA	TSCA Inventory notification - Active/Inactive	TSCA - EPA Regulatory Flags
Nitric acid	7697-37-2	X	ACTIVE	-
Water	7732-18-5	X	ACTIVE	-

Legend:
TSCA - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories
Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Australia (AICS), China (IECSC), Korea (ECL).

Component	CAS-No	DSL	NDSL	EINECS	PICCS	ENCS	AICS	IECSC	KECL
Nitric acid	7697-37-2	X	-	231-714-2	X	X	X	X	KE-25911
Water	7732-18-5	X	-	231-791-2	X	-	X	X	KE-35400

U.S. Federal Regulations

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Nitric acid	7697-37-2	65 - 70	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Nitric acid	X	1000 lb	-	-

Clean Air Act Not applicable

OSHA - Occupational Safety and Health Administration

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Nitric acid	-	TQ: 500 lb

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Nitric acid	1000 lb	1000 lb

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Nitric acid	X	X	X	X	X
Water	-	-	X	-	-

U.S. Department of Transportation

Reportable Quantity (RQ): Y
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security This product contains the following DHS chemicals:
Legend - STQs = Screening Threshold Quantities, APA = A placarded amount

Component	DHS Chemical Facility Anti-Terrorism Standard
Nitric acid	Release STQs - 15000lb Theft STQs - 400lb

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By
Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date 12-Mar-2009
Revision Date 25-Apr-2019
Print Date 25-Apr-2019
Revision Summary SDS sections updated. 2. 11.

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

SAFETY DATA SHEET

Version 3.4
Revision Date 06/28/2014
Print Date 02/08/2016

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name : Sodium bisulfate monohydrate

Product Number : 71657
Brand : Sigma-Aldrich
Index-No. : 016-046-00-X

CAS-No. : 10034-88-5

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone # : (314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Serious eye damage (Category 1), H318

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)
H318 Causes serious eye damage.

Precautionary statement(s)
P280 Wear protective gloves/ eye protection/ face protection.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/ physician.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms : Sodium hydrogen sulfatemonohydrate

Formula	:	$HNaO_4S \cdot H_2O$
Molecular Weight	:	138.08 g/mol
CAS-No.	:	10034-88-5
EC-No.	:	231-665-7
Index-No.	:	016-046-00-X

Hazardous components

Component	Classification	Concentration
Sodium bisulfate monohydrate		
	Eye Dam. 1; H318	-

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Sulphur oxides, Sodium oxides

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
no data available

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid dust formation. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Avoid breathing dust.
For personal protection see section 8.

6.2 Environmental precautions
Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Pick up and arrange disposal without creating dust. Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid formation of dust and aerosols.
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place.

Moisture sensitive.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters
Contains no substances with occupational exposure limit values.

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the

sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: crystalline Colour: light yellow
b)	Odour	no data available
c)	Odour Threshold	no data available
d)	pH	no data available
e)	Melting point/freezing point	no data available
f)	Initial boiling point and boiling range	no data available
g)	Flash point	not applicable
h)	Evapouration rate	no data available
i)	Flammability (solid, gas)	no data available
j)	Upper/lower flammability or explosive limits	no data available
k)	Vapour pressure	no data available
l)	Vapour density	no data available
m)	Relative density	2.103 g/cm3
n)	Water solubility	no data available
o)	Partition coefficient: n-octanol/water	no data available
p)	Auto-ignition temperature	no data available
q)	Decomposition temperature	no data available
r)	Viscosity	no data available
s)	Explosive properties	no data available
t)	Oxidizing properties	no data available

9.2 Other safety information
no data available

10. STABILITY AND REACTIVITY

10.1 Reactivity
no data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
no data available

10.4 Conditions to avoid
no data available

10.5 Incompatible materials
Strong bases, Strong oxidizing agents

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - rat - 2,490 mg/kg

Inhalation: no data available

Dermal: no data available

no data available

Skin corrosion/irritation
Skin - rabbit
Result: No skin irritation

Serious eye damage/eye irritation
Eyes - rabbit
Result: Severe eye irritation

Respiratory or skin sensitisation
no data available

Germ cell mutagenicity
no data available

Carcinogenicity

IARC:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
no data available

no data available

Specific target organ toxicity - single exposure
no data available

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Additional Information
RTECS: VZ1870000

