PORT OF FRIDAY HARBOR
ALBERT JENSEN AND SONS INC. BOATYARD AND MARINA
FRIDAY HARBOR, WA

MODEL TOXICS CONTROL ACT (MTCA)
AGREED ORDER NO. DE 18071

REMEDIAL INVESTIGATION WORK PLAN

Prepared for
The Port of Friday Harbor
Friday Harbor, WA

Prepared by
Leon Environmental, LLC and CRETE Consulting Inc.
Seattle, WA

July 2022

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Abbreviations and Acronyms

µg/kg	micrograms per kilogram
ADA	American With Disability Act
AET	Apparent Effects Threshold
BLWA	boat lift work area
BTEX	benzene, toluene, ethylbenzene, and xylene
cm	centimeter
COC	Constituent of Concern
CoC	contaminant of concern
COI	Constituent of Interest
COPC	Contaminant of Potential Concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CRETE	CRETE Consulting Inc.
CSL	cleanup screening level
DCAP	Draft Cleanup Action Plan
DMMP	Dredged Material Management Program
Ecology	Department of Ecology
EMNR	enhanced monitored natural recovery
ESA	Environmental Site Assessment
FDA	Former Dumping Area
FS	Feasibility Study
ft bgs	feet below ground surface
IOSA	Islands’ Oil Spill Association
IPG	Integrated Planning Grant
Jensen	Albert Jensen and Sons Boatyard and Marina
LDW	Lower Duwamish Waterway
L-E	Leon Environmental, LLC
mg/kg	milligrams per kilogram
MNR	monitored natural recovery
mS/cm	milliSiemens/centimeter
MTC	Marine Technical Center
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
OHW	ordinary high water
OPALCO	Orcas Power and Light Company
Order	Agreed Order No. DE 18071
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PoFH	Port of Friday Harbor
ppt	parts per trillion
PQL	practical quantitation limit
PSEP	Puget Sound Estuary Program
QA	quality assurance
QC	quality control
RM	Reid Middleton, Inc.
RI	Remedial Investigation
ROC	receptors of concern

SAP	Sampling and Analysis Plan
SCO	sediment cleanup objective
SCUBA	self-contained underwater breathing apparatus
SCUM	Sediment Cleanup User's Manual
SGC	silica gel cleanup
Shipyard Cove	Shipyard Cove Marina
SL	screening level
SLR	sea level rise
SMA	sediment management area
SMS	Sediment Management Standards
SQS	Sediment Quality Standard
SRWA	ship rail work area
TBT	tributyltin
TEQ	toxicity equivalent
Town	Town of Friday Harbor
TPH	total petroleum hydrocarbon
USDA	U.S. Department of Agriculture
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WDNR	Washington State Department of Natural Resources
WE	Whatcom Environmental Services

1. INTRODUCTION

The mutual objective of the State of Washington, Department of Ecology (Ecology) and the Port of Friday Harbor (PoFH) under Agreed Order No. DE 18071 (Order) is to provide for remedial action at the Albert Jensen & Sons Inc. site (Facility Site ID 42226979) (site or Jensen's) where there has been a release or threatened release of hazardous substances. The work under the Order involves conducting a Remedial Investigation (RI) and Feasibility Study (FS), conducting interim actions if required or agreed to by Ecology, and preparing a preliminary Draft Cleanup Action Plan (DCAP) to select a cleanup alternative. The purpose of the RI/FS, and preliminary DCAP for the Site, is to provide sufficient data, analysis, and evaluations to enable Ecology to select a cleanup alternative for the Site.

The overall goal of this project is to clean up the historical contamination associated with Jensen's and redevelop this formerly-thriving industrial facility into a revitalized community and economic hub that honors the site's history and its central role in shaping the Friday Harbor community, while providing: environmental restoration; public access and educational opportunities; outdoor-oriented recreation; affordable housing; live-work space; and a platform to provide the economic opportunity local businesses need to thrive. The steps planned during the 2021 - 2023 biennium to achieve this goal are focused on collaborating with Ecology to deliver work described in Agreed Order No. DE 18071, including: completion of a robust RI/FS; design, permitting and construction of Interim Actions to address the most immediate risks to human health and the environment; completion of a DCAP; execution of an effective public participation plan; and strategic planning for the design and construction that is anticipated in subsequent biennia.

1.1 Objectives of the Remedial Investigation

The objective for the remedial investigation is to address identified data gaps and refine the nature and extent of contamination exceeding preliminary Model Toxics Control Act (MTCA) cleanup levels, preliminary Sediment Management Standards (SMS) cleanup standards, and other regulatory requirements. This effort is expected to:

- Establish vertical and horizontal contamination profiles in areas where surface sediments exceed SQS.
- Delineate the nature and extent of debris throughout in-water sampling areas.
- Delineate the vertical and horizontal extent of dioxins/furans beyond the surface concentrations measured along the central marina shoreline, which may correlate with observed polychlorinated biphenyl (PCB) surface exceedances.
- Focus PCB analysis on areas showing benthic exceedances in surface sediments to facilitate subsequent background/human health evaluations.
- Delineate the vertical and horizontal extent of pesticides measured in surface sediments.
- Delineate the vertical and horizontal extents of metals, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and total petroleum hydrocarbons (TPH) in soils that exceed screening levels.
- Characterize the fill soils along the shoreline work areas and evaluate contamination exceeding corresponding screening levels.
- Delineate the extent of contamination in groundwater and characterize the potential migration of contamination in groundwater to surface water.

1.2 Regulatory Framework

Agreed Order No. DE 18071 (Order) was issued pursuant to the MTCA, RCW 70.105D.050(1). The Order requires the PoFH to perform an RI/FS and to prepare a DCAP, addressing both upland and in-water site contamination.

1.3 General Site Information

Albert Jensen and Sons, Inc. Boatyard and Marina
1293 Turn Point Road
Friday Harbor, WA 98250
Section 13, Township 35N, Range 3W
Parcel 351341005000

The project coordinator for the Port of Friday Harbor is:
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1.4 Legal Description of the Site

The site is referred to as Albert Jensen and Sons, Inc. Boatyard and Marina (Jensen's). The site constitutes a facility under RCW 70.105D.020(8). The site is defined by where a hazardous substance, other than a consumer product in consumer use, has been deposited, stored, disposed of, or placed, or otherwise come to be located. Based upon factors currently known to Ecology, the site is generally located at 1293 Turn Point Road, Friday Harbor, WA 98250 as shown in Figure 1, the Site Location Diagram provided as Exhibit A of the Agreed Order No. DE 18071.

Short/abbreviated legal description of parcel: PR GL 6 PR SE-SE EX CO RD Sec 13, T 35N, R 3W.

2. GENERAL FACILITY INFORMATION

The site is located at 1293 Turn Point Road on the southern shore of Shipyard Cove of the Salish Sea, on San Juan Island, San Juan County. Turn Point Road provides a direct connection from the Town of Friday Harbor (Town) to the site, which is located approximately 1.5 miles southeast of downtown. Turn Point Road continues to the east to Kansas Cove, and then becomes Pear Point Road as it follows the Island's southern shoreline to circle back to the Town. The site is located entirely within Shipyard Cove, a relatively shallow embayment that faces northward on the eastern side of San Juan Island. Shipyard Cove is generally protected by Brown Island; however, the site is exposed to roughly 2.5 miles of fetch from a northerly direction (Figure 2, Location & Vicinity Map).

The PoFH recently purchased the site from Albert Jensen & Sons, Inc. with the intent to redevelop the site and address existing environmental concerns. The property encompasses one parcel (351341005000) of approximately 4.8 acres of upland with 652 linear feet of shoreline and approximately 5 acres of aquatic lands currently managed under a Port Management Agreement (PMA No. 20-080023) with the Washington State Department of Natural Resources (WDNR). The site is partially developed and is currently underutilized due to impaired site conditions. Surrounding land uses include industrial, commercial and residential development. Shipyard Cove Marina and a barge ramp are located immediately to the northwest of Jensen's. Residential properties with private docks extend along the shoreline to the northeast of Jensen's.

3. PAST, CURRENT, AND FUTURE CONDITIONS

3.1 Site History/Past Land Use

Over a century of industrial uses have contributed to legacy contamination in the soil and marine sediment at this historical maritime site. The site was first developed as a shipyard before 1941; anecdotal evidence suggests that operations began as early as 1910. Originally, wooden boats were manufactured at the site, but when wooden boats were phased out in the middle of the 20th century, the site use moved from shipbuilding to boat repair and maintenance. Additional facilities, including a marina extending from the central shoreline into deeper intertidal and subtidal areas, and an upland fill area along the western property boundary extending from the upland into shallow intertidal areas, were built sometime between 1941 and 1972. Activities at the shipyard that likely contributed to increased contamination concentrations include the application and removal of antifouling paints, mechanical, and general maintenance work both over water and land, and treatment of wooden boats using pesticides. Also present on site was a former underground gasoline storage tank, a machine shop that was also used for hazardous chemical storage, a small dump site, and a marine railway.

3.2 Current Conditions and Land Use

Jensen’s is partially developed and is still used as a boat maintenance facility and shipyard (Figure 3, Existing Conditions). The site consists of three distinct areas: a boatyard, a marina, and an undeveloped upland and shoreline area. Jensen’s is zoned as Rural Industrial, which allows for light industrial, light manufacturing, seasonal residential, public, and some institutional uses.