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

12. ECOLOGICAL INFORMATION

12.1 Toxicity
no data available

12.2 Persistence and degradability
no data available

12.3 Bioaccumulative potential
no data available

12.4 Mobility in soil
no data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

no data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 3260 Class: 8 Packing group: III
Proper shipping name: Corrosive solid, acidic, inorganic, n.o.s. (Sodium bisulfate monohydrate)
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 3260 Class: 8 Packing group: III EMS-No: F-A, S-B
Proper shipping name: CORROSIVE SOLID, ACIDIC, INORGANIC, N.O.S. (Sodium bisulfate monohydrate)
Marine pollutant: No

IATA
UN number: 3260 Class: 8 Packing group: III
Proper shipping name: Corrosive solid, acidic, inorganic, n.o.s. (Sodium bisulfate monohydrate)

15. REGULATORY INFORMATION

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Acute Health Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Sodium bisulfate monohydrate	10034-88-5	1989-12-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Sodium bisulfate monohydrate	10034-88-5	1989-12-01

California Prop. 65 Components

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Eye Dam.	Serious eye damage
H318	Causes serious eye damage.

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	
Flammability:	0
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	0
Reactivity Hazard:	0

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 3.4 Revision Date: 06/28/2014 Print Date: 02/08/2016

APPENDIX D

Inadvertent Discovery Plan

Pre-Remedial Design Investigation
Inadvertent Discovery Plan
Central Waterfront Cleanup Site
Bellingham, Washington

October 14, 2020

Prepared for

Port of Bellingham
Bellingham, Washington

LANDAU ASSOCIATES

130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

TABLE OF CONTENTS

ATTACHMENT

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1.0 INTRODUCTION

This Inadvertent Discovery Plan (IDP) outlines procedures to perform in the event of the discovery of archaeological materials or human remains during work activities, in accordance with state and federal laws.

2.0 RECOGNIZING CULTURAL RESOURCES

A cultural resource discovery could be prehistoric or historic. Some examples include:

- An accumulation of shell, burned rocks, or other food-related materials
- Bones or small pieces of bone
- An area of charcoal or very dark-stained soil with artifacts
- Stone tools or waste flakes (e.g., an arrowhead or stone chips)
- Clusters of tin cans or bottles, logging or agricultural equipment that appears to be older than 50 years
- Buried railroad tracks, decking, or industrial materials.

If the item(s) inadvertently discovered are unknown in age and origin, assume the material is a cultural resource. See Attachment D-1 for photographs of the examples of the items listed above.

3.0 ONSITE RESPONSIBILITIES

Step 1: *Stop Work.* If an employee, contractor, or subcontractor believes that he or she has uncovered a cultural resource at any point in the project, project work must stop immediately. Notify the appropriate party(s). Leave the surrounding area untouched, and provide a demarcation adequate to provide for the security, protection, and integrity of the discovery. The discovery location must be secured at all times by a temporary fence or other form of onsite security.

Step 2: *Notify Licensed Archaeologist/Cultural Resource Specialist.* This project does not have an established Archaeological Monitor. In the event of an inadvertent discovery, Landau Associates, Inc. (LAI) will contact the following licensed Archaeologist/Cultural Resource Specialist in the Bellingham, Washington area.

- Caldera Archaeology, LLC
  1155 North State, Suite 428
  Bellingham, Washington 98227
  (360) 332-2600

Step 3: *Notify the Project Manager.* Notify the Port of Bellingham Project Manager, involved consultant and subcontractor Project Managers, and the Washington State Department of Ecology (Ecology) Project Manager, or other applicable contacts:

Company Tile	Name	Phone	Email
Port of Bellingham Project Manager	Ben Howard	(360) 715-7365	benh@portofbellingham.com
LAI Project Manager	Jeff Fellows	(206) 218-6501	jfellows@landauinc.com
Ecology Project Manager	John Guenther	(360) 255-4381	jgue461@ecy.wa.gov

The Project Manager or applicable representative will make the necessary calls and notifications. If human remains are encountered, treat them with dignity and respect at all times. Cover the remains with a tarp or other materials (not soil or rocks) for temporary protection and to shield them from being photographed. **Do not call 911 or speak with the media. Do not take pictures unless directed to do so by representatives of the Washington State Department of Archaeology and Historic Preservation (DAHP).**

4.0 FURTHER CONTACTS AND CONSULTATION

Project Manager Responsibilities (LAI):

- Project Find: The Project Manager (LAI) is responsible for taking appropriate steps to protect the discovery site, if a cultural resource is discovered. Work will stop immediately in a surrounding area adequate to provide for the complete security of the location, the protection, and the integrity of the resource. Vehicles, equipment, and unauthorized personnel will not be permitted to traverse the discovery site. Work in the immediate area will not resume until treatment of the discovery has been completed following provisions for treating archaeological/cultural material as set forth in this document.
- Direct Construction Elsewhere: The Project Manager may direct construction away from the discovered cultural resources to work in other areas prior to contacting the concerned parties.
- Contact Senior Support Staff: If the Senior Support Staff person has not yet been contacted, the Project Manager must do so.

Senior Support Staff/Delegated Cultural Resource Specialist Responsibilities:

- Identify the Find: The Senior Support Staff (or delegated Cultural Resource Specialist), will ensure that a qualified professional archaeologist examines the area to determine if an archaeological find has been identified.
  - If it is determined not to be an archaeological or historic find, or human remains, work may proceed with no further delay.
  - If it is determined to be an archaeological find, the Senior Support Staff or Cultural Resource Specialist will continue with necessary notifications.
  - If the find may be human remains or funerary objects, the Senior Support Staff or Cultural Resource Specialist will ensure that a qualified physical anthropologist examines the find. If it is determined to be human remains, refer to the procedure described below.

- Notification of DAHP: The Senior Support Staff (or delegated Cultural Resource Specialist) will contact the involved agencies (if any) and the DAHP.
- Notification of Tribes: If the discovery may be of interest to Native American Tribes, the DAHP and Ecology Coordinator will coordinate with the interested and/or affected tribes.

Washington State Department of Archaeology and Historic Preservation contacts:

Name	Title	Phone
Dr. Allyson Brooks	State Historic Preservation Officer	(360) 586-3066 allyson.brooks@dahp.wa.gov
Rob Whitlam, Ph.D.	Staff Archaeologist	(360) 586-3050 rob.whitlam@dahp.wa.gov

5.0 SPECIAL PROCEDURES FOR THE DISCOVERY OF HUMAN SKELETAL MATERIAL

Human skeletal remains, regardless of antiquity or ethnic origin, will at all times be treated with dignity and respect. Photographs will not be taken at any time, unless pre-approved to do so.

The LAI Project Manager and project team will comply with applicable state and federal laws for non-federal lands, and the following procedure:

1) In all cases you must notify a law enforcement agency or Medical Examiner/Coroner's Office
    a. The LAI Project Manager or designated member of the project team will comply with actions described above and immediately notify the local law enforcement agency or medical examiner/coroner's office.
    b. The Medical Examiner/Coroner (with assistance of law enforcement personnel) will determine if the remains are human, whether the discovery site constitutes a crime scene, and will then notify DAHP.
        i. Bellingham Police Department
        505 Grand Avenue
        Bellingham, Washington 98225
            1. Emergency phone number: 911
            2. Non-Emergency phone number: (360) 778-8804
            3. Main Office: (360) 778-8800
2) Participate in Consultation:
    a. Per the Revised Code of Washington (RCW; RCW 27.44.055, RCW 68.50, and RCW 68.60), DAHP will have jurisdiction over non-forensic human remains. Ecology staff will participate in consultation.
3) Further Activities:
    a. Documentation of human skeletal remains and funerary objects will be agreed upon through the consultation process described in RCW 27.44.055, RCW 68.50, and RCW 68.60.

b. When consultation and documentation activities are complete, construction in the discovery area may resume as described above.

6.0 DOCUMENTATION OF ARCHAEOLOGICAL MATERIALS

Archaeological deposits discovered during construction will be assumed eligible for inclusion in the National Register of Historic Places (under Criterion D) until a formal Determination of Eligibility is made.

Project staff will ensure the proper documentation and field assessment will be made of discovered cultural resources in cooperation with the involved parties: federal agencies (if appropriate), DAHP, Ecology, affected tribes, and a contracted consultant (if required).

Prehistoric and historic cultural material discovered during project activities will be recorded by a professional archaeologist/cultural resource specialist on a cultural resource site or isolate form using standard and approved techniques. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for minimal subsurface exposures. Discovery locations will be documented on scaled site plans and site location maps.

Cultural features, horizons, and artifacts detected in buried sediments may require further evaluation using hand-dug test units. Units may be dug in controlled fashion to expose features, collect samples from undisturbed contexts, or to interpret complex stratigraphy. A test excavation unit or small trench might also be used to determine if an intact occupation surface is present. Test units will be used only when necessary to gather information on the nature, extent, and integrity of subsurface cultural deposits to evaluate the site's significance. Excavations will be conducted using state-of-the-art techniques for controlling provenance, and the chronology of ownership, custody, and location recorded with precision.