3.2.1 Boatyard

The existing boatyard is located in the southwestern portion of the parcel. It encompasses approximately 1.5 acres of level work areas including boat storage, a laydown area, and a wash pad. Four buildings are associated with current boatyard operations: an office/retail building, a machine shop, a storage building, and a water treatment building through which water from the wash pad is circulated and then discharged into an evaporating pond on site. The boatyard infrastructure also includes a 35-ton travel lift that needs maintenance or replacement in the near future. The marine services provided at the boatyard include haul-out, pressure wash, bottom paint, light mechanical, chandlery and parts, and boat storage. The boatyard area has several areas where maintenance was deferred by the prior owner. Ongoing releases from the degraded structures (e.g., visible sheen associated with the creosote pilings) have been observed.

The shoreline along the active boatyard area is characterized by either vertical structures or steep berms. The boat pullout area consists of two piers supported by creosote-treated piling, ecology blocks, and a concrete wall. The shoreline here is a stacked ecology block bulkhead, through which uncharacterized upland fill material is sloughing into intertidal areas. Along the western property line, a fill area partially contained by a failing creosote-treated bulkhead extends from the uplands out into intertidal area. This bulkhead is in an advanced state of failure, acting as a source of creosote-treated wood debris and allowing uncharacterized fill to spill into intertidal areas. The intertidal areas here are barren of any vegetation.

3.2.2 Marina

Jensen’s also continues to operate an active marina that occupies the deeper intertidal and subtidal areas of the site. The existing marina includes approximately 50 slips; just over half are wood-framed, covered moorage. Marina structures include the main pier and a system of floats and floating finger piers consisting of creosote-treated piles and wood floats on unwrapped Styrofoam, three areas consisted of piling-supported boat house structures, an offshore piling-supported pier, a concrete floating breakwater, and various standalone piles and dolphins. A substantial amount of maintenance to these structures, as well as the associated electrical was was deferred prior to the PoFH purchase. Numerous piles are in advanced states of disrepair, including many that have already failed. Many of the floats are supported by open-cell Styrofoam, which appear to be highly degraded. Floats and piers are covered with solid wooden decking (both treated and untreated) in various conditions.

The PoFH demolished and removed most of the boathouses in 2021, and is in the process of replacing all remaining degraded marina infrastructure. Expansion of the marina is anticipated as part of the long-term redevelopment of the property.

The entire shoreline area, extending from intertidal elevations out to at least shallow subtidal depths, is heavily impacted with a substantial volume of debris, including concrete, tires, metal (motors, small parts, etc.), plastic, and other general rubbish. Within the boathouse areas, there appears to be some debris present on the seafloor, including tires that can be observed from the marina floats.

3.2.3 Undeveloped Upland and Shoreline Areas

The undeveloped area in the eastern portion of the property consists of approximately 2 acres of open grassy field and gravel parking areas. This area slopes moderately from Turn Point Road toward the waterfront and terminates at a low bank.

A derelict boat building structure is located near the shoreline east of the current boatyard area. Four rails (two rails per pair), which appear to be composed of deteriorating 10-inch x 10-inch creosote-treated timbers, extend from the intertidal area waterward of the derelict boat building structure out to subtidal elevations. It is not clear how far the rails extend, because they dive under the sediments at approximately 85 feet from the waterward edge of the concrete pad. The marine rails were originally used to launch boats and were later used to pull out boats for repair. These derelict structures are likely sources of contamination to upland, intertidal, and subtidal areas. The concrete pad at this location was added later and is not original to the marine rail system.

The undeveloped area also contains the remnants of a small derelict cabin, a small oil storage building further east, and a shallow dug well. An underground storage tank was formerly located in the field south of the oil storage building. The upper shoreline area appears to be composed of upland fill material and garbage (metal, plastic, concrete, wood waste, etc.), which is consistent with historical descriptions of the area being used as a dump. The garbage and fill material from the upper shoreline are emerging from the bank as it descends to upper intertidal elevations. There appears to be a remnant shoreline timber (some treated) structure, possibly an old pier or ramp, which has left a debris pile extending from the upper shoreline down to intertidal elevations.

3.3 Future Land Use

3.3.1 Master Plan

The PoFH is planning to redevelop two adjacent PoFH-owned properties: the former Albert Jensen and Sons Boatyard and Marina (Jensen's) and the former Shipyard Cove Marina (Shipyard Cove). The PoFH acquired the Jensen's property in 2018 with the goal of redeveloping the facility to retain existing marine related services and jobs, and to expand on maritime-related business opportunities, while restoring portions of the shoreline and providing public waterfront access. To guide this process, the PoFH prepared the Albert Jensen and Sons Boatyard & Marina Master Plan in 2018 (PoFH 2018). In 2019 the PoFH embarked on an update to the 2018 Master Plan after obtaining an Integrated Planning Grant (IPG) from Ecology to support the planning, cleanup, and redevelopment of the contaminated Jensen's property. In 2019 the PoFH acquired the adjacent Shipyard Cove property and decided to include both properties in the master plan update guiding the redevelopment of the joined properties to fully realize their development potential. The PoFH completed the new Master Plan (L-E and Reid Middleton 2020) in early 2020; however, the 2021 election cycle resulted in a new PoFH Commission composition. In response to the COVID-19 pandemic, the new PoFH Commission determined in early 2022 that changing priorities and community demands warrant a reevaluation of the current Master Plan (L-E and RM 2020). The PoFH anticipates that this process will occur throughout 2022.

Compatibility of the ongoing boatyard operations with the planned marina improvements, public access to parts of the site, and other potentially developed businesses and facilities (especially around issues such as safety, parking, and access) will be addressed as part of the master planning effort that is currently underway. Due to the contaminated soils, sediments and groundwater resulting from decades of industrial use at the Jensen's property, the redevelopment must be integrated with the cleanup of the former Jensen's property, especially the former boatyard area, shoreline, and aquatic areas, which are subject to Ecology-led remedial actions under the MTCA. Marina improvements may also be compatible and conducted co-incident with anticipated remedial actions for the site. The master plan will be coordinated with Ecology and the public.

3.3.2 Boatyard

The PoFH has determined that at least some of the deferred maintenance projects noted in Section 3.2.1 must be completed on an expedited basis to sustain current and future operations. These projects may be the subject of interim actions proposed under a subsequent remedial action grant application. The PoFH is coordinating all maintenance work with Ecology.

Under the 2020 Master Plan (L-E and RM 2020), the existing boatyard will be relocated further northwest from its current location on the former Jensen's property to the former Shipyard Cove property. It will extend to the vehicle turnaround planned at the future barge ramp. Moving the boatyard to this area allows for consolidating the required water access with the commercial barge ramp and freeing up the shoreline along the existing boatyard for cleanup and restoration. The new boatyard area will encompass approximately the same square footage as the existing one and will consist of a paved open-air laydown area and a paved and covered workspace built into the hillside. A substantial retaining wall of varying height will be required to construct the covered work areas on the hillside.

A barge ramp access road running through the center of the reconfigured Jensen's/Shipyard Cove facility will provide convenient access to the work areas on either side of the road and to the barge ramp. Sufficient environmental controls on runoff to keep potential hazardous materials out of Shipyard Cove will be implemented. A boatyard shop building is proposed in the northeastern corner of the future boatyard area. This building would be accessible from the marina parking area and from the shoreline promenade. The boatyard area will be fenced and gated, and either a landscape buffer and fence combination, a wall, or a combination of these two alternatives, will be constructed to separate the boatyard from the public access areas for safety and aesthetic reasons. The wall option may also be constructed to address sea level rise (SLR) and flood protection for the boatyard.

Although some infrastructure and site uses described in the 2020 Master Plan (L-E and RM 2020) are likely to change in response to the current master planning effort, the future barge ramp and associated access road are unlikely to change. The existing barge landing and Travel Lift Pier (TLP) are essential infrastructure for marina operations; however, the TLP is located in the area where the highest concentrations of potential contaminants of concern were measured, and based on existing data the PoFH presumes that the remedial investigation and feasibility study will conclude that it must be removed in order to remediate upland and in-water contaminants. Because this infrastructure is essential for marina operations, these functions must be replaced elsewhere on site before the PoFH can decommission the TLP and complete site cleanup. For this reason, the PoFH expects that the new barge ramp and associated access road described in the 2020 Master Plan (L-E and RM 2020) will be retained in the new Master Plan.

3.3.3 Marina

The PoFH has determined that at least some of the deferred maintenance projects noted in Section 3.2.2 must be completed on an expedited basis to sustain current and future operations. Coordinating subsequent remedial actions with marina maintenance and redevelopment is a key consideration for this project. Under the 2020 Master Plan (L-E and RM 2020), the two existing marinas on the project site will be consolidated into one larger marina with two access points (Attachment B, L-E and RM 2020). The PoFH does not expect this long-term goal to change as a result of the current master planning process. A variety of alternatives and potential phasing opportunities were reviewed as part of the Master Planning process for the in-water facilities. The new dock facilities will provide a range of slip sizes and provide double slip berths and side tie moorages. In the short-term, the PoFH is replacing and reconfiguring existing marina infrastructure for more efficient operations. In the long-term, the new docks will likely extend further out into the bay than the existing docks to accommodate demand for additional boat moorage in the Friday Harbor community.

The construction materials and final configuration will be determined in the design phase, but the following are general components of the long-term reconfigured dock systems. During the initial redevelopment phase, two new access piers may be constructed replacing the two existing ones in roughly similar locations. The two pile-supported fixed pier(s) would be constructed from land out to sufficient water depth to allow for an 80-foot-long gangway to access the new float systems. Any new pier infrastructure will have grated deck surfaces that meet American with Disability Act (ADA) accessibility requirements and minimize shading of nearshore habitat. The 80-foot-long gangways will meet current ADA requirements for accessibility to recreational moorage facilities. The final configuration will be determined later, but the PoFH is evaluating both a single access pier located in a central location and the dual-access configuration described above.

The new moorage slip facilities will be constructed of floating docks to allow for moorage in all tidal conditions. The docks will be placed offshore such that the docks do not ground out at extreme low tide. The PoFH is fabricating floats constructed with timber framing and grated decking supported by 18-inch high density poly ethylene (HDPE) pontoons to minimize shading. The adapted these same components in the design for the outer wave attenuators. Floats will be anchored by steel piling; however, concrete piling or anchor chain systems could be utilized for the design as well.

The new moorage facility will have full utility systems that meet code requirements and provide typical requested services for a marina. The utility systems will include a fire standpipe system (wet or dry depending on codes and local requirements), a potable water system to hose bibs, electrical and lighting services to the slips and on the docks, a boat sewage pump out or at the-slip pump out system for boat sewage handling, and other appurtenances such as life rings, and fire extinguishers. The specific utility system features will be determined in the design phase. The final configuration, elements, and materials of construction will be determined based on permitting, design, funding, and other factors.

3.3.4 Undeveloped Upland and Shoreline Areas

Under the 2020 Master Plan (L-E and RM 2020), the undeveloped upland and shoreline areas would include public facilities including a new Marine Technical Center (MTC), a reconstructed boat building, a kayak launch, and open lawn, picnic area, and loop trail.

The MTC project was anticipated in two phases. The first phase included the MTC and the demolition of the dilapidated old boat building, to the west of the proposed MTC. The second phase was expected to include the construction of a new building replacing within the demolished boat building in its current footprint. The purpose of the project was to revitalize the property by providing marine related business incubation space, to house the Islands' Oil Spill Association (IOSA) Headquarters, other office and light industrial workspace, and to provide public shoreline access.

The MTC building was proposed to be constructed in the eastern upland portion of the parcel that is currently undeveloped and mostly consists of an open grass covered area. It was to be located between the existing main access drive to the property and the shoreline. The proposed building was anticipated with a mass timber grid and diaphragm structure with gable roofs echoing its marine industrial purpose, setting, and the history of the site. Its footprint was anticipated at nearly 9,500 sf.

Movable planters, benches, and picnic tables were considered between the reinforced lawn strip and the covered exterior space along the southside of the building. Hookups for power and water would be available to host private and public outdoor events. Landscape plantings, utilizing native plants, and a variety of well adapted plants, including trees, shrubs, and groundcovers, were proposed along the new access drive near the eastern property line, along the northern edge of the building at the small entry plaza on the southwest corner of the building, and along the southside of the building. Additionally, the area between the MTC and the old boat building may be planted with native vegetation to restore riparian function.

The topography of the site and other requirements i.e., matching the grades of the future improved main access drive to the property, and providing ADA access to both levels of the building, would necessitate import and placement of fill materials and construction of retaining walls to accommodate the MTC and associated infrastructure. Structural fill material of crushed rock would be needed under building slabs and pavement surfaces. The PoFH intends to import fill materials from their stockpile at the Friday Harbor Airport, including compactable soil and sand. Stockpile areas were intended west of the project site within existing gravel and paved surfaces upland of the shoreline. Total anticipated earthwork volumes are approximately 3,500 cy; mostly cut.

The PoFH's plans for the undeveloped upland and shoreline areas is likely to change as a result of the current planning effort. A potential alternative the PoFH is evaluating includes expanding existing boatyard uses into the undeveloped area; however, the PoFH is likely to evaluate other alternatives in response to community input provided during the new master planning process. It is essential that the new master planning effort be an integral component of the remedial investigation and feasibility study to insure that clean up in compatible with future uses.

4. PAST FIELD INVESTIGATIONS

4.1 Upland

Investigations of upland areas have been conducted by Whatcom Environmental Services and by CRETE Consulting Inc. (CRETE) and are summarized in the reports below. This work has included soil, groundwater, and stormwater pond solids sampling. Additional data and information were acquired from publicly available information sources and references cited below.

Author	Year	Report
U.S. Department of Agriculture	2009	Soil Survey of San Juan County Area, Washington
Whatcom Environmental Services	2017	Phase I Environmental Site Assessment, Jensen’s Shipyard, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Initial Investigation Report, Jensen’s Shipyard, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Draft Remedial Investigation Report, Jensen’s Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
San Juan Surveying	2018	Topographic Survey for Port of Friday Harbor – Jensen’s Shipyard Planning Map
Shannon & Wilson	2019	Conceptual Site Model and Data Gaps Report, Former Jensen Shipyard, Friday Harbor, Washington
Leon Environmental, LLC and Reid Middleton, Inc.	2020	Port of Friday Harbor, Jensen’s / Shipyard Cove Master Plan, Friday Harbor, Washington.
Essency Environmental, LLC	2020	Critical Areas Report, Jensen Marine Trades Center – Port of Friday Harbor
CRETE Consulting Inc.	2021	Summary of IOSA/MTC Test Pitting and Data – Port of Friday Harbor, Jensen’s Marina

4.2 In-Water

The past field investigations of the in-water areas were primarily conducted by Whatcom Environmental Services (WE) as part of preliminary redevelopment planning. These data are summarized in three reports that WE prepared for the Jensen’s site: *Phase I Environmental Site Assessment* (WE, 2017a), *Draft Sediment Data Report* (WE, 2018c), and the *Draft Remedial Investigation Report* (WE, 2018d). Additional data and information were acquired from publicly available information sources and references cited below.

Author	Year	Report
Washington Department of Ecology	2001	Concentrations of Selected Chemicals in Sediments from Harbors in the San Juan Islands
U.S. Department of Agriculture	2009	Soil Survey of San Juan County Area, Washington
Whatcom Environmental Services	2017	Phase I Environmental Site Assessment, Jensen’s Shipyard, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2017	Sediment Sampling and Analysis Plan, Jensen’s Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Initial Investigation Report, Jensen’s Shipyard, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Sediment Investigation, Sediment Sampling and Analysis Plan, Jensen’s Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Draft Sediment Data Report, Jensen’s Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington

Author	Year	Report
Whatcom Environmental Services	2018	Draft Remedial Investigation Report, Jensen’s Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
San Juan Surveying	2018	Topographic Survey for Port of Friday Harbor – Jensen’s Shipyard Planning Map
Leon Environmental, LLC	2019	Intertidal and Subtidal Conceptual Site Model and Data Gaps Report, Jenson and Sons Boatyard and Marina, Friday Harbor, Washington.
Leon Environmental, LLC and Reid Middleton, Inc.	2020	Port of Friday Harbor, Jensen’s / Shipyard Cove Master Plan, Friday Harbor, Washington.
Fairbanks Environmental Services, Inc.	2020	Port of Friday Harbor Albert Jensen and Sons Boatyard and marina Eelgrass and Macroalgae Survey
Marine Surveys & Assessments	2021	Jensen Marina Habitat Survey Report

5. CONCEPTUAL SITE MODEL AND DATA GAPS

5.1 Physical Habitat Features

The Project site is located within Shipyard Cove, a relatively shallow embayment that faces northward on the eastern side of San Juan Island, immediately southeast of downtown Friday Harbor. Site bathymetry, uplands topography, and key subareas (San Juan Surveying, 2018) are shown in Figure 3. Shipyard Cove is generally protected by Brown Island; however, the Project site is exposed to roughly 2.5 miles of fetch through a narrow window from a direct northerly direction.

The shoreline along the active boatyard area is characterized by either vertical structures or steep berms. The less developed areas along the eastern side of the property, especially waterward of the old boat building structure, are more gently sloped with areas of estuarine marsh plants. The full extent of the site's low waterfront bank is composed of fill and debris, with contaminated soils known to exist in the active boatyard areas.

The undeveloped portions of the Project site are dominated by open grassy areas; other native vegetation is limited. Native trees and shrubs (a mix of evergreen and deciduous species) are found on the hillside east of the boatyard, near Turn Point Road, and in limited patches along the shoreline. Native plants present include Douglas fir (*Pseudotsuga menziesii*) and Pacific madrone (*Arbutus menziesii*), as well as native rose (*rosa sp*.) and ocean spray (*Holodiscus discolor*). Some areas of estuarine marsh vegetation, dominated by pickleweed (*Sarcocornia perennis*) and seaside plantain (*Plantago maritima*), were observed along the shoreline, especially waterward of the old boat building structure; however, substrate in all of these vegetated areas is highly impacted by a substantial volume of debris (typically concrete rubble, metal, plastic, wire, treated and untreated wood, etc.).