Spatial information, depth of excavation levels, natural and cultural stratigraphy, presence or absence of cultural material, and depth to sterile soil, regolith, or bedrock will be recorded for each probe on a standard form. Test excavation units will be recorded on unit-level forms, which will include plan maps for each excavated level, and material type, number, and vertical provenance (depth below surface and stratum association where applicable) for the artifacts recovered from the level. A stratigraphic profile will be drawn for at least one wall of each test excavation unit, as appropriate.

If relevant, sediments excavated for purposes of cultural resources investigation will be screened through ⅛-inch mesh, unless soil conditions warrant ¼-inch mesh.

Prehistoric and historic artifacts collected from the surface and from probes and excavation units will be analyzed, catalogued, and temporarily curated. Ultimate disposition of cultural materials will be determined in consultation with the federal agencies (if appropriate, DAHP, Ecology, and the affected tribes.

Within 90 days of concluding field activities, a technical report describing the monitored and resultant archaeological excavations will be provided to the Project Manager (LAI), who will forward the report for review and delivery to Ecology, the federal agencies (if appropriate), DAHP, and the affected tribe(s).

If assessment activities expose human remains (e.g., burials, isolated teeth, or bones), the procedures described above will be followed.

7.0 PROCEEDING WITH WORK

Work outside the discovery location may continue while documentation and assessment of the archaeological/cultural resources proceeds. A professional archaeologist/cultural resource specialist must determine the boundaries of the discovery location. In consultation with Ecology, DAHP, and affected tribes, the Project Manager (LAI) will determine the appropriate level of documentation and treatment of the resource. If there is a federal nexus, Section 106 consultation and associated federal laws may need to be considered to support the final determinations about treatment and documentation.

Project work may continue at the discovery location only after the procedures outlined in this IDP are followed and the Project Manager (LAI), DAHP, any affected tribes, Ecology (and the federal agencies, if appropriate) determine that compliance with state and federal law is complete.

8.0 RECIPIENT/PROJECT PARTNER RESPONSIBILITY

This IDP must be immediately available on site, be implemented to address any discovery, and be available by request by any party.

9.0 USE OF THIS REPORT

This IDP has been prepared for the exclusive use of the Port of Bellingham for specific application to Central Waterfront Remedial Design and Permitting project. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. LAI makes no other warranty, either express or implied.

ATTACHMENT D-1

Support for Inadvertent Discovery Plan Implementation

Implement the IDP if …

You see chipped stone artifacts.

- Glass-like material
- Angular
- “Unusual” material for area
- “Unusual” shape
- Regularity of flaking
- Variability of size

Implement the IDP if …

You see ground or pecked stone artifacts.

- Striations or scratching
- Unusual or unnatural shapes
- Unusual stone
- Etching
- Perforations
- Pecking
- Regularity in modifications
- Variability of size, function, and complexity

Implement the IDP if …

You see bone or shell artifacts.

- Often smooth
- Unusual shape
- Carved
- Often pointed if used as a tool
- Often wedge shaped like a "shoehorn"

Bone Awls from Oregon and Bone Wedge from California

Implement the IDP if …

You see bone or shell artifacts.

- Often smooth
- Unusual shape
- Perforated
- Variability of size

Implement the IDP if …

You see fiber or wood artifacts.

- Wet environments needed for preservation
- Variability of size, function, and complexity
- Rare

Artifacts from Mud Bay, Olympia, Washington

Implement the IDP if …

You see historic period artifacts.

Artifacts from Downtown Seattle, Alaskan Way Viaduct (Upper Left and Lower) and Unknown Site (Upper Right)

Implement the IDP if …

You see strange, different or interesting looking dirt, rocks, or

- Human activities leave traces in the ground that may or may not have artifacts associated with them
- “Unusual” accumulations of rock (especially fire-cracked rock)
- “Unusual” shaped accumulations of rock (e.g., similar to a fire ring)
- Charcoal or charcoal-stained soils
- Oxidized or burnt-looking soils
- Accumulations of shell
- Accumulations of bones or artifacts
- Look for the “unusual” or out of place (e.g., rock piles or accumulations in areas with few rock)

Implement the IDP if …

You see strange, different or interesting looking dirt, rocks, or

- "Unusual" accumulations of rock (especially fire-cracked rock)
- "Unusual" shaped accumulations of rock (e.g., similar to a fire ring)
- Look for the "unusual" or out of place (e.g., rock piles or accumulations in areas with few rock)

Site on Muckleshoot Indian Reservation, near WSDOT ROW along SR 164

Implement the IDP if …

You see strange, different or interesting looking dirt, rocks, or

- Often have a layered or “layer cake” appearance
- Often associated with black or blackish soil
- Often have very crushed and compacted shells

Implement the IDP if …

You see historic foundations or buried structures.