The marina occupies the deeper intertidal and subtidal areas of the Project site. Marina structures include the main pier and a system of floats and floating finger piers, three areas of piling-supported boat house structures, an offshore piling-supported pier, a concrete floating breakwater, and various standalone piles and dolphins. A substantial amount of maintenance has been deferred and the marina infrastructure was transferred to the PoFH in generally poor condition. Numerous piles are in advanced states of disrepair. Many of the floats are supported by open-cell Styrofoam, which appear to be highly degraded. Floats and piers are covered with solid wooden decking (both treated and untreated) in various conditions. Within the boathouse areas, there appears to be some debris present on the seafloor, including tires that can be observed from the marina floats. The PoFH is in the process of replacing deteriorated piling, floats, and boathouses.

The entire shoreline area, extending from intertidal elevations out to at least shallow subtidal depths, is heavily impacted with a substantial volume of debris, including concrete, tires, metal (motors, small parts, etc.), plastic, and other general rubbish.

Patches of eelgrass (*Zostera marina*) may be present in the subtidal areas of Shipyard Cove; eelgrass beds in the vicinity of the project site were found historically to occur at depths up to minus 21 feet MLLW (WDNR, 2001). An eelgrass survey conducted in June 2020 found two small patches of eelgrass at approximately -7 feet MLLW, one patch on either side of the Jensen's walkway float (Fairbanks, 2020).

A subsequent habitat survey performed on June 10-11, 2021 (MSA, 2021) documented Zostera marina eelgrass in one small bed and one patch between approximately -3.5 ft to – 6 ft MLLW. The small bed, measuring approximately 1,000 square feet and ranging in density from 0 to 16 turions per square meter, was documented on the west side of the marina, between the two main boathouse areas. The patch, measuring 3 feet by 1 foot with a density of 43 turions per square meter, was documented to the west of the bed and main walkway float.

5.1.1 Shoreline Characteristics

The upper shoreline areas at the Jensen's site consists predominantly of fill and debris that extend above ordinary high water (OHW). Except for the central area of the shoreline below the old boat building structure, the filled areas tend to descend steeply to upper intertidal elevations, where they generally level off to more natural slopes in intertidal and subtidal areas. Throughout the boatyard area, this filled shoreline consists of berms and vertical structures (creosote-treated bulkheads, ecology block walls, etc.). The upper shoreline of the undeveloped eastern area consists of what appears to be general rubbish and fill soils. The central shoreline of the Project site, located generally below the old boat building structure and between the marina pier (western boundary) and the old oil storage building (approximate eastern boundary), is more naturally-sloped with pickleweed growing in large areas of the upper intertidal zone; however, this shoreline is highly impacted with concrete rubble, debris, and a concrete pad. Fill materials were observed up to 7.5-feet below ground surface along the shoreline bank near the oil shed. There is no natural shoreline within the Project site. Immediately west of the Project site, a marina and barge landing facility operate along the shoreline. The shoreline immediately east of the Project site is a residential property. Additional descriptions of specific sections of the Project area shoreline are provided below.

The shoreline along the western side of the Project site shoreline below the boatyard consists of an overgrown, gravel-paved filled area partially contained by a failing creosote-treated bulkhead. The aerial photographs provided in WE's Phase I Environmental Site Assessment (ESA) (WE, 2017a) suggest that the area was filled between 1941 and 1972. The bulkhead is in an advanced state of failure, allowing fill to spill into intertidal areas. At intertidal elevations, the substrate consists of pea gravel, small cobbles, sand, and debris; this area is barren of any vegetation. Additional debris (including broken creosote-treated piling, larger metal and concrete) is present at deeper intertidal elevations.

The boatyard shoreline immediately east of the bulkhead consists of a steep berm separating the upland working area of the boatyard from intertidal areas. The berm is composed of rubble, garbage and other debris (metal, concrete, etc.). A small outfall pipe (~6-inch diameter), which serves as an emergency overflow from the boatyard stormwater detention and evaporation pond, extends from the base of the berm at roughly the midpoint of this stretch of shoreline. This outfall is shown in Figure 4. A band of vegetation (pickleweed, gumweed, henstooth, and drift algae) extends roughly 10 feet to 20 feet from the top of the berm, but ends abruptly at intertidal elevations. At upper and shallow intertidal elevations, the substrate consists of pea gravel, small cobble, sand, and debris (garbage, concrete, metal, etc.). A light sheen was observed in limited areas of the intertidal substrate. Except for potential clam shows, there was no obvious benthic activity noted within the barren intertidal area during an October 8, 2018, site evaluation; however, a benthic survey is anticipated as part of the remedial investigation phase to more fully assess the status of the benthic community. Additional debris (including broken creosote-treated piling, larger metal, and concrete) is present at deeper intertidal elevations.

The boat pullout area is located between the bermed shoreline to the west and the old overwater deck to the east. The boat pullout consists of two piers supported by creosote-treated piling, ecology blocks, and a concrete wall. Each pier is covered with timber decking and a single concrete rail for a boat lift to operate. The shoreline here is a vertical bulkhead, consisting of stacked ecology blocks. Upland fill material is sloughing through the eastern side of the ecology block bulkhead into intertidal areas. The substrate beneath each pier is covered in a substantial volume of debris, including concrete, metal, wire, engine parts, and other garbage. The boat haulout area between the two piers is maintained at deeper depths than on either side. The substrate between the piers is covered in shell hash, with less debris evident than in surrounding areas. As throughout the Project site, debris extends throughout the intertidal area, with larger debris present at deeper elevations.

The shoreline immediately east of the boat pullout is completely covered by an old overwater deck and the marina pier. The overwater deck is composed of solid timber decking and supported by creosote-treated piles; however, the structure is in poor condition due to deferred maintenance. The marina pier is located immediately east of the overwater deck and is currently in operational condition. It is built with solid CCA-treated decking and supported by creosote-treated piles. The shoreline along the overwater deck and marina pier is a vertical bulkhead, consisting of stacked ecology blocks. The bulkhead is leaning waterward and requires maintenance. There is evidence that the bulkhead is being undermined, with settling observed in soils on the immediate upland side of the bulkhead. The substrate beneath the overwater deck and marina pier is covered in a substantial volume of debris that is consistent with shoreline conditions along the boatyard.

The shoreline immediately east of the marina pier and waterward of the old boat building structure features a more natural-appearing slope, but the intertidal substrate consists of cobbles, imported gravel, mud, and concrete rubble. Concrete pads located between the marina pier and the old boat building extend from intertidal elevations up to the active boatyard. Four rails (two rails per pair), which appear to be composed of 10-inch x 10-inch creosote-treated timbers, extend out to subtidal elevations. It is not clear how far the rails extend, because they dive under the sediments at approximately 85 feet from the waterward edge of the concrete pad. The upper intertidal area consists of pickleweed that extends all the way up to the old boat building; this upper area is addressed in the ship rail work area (SRWA) in the uplands. There is evidence that clams may be present at lower intertidal elevations, but similar to the entire western half of the Project site, the benthic community in this area appears relatively barren.

The shoreline along the eastern boundary of the Project site is located below the undeveloped area. The upper shoreline area appears to be composed of upland fill material and garbage (metal, plastic, concrete, wood waste, etc.), which is consistent with historical descriptions of the area being used as a dump (WE, 2017a). There appears to be a remnant shoreline timber (some treated) structure, possibly an old pier or ramp, which has left a debris pile extending from the upper shoreline down to intertidal elevations. The upper shoreline features mature vegetation (primarily native trees and shrubs, and invasive blackberries and scotch broom). Extending inland from the intertidal area along the eastern shoreline is buried debris and fill materials that comprise the bank. The debris and fill extend inland towards the oil shed and former abandoned cabin (demolished), comprising the Former Dumping Area (FDA). The garbage and fill material from the upper shoreline are emerging from the bank as it descends to upper intertidal elevations. Bank vegetation consists of snowberry, ocean spray, blackberry, and scotch broom. Upper intertidal vegetation consists of Turkish towel and ulva, which transition to pickleweed and rockweed at lower elevations. The intertidal substrate consists of gravel and cobble at upper intertidal elevations transitioning to mud, algae, and debris at lower intertidal elevations. Consistent with the entire Project site shoreline, a substantial field of debris extends out to subtidal elevations.

5.1.2 Upland Areas

5.1.2.1 Ship Rail Work Area

The SRWA includes rail lines east of the pier and the old boat building structure. The SRWA has a lower elevation than the surrounding uplands, including high intertidal elevations with abundant pickleweed. This rail lines were used to transport boats during ship building and maintenance, and contamination in the SRWA is likely a result these activities. As outlined by Shannon & Wilson (2019), SRWA contamination may include metals from paint stripping operations, possibly impacted fill used to develop the SRWA, and TPH-DRO and cPAH from boat maintenance and drained boat bilge water. The SRWA may have also collected stormwater runoff, soils and debris eroded from adjacent upland areas. There are currently no operations that occur within the SWRA.

5.1.2.2 Boat Lift Work Area

The boat lift work area (BLWA) is an approximately 100-foot-wide area along the shoreline, immediately west of the SRWA and extending west to the western property line. The adjacent shoreline, from west to east, includes the small fill area that projects into the water, the berm area with an outfall, the boat pullout, the old overwater deck, and the marina pier. Activities conducted in this area may be similar to those of the SRWA, including paint stripping, paint applications, draining boat bilges, treated wood use, and possibly impacted fill materials used to develop and elevate this area in the past (Shannon 2019). Current operations include best management practices to minimize the potential for contaminant releases.

5.1.2.3 Former Dumping Area

The FDA is located to the east of the SRWA along the shoreline. This shoreline area was formerly used for dumping of miscellaneous boat parts or debris was observed during the Phase I Environmental Site Assessment by Whatcom Environmental Services (Whatcom 2017). Debris observed has included tires, plastic, metal parts, two engine blocks, hoses, cables, a large battery, and other metal and wood debris. No sheen or staining has been noted in the FDA.

A former cabin was located about 50 feet east of the FDA and a former oil shed was located adjacent to the FDA. The former owner indicated that the shed contained 300-gallon gasoline and diesel ASTs and a 300-gallon waste oil tank. During the Phase 1 ESA a waste oil AST along with several smaller diesel, gasoline, and waste oil drums were observed. No evidence of spills or overtopping were noted in or around the building and concrete flooring was present throughout the shed for containment in the event of a spill (Whatcom 2017).

To the south and southeast of the FDA is a large grassy area that formerly included a residence. A water well may be present near the southern edge of the grassy area but no well information was provided in previous documents. A UST was also formerly located near the western edge of the grassy area. The former UST was used to fuel equipment onsite, and was removed in the 1980’s. The former owner indicated that the former UST contained gasoline. Soil and groundwater sampling in this area suggest that no contamination is present.

5.1.2.4 Former Above Ground Storage Tank

It is suspected that an AST was formerly located south of the central former shop building. There is no documentation regarding the size or contents of the former AST. Results from a shallow soil sample suggest that the AST likely contained a heavier fuel such as heating oil.

5.1.2.5 Shop Floor Drain and Outfall

The shop building has also been noted as the machine shop building in previous documents, suggesting the presence of lubricants and cleaning solvents. A 3-inch diameter floor drain is present near the northwest corner of the building. The drain was used to dispose of liquids from the machine shop. The drain was investigated in the past, at which time it was noted that the drain appeared to flow to a holding tank or drum underground. The former owner noted that the tank or drum may have been perforated or may have contained a drain line for the contents to drain, but the destination of the contents was unclear. The tank or drum was not removed as part of previous investigations. A sample of material collected from the drain contained elevated TPH and metals plus PAHs, tetrachloroethene and a few other VOCs.

5.1.2.6 Stormwater Pond

The stormwater detention pond is located in the southwest portion of the property, west of the shop building. The pond is lined and equipped with a pump and fountain to facilitate evaporation. The pond is emptied of water annually. When emptied, the water is transported offsite and dumped on the ground and allowed to infiltrate. Ordinarily, the water is dumped on the property to the south, across Turn Point Road. A sample of pond sediment collected in 2018 indicated the presence of elevated metals concentration. No other analytes were tested.

5.1.2.7 Former Orcas Power and Light Company Pad

A former Orcas Power and Light Company (OPALCO) storage area in the western portion of the site was identified and investigated for surface contamination. The pad is the building foundation of an OPALCO building that burnt down, possibly contributing to cPAHs. Shipyard activities, paint-stripping, and stored creosote-treated wood are possible sources of contamination. (Shannon 2019).

5.1.2.8 Wooded Hillside Area Along Turn Point Road

The wooded hillside area south of the OPALCO pad area, the stormwater pond, and the shop building has not been investigated. No RECs were noted in the Phase I ESA (Whatcom 2017) and no subsequent investigation activities were conducted in this area.

5.1.3 Hydrology

The site is entirely saltwater (25 parts per thousand) and experiences mixed semidiurnal tides, with a tidal range of 7.76 feet (NOAA, Station ID 9449880). The average annual precipitation at the property is approximately 20 to 40 inches, the average annual air temperature is approximately 48 to 50°F, and the average frost-free period is 200 to 240 days (WE, 2017a). The shoreline orientation faces northward and is entirely open to the dynamics of tides, waves, and winds from Puget Sound. No wind-wave analysis has been conducted at the Project site; however, this information has been identified as necessary to support necessary marina maintenance and improvement. Freshwater input is expected to be primarily surface runoff and seepage from storm events. With the exception of the single, 6-inch pipe extending from the berm along the boatyard area (Figure 4, Outfall photo), no other watercourses or outfalls were observed. The 6-inch pipe serves as the emergency overflow from the onsite stormwater detention and evaporation pond. The pond overflow pipe is included in Jensen's National Pollutant Discharge Elimination System (NPDES) Boatyard General Permit Coverage (WAG994386). At the time of the inspection, there was no indication that discharges have occurred from the pipe. The PoFH reports that no discharges have ever occurred and anticipates vacating the pond and pipe as part of future marina improvements. WE collected limited groundwater data at the Project site and identified a generally northward movement of groundwater from the uplands to and into the intertidal and subtidal areas

(Figure 5, Groundwater Elevation) (WE, 2018d), but did not calculate volumes or definitively confirm interaction with marine waters. Although no detailed hydrologic study has been performed, the site is characterized by a relatively shallow groundwater table that may be influenced by the tidal cycle throughout the nearshore. Tidal response is typically observed in shallow shoreline aquifers of this nature to about 50 to 100 feet inland, depending on the aquifer thickness and soil type. The sloped shoreline is comprised of materials generally pervious to groundwater flux, and the surrounding upland ground surface consists of unpaved soils that do not limit infiltration and percolation of precipitation.

5.1.4 Site Geology

Soils in the upland area of the subject property are described in the Soil Survey of San Juan County Area, Washington (U.S. Department of Agriculture [USDA], 2009) and summarized in the Phase I ESA prepared by WE (WE, 2017a). The Soil Survey designates the upland soil as a mixture of Beaches-Endoaquents, tidal-Xerorthents association; Mitchellbay-Rock Outcrop-Killebrew complex; and Cady-Rock Outcrop Complex. The soil is composed of approximately 38% Beaches-Endoaquents, tidal-Xerorthents association; 26% Mitchellbay-Rock Outcrop-Killebrew complex; and 36% Cady-Rock Outcrop Complex.

Soils in the grassy uplands area included up to 1-foot of dark-brown organic-rich topsoil, with an underlying gravelly fine to medium-grained sand, orange-brown in color and observed up to 5-feet below ground surface (ft bgs). Below this gravelly sand was observed a firm to hard, brown to gray, sandy silt with minor to some clay content. An occasional erratic boulder was observed in the undisturbed upland soils (CRETE 2021).

5.2 Nature and Extent of Contaminants

5.2.1 Soil and Groundwater

Screening level (SL) development is described in detail in Section 8 of this RIWP. Conservative SLs were developed for soil and groundwater as a means of assessing constituents of interest and the nature and extent of soil and groundwater contamination based on available pre-RI data. In future RI phases, SLs will be refined into cleanup levels, including evaluating soil protective of groundwater SL exceedances versus empirical groundwater data.

Constituents of interest (COIs) were selected based on having greater than a 5% detection frequency and at least one detected value over the screening level (Appendix A). This approach is consistent with the procedure for determining Contaminants of Potential Concern (COPCs) in EPA and Oregon Department of Environmental Quality risk assessment guidance. For groundwater, due to the limited set of existing data, a groundwater COI was also assessed based on saturated soil screening level exceedances.

The selected groundwater COIs are:

- TPH-Dx
- Metals
    - Cadmium
    - Chromium
    - Copper
    - Lead
    - Mercury
    - Zinc

The selected soil COIs are:

- TPH-G
- TPH-Dx
- Dioxins/Furans
- PAHs
    - 1-methylnaphthalene
    - 2-methylnaphthalene
    - Acenaphthene
    - Anthracene
    - Fluoranthene
    - Fluorene
    - Naphthalene
    - Pyrene
- cPAHs
- Metals
    - Arsenic
    - Cadmium
    - Chromium
    - Copper
    - Lead
    - Mercury
    - Zinc

As discussed in Section 5.5.2, soil samples will be analyzed for PCB aroclors, pesticides, and TBT even though these analytes were not determined to be COIs based on existing analytical data.

5.2.1.1 Soil Contamination

A significant surface soil dataset has been developed during previous investigations but a more limited subsurface dataset is available. Table 5-1 (Tables section) provides a soil data summary for the COIs. Figures 6 through 29 illustrate the distribution of soil SL exceedances for select compounds in surface, vadose zone, and saturated zone soil.

No soil samples have been analyzed for TBT, semi-volatile organic compounds (other than PAHs), volatile organics, or pesticides.

5.2.1.1.1 Petroleum

TPH-G/benzene, toluene, ethylbenzene, and xylenes (BTEX) were analyzed in 10 soil samples. BTEX compounds have not been detected. TPH-G has been detected above the SL in 2 samples (MW-1 12 ft and SRWA-3 0-6 in) and 32 and 84 mg/kg, respectively.

The extent of TPH-Dx exceeding SLs is illustrated in Figures 6 to 28. TPH-Dx was detected at elevated concentrations in surface soil at MW-1 and SWRA-3, in the vadose zone at AST-1 2 ft bgs, and in the saturated zone at BLWA-6. Other soil concentrations of TPH-Dx are reported for the BLWA, SRWA, OPALCO pad, shop, and shipyard cove areas at concentrations below the SL.

5.2.1.1.2 Polychlorinated Biphenyls (PCBs)

Limited soil and groundwater PCB aroclor data have been collected (10 samples). Concentrations at SWRA-3 and MW-4 soil boring in surface soil were below the SL. PCB was not detected at MW-4 at 11 ft bgs. PCB was also not detected in surface or subsurface soil (up to 5 ft bgs) in the OPALCO pad area.

PCBs may also be present in surface soil at MW-3 in the SRWA as discussed in the following section.

5.2.1.1.3 Dioxins and Furans

Limited soil and groundwater dioxins/furans data have been collected (2 samples). Dioxin and furan concentrations (evaluated as total 2,3,7,8-TCDD equivalence) exceeded the SL in surface soil L at MW-4 and MW-3.

A preliminary evaluation of the homologs indicates that the MW-4 signature is similar to background data, while the MW-3 signature has elevated furans suggesting a site impact, potentially from PCBs.

5.2.1.1.4 Metals

Extensive soil sampling and analysis for metals has been performed. The distribution of SL exceedances for six of the seven metals COIs in soil are illustrated in Figures 9 through 26. Separate figures are provided for surface, vadose zone, and saturated zone soil for each COI. Copper is the most prevalent metal COI in soil. All of the metals show a similar pattern of more widespread distribution in the surface soil with vadose and saturated zone impacts focused in the primary source areas: the BLWA and SRWA. Less consistent SL exceedances of copper, zine, and arsenic occur near the OPALCO pad, the FDA, the AST, and the shop drain.

5.2.1.1.5 PAHs

Extensive soil sampling and analysis for PAHs has been performed. The distribution of SL exceedances for PAHs is similar to the distribution for the metals. CPAH exceedances are widespread in surface soil with vadose zone impacts focused in the primary source areas: the BLWA and SRWA (Figures 27 through 29).

5.2.1.2 Groundwater Contamination

Six groundwater monitoring wells were installed at the Site in 2018. Groundwater sampling has been performed twice (August 2018 and February 2020) and the data are summarized in Table 5-2 (Tables section). In 2018, groundwater samples were analyzed for metals, TPH-G/BTEX, TPH-Dx, and PAHs. In 2020 TPH-G and PAHs were not analyzed but NWTPH-Dx with silica gel cleanup (SGC) and volatile organic compounds (VOCs) were added to the analytical suite. Groundwater sampling was not performed based on tidal study results so it is not clear that sampling was performed at the appropriate time during the tidal cycle although, during the 2020 event, sampling was performed following a negative low tide at estimated tidal lags that would results in low water elevations in MW-2, MW-3, and MW-5. Specific conductivity data indicate that there is significant sea water influence at MW-2 and MW-3.

Cadmium, mercury, PAHs and VOCs (including BTEX) were not detected in any sample. During the 2018 sampling event, TPH-G was detected in MW-2 and TPH-D was detected in MW-1 and MW-2. TPH-D was not detected in these wells during the 2020 sampling event.

Chromium, lead, nickel, and zinc were detected in one to six wells, but all results were below SLs. Copper exceeded SLs in both events at MW-1. Copper exceedances also occurred at MW-2, MW-3, and MW-4, but the results were not consistent. There were no exceedances of SLs at MW-5 and MW-6.

The estimated extent of groundwater exceedances of SLs is illustrated on Figure 5.

5.2.2 Sediment Characteristics

Sediments within the Project site have been minimally characterized and additional sediment sampling is anticipated as part of a subsequent remedial investigation; however, existing data support a preliminary conclusion that contaminants originating from Jensen's operations are generally concentrated around the central boatyard area and have not migrated offsite via intertidal or subtidal pathways (WE, 2018c). A summary of grain size and other conventional sediment characteristics is provided in WE's Draft Sediment Data Report (WE, 2018c). A summary of SMS exceedances detected during the 2018 characterization (WE, 2018c) is provided in Table 5-3 (Tables section). WE's sediment data (WE, 2018c) are reproduced in Appendix A.

Previous sediment characterizations at the Jensen Shipyard were limited and focused only on surface conditions. Sediment samples were collected from the site by the Department of Ecology in 1997 as part of a larger study conducted to determine the occurrence and extent of toxic chemicals associated with marina activities in four harbors in the San Juan Islands. The results of sediment chemical testing were summarized in a 2001 Department of Ecology report titled Concentrations of Selected Chemicals in Sediments from Harbors in the San Juan Islands (Ecology, 2001). Two sediment samples collected within the aquatic area of the subject property exceeded the screening level of 73 micrograms per kilogram (µg/kg) for tributyltin (TBT) at concentrations of 135.3 µg/kg (FR1) and 74.8 µg/kg (FR3) (Ecology, 2001).

In February 2018, upland soil and marine sediment samples were collected by WE and the results summarized in the report Initial Investigation Report (WES, 2018a). Fifteen soil samples and thirteen sediment samples were collected during the investigation. The soil sample results indicated that portions of the site are contaminated with metals (primarily copper and lead), petroleum compounds, and cPAHs.

In August 2018, WE collected additional sediments in accordance with the Sediment Investigation, Sediment Sampling and Analysis Plan (SAP) (WE, 2018b) approved by Ecology. The purpose of the study was to further characterize sediment quality in the marine area of the Shipyard and Marina site. An additional seven surface sediment samples were collected. Three of the sampling stations had been previously sampled during February and were resampled to supplement the original data set with an evaluation of dioxins/furans. The results were summarized in WE's Draft Sediment Data Report (WE, 2018c).

Collectively, the sediment sample results indicated that marine surface sediments (particularly near the shore) contain concentrations of metals, PAHs, PCBs, phthalates, pesticides, and tributyltin that exceed regulatory thresholds. The elevated concentrations were detected in samples collected from the nearshore marine areas close to the old marine railways and the current boat travel lift. Elevated concentrations were also present to a lesser extent in samples collected further west of the lifts and beneath the covered boat moorage slips. Sediment results were compared to the Sediment Quality Standards (SQS) marine chemical criteria levels (Chapter 173-204-320 *Washington Administrative Code* [WAC]), where applicable. TBT and dioxins/furans results were compared to the established sediment natural background value, which is the basis for the Dredged Material Management Program (DMMP) dioxin/furan screening level (USACE, 2016). Chemicals with concentrations exceeding applicable target criteria and screening levels include PCBs, various PAHs, phthalates, pesticides, copper, zinc, mercury, and TBT. WE's surface sediment concentrations figures (WE, 2018c) (TBT, PCBs, mercury, and fluoranthene) are provided in this report as Figures 30 through 33. The study recommended further sediment sampling to more thoroughly delineate the presence of chemicals in sediment at the site.

Additionally, the entire in-water area is known to be heavily impacted with a substantial volume of debris from intertidal elevations out to at least shallow subtidal depths. Within the boathouse areas, there appears to be some debris present on the seafloor, including tires that can be observed from the marina floats. The dense concentration and extent of debris observed is expected to interfere with subsequent sediment sampling efforts.

The following paragraphs describe known contaminated sediment characterization of surface sediments (WE, 2018d) and offer a starting platform for additional sediment characterization during the remedial investigation phase.

5.2.2.1 Tributyltin (TBT)

Elevated TBT concentrations were encountered throughout nearshore areas adjacent to upland work areas at the site. TBT concentrations were particularly elevated in the intertidal zone along the base of the historical western railway. The DMMP screening level was exceeded at sample locations SED-7, SED-8, SED-9, SED-10, and SED-13. Additionally, the screening level was exceeded directly offshore from the marine railways at sample location SED-14. All other samples contained detectable concentrations of TBT below the screening level. TBT concentrations reported by WE (WE, 2018c) are shown in Figure 30.

5.2.2.2 Polychlorinated Biphenyls (PCBs)

PCB concentrations (evaluated as total Aroclors) exceeded the applicable criteria levels in the nearshore area at the end of the travel lift slip (SED-9), at the intertidal zone located at base of the historical western railway (SED-10 and SED-13), and directly offshore from the marine railway (SED-14). Samples SED-10, SED-13, and SED-14 were compared to the SQS criteria. Due to the elevated organic carbon content, sample SED-9 was compared to Apparent Effects Threshold (AET) criteria, as recommended in Ecology's Sediment Cleanup User's Manual (SCUM) Table 8-1 (Ecology, 2021). All other samples contained detectable concentrations of PCBs below applicable criteria. This evaluation compared PCB Aroclors to benthic criteria. Although the initial sediment sampling effort will focus on PCB Aroclors, if required, it is anticipated that supplemental field mobilizations of the remedial investigation will collect PCB congener data for comparison to applicable toxicity equivalent (TEQ) background criteria and human health protective levels. PCB concentrations reported by WE (WE, 2018c) are shown in Figure 31.

5.2.2.3 Dioxins/Furans

Dioxins/furans concentrations (evaluated as total 2,3,7,8-TCDD equivalence) exceeded the established sediment natural background value (4 parts per trillion [ppt] TEQ), which is the basis for the applicable DMMP screening level in the nearshore areas at the north end of the boat travel lift (SED-9d) and at the base of the historic western railway (SED-10d and SED-13d). Dioxins/Furans have not been evaluated in any other marine areas of the site.

5.2.2.4 Metals

Elevated metals concentrations were encountered in the nearshore area. Copper, mercury, and zinc concentrations exceeded applicable SQS criteria at sample stations located in the intertidal zone at base of the historical western railway (SED-10 and SED-13). Additionally, mercury exceeded the criteria just northeast of the railway (SED-11), and copper exceeded the AET criteria at the end of the travel lift slip (SED-9). No other metals exceeded the applicable criteria in marine sediment at the site. Mercury concentrations reported by WE (WE, 2018c) are shown in Figure 32.

5.2.2.5 Organic Chemicals

Benzyl alcohol concentration exceeded the SQS criteria at sample station SED-9. The result was flagged by the lab as being an estimated concentration (J-flagged) and was only slightly above the SQS criteria. The result may or may not be of concern. Detected organic chemical concentrations did not exceed applicable SQS criteria at any other sampling station. However, numerous organic chemical results were reported at elevated detection limits that are above applicable SQS (and/or AET) criteria.

5.2.2.6 Phthalates

Butylbenzyl phthalate and dimethyl phthalate concentrations exceeded the SQS criteria at one sample station located at the north end of the boat travel lift (sample station SED-9). No other phthalate exceedances were encountered in marine sediment at the site.

5.2.2.7 Polycyclic Aromatic Hydrocarbon (PAH)

Various PAH constituent concentrations exceeded the SQS criteria levels in the nearshore areas at the north end of the boat travel lift (SED-9) and at the base of the historical western railway (SED-10 and SED-13). PAH constituents detected at sample station SED-9 exceeded six of the eighteen criteria levels. PAH constituents detected at sample station SED-10 exceeded eleven of the eighteen criteria levels. PAH constituents detected at sample station SED-13 exceeded three of the eighteen criteria levels. No other PAHs exceeded the applicable criteria levels in marine sediment at the site. Evaluation of cPAH risk is anticipated in a subsequent remedial investigation. Fluoranthene concentrations reported by WE (WE, 2018c) are shown in Figure 33.

5.2.2.8 Chlorinated Organics

No chlorinated organics were detected in sediment at the site above applicable SQS criteria. However, due to the dilution factors (created by converting data to dry weight and also converting to carbon normalized data), some laboratory detection limits were elevated greater than the SQS criteria.

5.2.2.9 Pesticides

Total chlordane exceeded the DMMP screening level at two sample stations located approximately 300 and 450 feet from shore, beneath the covered boat slips (SED-3 and SED-5). There were no other chemical criteria exceedances at those sample stations. Pesticides were not evaluated during the most recent sampling event.

5.3 Physical Processes Conceptual Site Model

The physical processes description synthesizes what is known about important physical processes operative on and within the embayment where Jensen's is located. The twin foci include identifying the sources and transport pathways that introduced chemical contamination to the sediments, and on the processes that govern sediment transport. This information, coupled with data regarding the nature and extent of sediment contamination, will inform a prudent and cost-effective approach to address the need for and nature of remediation. Upland contamination can most directly impact sediment via erosion of surface soil to sediment. Surface water and sediment can also be impacted via the soil-groundwater-surface water and the soil-groundwater-sediment pathways. These processes and pathways will be further evaluated during the RI.

The following sections discuss likely transport pathways at Jensen's. These pathways are shown conceptually in Figure 34 (In-Water Physical Conceptual Site Model – Plan View) and Figure 35 (In-Water Physical Conceptual Site Model – Cross Section).

5.3.1 Hydrodynamics

Shipyard Cove is subject to a range of hydrodynamic forces that potentially affect the movement and stability of the sediments. Water circulation is primarily influenced by the open and unimpeded connection to Puget Sound, so natural tides, currents, and wind-generated waves can be expected to sort and distribute intertidal and shallow subtidal sediments. During storm events, significant discharges from surface runoff, would be expected and (depending on storm strength, duration, and direction) could further concentrate sediment contamination along the shore or disperse it. There is regular active boat traffic via the shipyard and adjacent marine based activities (i.e., a barge landing operation located immediately north of the shipyard), which are large enough that propeller-generated currents (propwash) are likely to redistribute surface sediments in the shallower locations of the shipyard.

Sediment transport and sedimentation rates in Shipyard Cove, particularly around the Project site, are unknown. Shipyard Cove is entirely open to Puget Sound, so tides, currents, and wind-generated waves are expected to be dynamic forces that influence deposition and distribution of surface sediments. However, the Project site is generally sheltered from the east, west, and south by the shoreline of Shipyard Cove. The adjacent Shipyard Cove Marina shelters Jensen's from northwest exposure, and Brown Island also shelters Jensen's from north-northwest exposure.

The sediment bed in Shipyard Cove seems to be stable under normal circumstances. The Project site is exposed primarily to wind and wave energy coming from the north, which is expected to occur only during episodic events. Bathymetry shows a shallow sill gently sloping into deeper marine waters. Because of the embayment's northern orientation, wind and wave forces are expected to concentrate sediments up the shoreline or redistribute sediments east/west along the shoreline. Given the shallow depth of the embayment and the amount of regular boat activity, it is likely that propwash is a more important factor in sediment transport and redistribution, particularly in the vicinity of the boat lift at Jensen's and the barge landing site on the adjacent property.

5.3.2 Water Column/Suspended Sediment

Shipyard Cove is relatively sheltered, open only to wind and wave induced forces from the north. Because there is little indication of sediment deposition across the Project site, sedimentation rates are expected to be low; however, no data has been collected for the area. Similarly, no current water velocity information is available, which would help evaluate sediment transport.

5.3.3 Groundwater Transport

Groundwater flow at the site is toward the shoreline. Shoreline groundwater quality was not assessed during previous site investigations although elevated soil concentrations are present along the shoreline. Tidal fluctuation impacts groundwater flow and creates substantial dilution and attenuation within the upland shoreline and in the hyporheic zone. Soil and groundwater quality and flow will be assessed to determine if this is a significant transport mechanism.

5.3.4 Lateral Loads

A single, 6-inch pipe extends from the berm along the boatyard area (Figure 5, Outfall photo). The pipe serves as the emergency overflow from the onsite stormwater detention and evaporation pond. The pond is located in the southwest portion of the property, west of the machine shop. It is equipped with a pump and fountain to facilitate evaporation, but is emptied of water annually (WE, 2017a). The pond receives wash water from a wash pad located at the end of the boat pullout. Wash water is treated in a closed-loop system using enzymes and diverted to the pond (WE, 2017a). Although the pond has been identified as a potential area of concern for tributytins and other heavy metals (WE, 2017a), there is no indication that discharges have occurred from the emergency overflow pipe, and the PoFH confirms that no discharges have ever occurred. No other point source outfalls or streams have been identified as discharging to the embayment where Jensen's Shipyard is located, although a sheen was observed close to the creosote pilings supporting the travel lift during a May 9, 2019, site visit.

5.4 Potential Human and Ecological Receptors

A complete CSM includes general information about sources leading to chemical contamination of sediment, water, and biota. The model also includes pathways for human exposure to chemicals through these media. With sufficient information, for each pathway-media combination, a determination can be made as to whether the pathway is complete or incomplete. A complete exposure pathway includes an exposure medium and exposure point, a potentially exposed population, and an exposure route. Incomplete pathways do not meet these criteria. They may require assessment, but cannot be evaluated quantitatively since both exposure (a complete pathway) and toxicity are required to quantify risk. The identification of complete or incomplete pathways can be used to inform the data gaps analysis. Complete pathways expected to represent a potential exposure of health concern may need to be evaluated in a risk assessment, if potential remedial alternatives include scenarios where final surface concentrations of chemicals exceed SMS criteria. For pathways identified as having low exposure and risk potential relative to other pathways being evaluated, a determination will be made in consultation with Ecology about the utility of some type of evaluation of the pathways (e.g., comparisons to other quantified exposure pathways) for risk communication purposes or to evaluate whether a standardized remediation remedy would achieve adequate compliance with existing standards and acceptable reduction of risk. The exposure parameters and the likelihood of exposure under both current and future land use at the site may need to be evaluated for any significant exposure pathways.

For the upland areas, the potential receptors may be exposed via direct contact or ingestion. Current and future human receptors may be exposed to hazardous substances by direct contact or ingestion of soil, groundwater, contaminated stormwater and associated sediment, or by inhalation of dust. These pathways are considered complete but minor as they are primarily incidental to construction and normal boatyard work where measures are taken to reduce exposure, such as the use of personal protective equipment while accomplishing work. Vapor intrusion is not considered a pathway of concern since VOCs (including naphthalene) have not been detected in groundwater and only diesel or heavier hydrocarbons are present.

5.4.1 Potential Human Exposure Scenarios

Potential human exposure scenarios are described qualitatively below. If required, subsequent quantitative analysis is expected to occur as part of a remedial investigation.

5.4.1.1 Water Recreation

Direct contact with embayment waters is a key exposure scenario to be considered for people. Recreational opportunities abound around the island and throughout the San Juan archipelago. Water recreation at Jensen's can include swimming, self-contained underwater breathing apparatus (SCUBA) diving, pleasure boating, fishing, and time spent on the marina floats. These potential exposure scenarios are focused primarily on the surface water pathway. Although sediment contact may occur during such activities, the frequency and duration of this contact is expected to be much lower than the shore recreation scenario. For this reason, any risk associated with potential sediment exposure during water recreation is addressed through the direct-contact scenario for shore recreation.

Site access, either by the upland or via boat, is not restricted to the public, but many recreational activities would be unsafe or undesirable given vessel traffic and the current debris impacts to shoreline and shallow subtidal lands.

The current frequency of swimming in the site is unknown; however, it is assumed that recreational swimming rarely occurs at or around Jensen's. Similarly, although the frequency that recreational SCUBA diving occurs around Jensen's is unknown, it is expected to be low. The most likely exposure scenarios include incidental exposure during boating, fishing, and spending time recreating on the marina's floats. Future remediation and restoration actions that could be conducted at the site could change the frequency of these recreational activities; however, a substantial increase is not anticipated.

A water recreation scenario could be developed for the site, but the utility is expected to be low. A risk assessment conducted by King County (King County, 1999) found that risks associated with swimming in the Duwamish River and Elliott Bay due to water exposure were small. As part of the anticipated remedial investigation for Jensen's, the Duwamish River and Elliott Bay water recreation exposure scenarios will be compared to conditions at Jensen's; however, because risk associated with water recreation exposure scenarios is expected to be low, these scenarios are not anticipated to require subsequent evaluation. A determination about whether subsequent evaluation is required will be made in consultation with Ecology.

5.4.1.2 Shore and Upland Recreation

Boat owners, trespassers, and other public users of the property may be exposed to surface soil through incidental contact or dust. Exposures are anticipated to be incidental but the exposure pathway is complete. Soil cleanup levels developed for the site will address this exposure pathway.

Activities with the potential for sediment exposure include beach play, clamming, launching small vessels, and shoreline fishing. Direct contact with sediments can be either incidental (e.g., sinkers and fishing lines coming into contact with bedded or suspected sediment during normal activity and fishers contacting this sediment incidentally upon retrieval) or more extreme (e.g., sunbathing or being partly buried in sand as part of the beach experience). These same fishers and other recreationalists may also make additional incidental contact with surface water and suspended sediment while wading; however, risk associated with suspended sediments is expected to be low, and surface water exposure is addressed above in the water recreation scenario. The shore recreation scenario focuses on sediment pathway exposures, including dermal contact and incidental ingestion.

Shore recreation exposure to sediments is not expected to be prominent on intertidal areas along the western half of the property in front of the active boatyard; however, the eastern half of the property is likely to serve as a primary place for the public to access intertidal habitat at Jensen's. Currently, many recreational activities would be unsafe or undesirable given the current debris-impacted shoreline, but future remediation of the Project site is expected to address these impacts and encourage more public access.

A beach play scenario was developed to assess risks to young children (i.e., up to 6 years of age) from playing in intertidal sediments at publicly accessible beaches on the Lower Duwamish Waterway (LDW) that have public access from the shore (Windward, 2007). Assumptions in this study included unlimited public access from the shore, including from residential areas directly adjacent to the shore. The exposure parameters for this scenario, which were based on a survey of recreational lake use in King County (Parametrix, 2003), evaluated significant sediment exposure to children's bodies occurring 65 days/year. Other recreational exposure scenarios evaluated in this study focused on adult recreation are expected to be less protective than the child exposure scenario. As part of the anticipated remedial investigation for Jensen's, the LDW shore recreation exposure scenarios will be compared to conditions at Jensen's.

5.4.1.3 Occupational Exposure

Boatyard workers may be exposed to surface soil through incidental contact or dust. Exposures are anticipated to be incidental but the exposure pathway is complete. Personal protective equipment used by boatyard workers may help mitigate this exposure pathway. Soil cleanup levels developed for the site will address this exposure pathway.

Site construction workers may be exposed to soil and groundwater during earthwork activities, such as utility installation or site cleanup, due to incidental contact or dust. Workers exposed to contaminants during earthwork will use personal protective equipment to protect from the types and concentrations of contaminants that are present. Soil and groundwater cleanup levels developed for the site will address this exposure pathway.

Much of the work around piers and water craft necessarily involves some incidental exposure to site water and sediment. Work performed on piers, pilings, and boat bottoms occurs on site, resulting in more than incidental exposure to water and sediment, although such activities are expected to be relatively infrequent. Occupational exposures may also occur during marina improvements/ maintenance planned by the PoFH. Workers on moored vessels and on dock structures could potentially come into contact with sediment, but are more likely to contact surface waters. Most workers are typically aboard the vessels and well above the water surface. Accordingly, worker exposure to Project site waters and sediments would be relatively infrequent, resulting in potentially complete, but low, exposure. Other occupational exposure, such as a biologist conducting field investigations for marina maintenance or restoration work, is likely, but expected to be of low risk due to a lower exposure frequency and duration. Overall, occupational exposure to water and sediments is expected to be much lower than in the shore recreation and shellfish collection exposure scenarios; however, the need to evaluate occupational scenarios will be established in consultation with Ecology.

5.4.1.4 Fish, Crab, and Shellfish Collection

The extent and frequency of recreational collection of fish, crab, and shellfish within the embayment and specifically from the Jensen Shipyard property is unknown. It is known that various fishes, crab, and shellfish (clams and oysters) are present at this location; however, the PoFH indicates that long-term residents have reported that there is no history of fishing, clamming, or crabbing in the tidal or shallow bedland areas of Jensen's. For the purposes of this CSM, it is assumed that there are no recreational or commercial fisheries that operate within the Project area. This assumption must be validated as part of the anticipated remedial investigation. The potential for shellfish collection in the future is anticipated to be evaluated in a subsequent phase of work.

5.4.1.5 Fish, Crab, and Shellfish Consumption

Likewise, the extent and frequency of any subsequent consumption of fish, crabs, and shellfish collected from the Jensen Shipyard area (or within the shallow embayment) are unknown; however, existing evidence suggests that seafood consumption does not occur. For the purposes of this CSM, it is assumed that no shellfish consumption from the Jensen's shoreline is occurring; however, the potential for shellfish consumption in the future is anticipated to be evaluated in a subsequent phase of work. If cleanup levels are ultimately based on results of a risk evaluation and not sediment natural background, tribal consumption scenarios may be evaluated.

5.2.1.6 Selection of Exposure Scenarios for Additional Evaluation

Specific exposure assumptions will be developed in consultation with Ecology to identify complete pathways, which must include an exposure medium, exposure point, a potential exposed population, and an exposure route. Complete pathways will be subsequently evaluated to determine whether site-specific risk calculations are required, versus comparing a qualitative site-specific risk evaluation against risk quantified at similar sites.

Potential exposure scenarios are summarized in Table 5-4. These scenarios will be re-evaluated in the RI.

Table 5-4. Potential Exposure Scenarios

Exposure Scenario	Exposure Point	Exposure Medium	Exposed Population	Exposure Route	Anticipated Analysis	Comment
Water Recreation	Project Site	Sediment	Resident	Dermal, Ingestion[1]	Qualitative	Exposure via swimming is lower than exposure via other pathways.
		Surface Water	Resident	Dermal, Ingestion[2]	Qualitative	King County study (King County, 1999) suggests that risks associated with water recreation are within accepted levels. Anticipated RI will validate King County conclusions against site-specific data.
Shore and Upland Recreation	Upland, Shoreline, and Intertidal	Soil	Resident	Dermal, Ingestion[1]	Soil data will be compared to MTCA criteria.	Boat owners, trespassers, and other public site users may have incidental exposure to upland soil via direct contact or dust.
		Sediment	Resident	Dermal, Ingestion[1]	Qualitative	To be further evaluated.
		Surface Water	Resident	Dermal, Ingestion[2]	Qualitative	Exposure attributable to resuspended sediment in water column is insignificant compared to that from direct contact with bedded sediment. Exposure is expected to be much lower than in the swimming scenario.
Occupational	Boatyard	Surface Soil	Worker	Dermal, Ingestion[1]	Soil data will be compared to MTCA criteria.	Boatyard workers may have incidental exposure to upland soil via direct contact or dust.
		Sediment	Worker	Dermal, Ingestion[1]	Qualitative	Exposure is expected to be much lower than that evaluated in the shore recreation and shellfish collection exposure scenarios.
		Surface Water	Worker	Dermal, Ingestion[2]	Qualitative	Exposure is expected to be less than in the swimming scenario.
	Construction	Soil and Groundwater	Worker	Dermal, Ingestion[1]	Data will be compared to MTCA criteria.	Workers engaged in habitat restoration or site cleanup projects may come in contact with soil and groundwater. Workers will wear appropriate PPE to limit exposure.
		Sediment	Worker	Dermal, Ingestion[1]	Qualitative	Workers engaged in habitat restoration or site cleanup projects may come in contact with sediment. Further evaluation will help to identify what level of PPE is appropriate.
		Surface Water	Worker	Dermal, Ingestion[2]	Qualitative	Exposure is expected to be less than in the swimming scenario.
Fish, Crab and Clam Collection	Shoreline and Intertidal	Sediment	Resident	Dermal, Ingestion[1]	Qualitative	Sediment exposure will occur during shellfish collection. Exposure is expected to be similar to shoreline recreation.
		Surface Water	Resident	Dermal, Ingestion[2]	Qualitative	Exposure attributable to resuspended sediment in water column is insignificant compared to that from bedded sediment.
	Project Site	Sediment	Resident	Dermal, Ingestion[1]	Qualitative	Incidental exposure during fishing and crabbing is insignificant.
		Surface Water	Resident	Dermal, Ingestion[2]	Qualitative	Incidental exposure is less than the swimming scenario.

Exposure Scenario	Exposure Point	Exposure Medium	Exposed Population	Exposure Route	Anticipated Analysis	Comment
Fish, Crab and Clam Consumption	N/A	Tissue	Resident	Ingestion	Qualitative	To be further evaluated.

Notes:
[1] Incidental ingestion associated with dermal contact.
[2] Incidental water ingestion associated with dermal contact.

5.4.2 Potential Ecological Receptors

Ecological values include those roles and processes vital to ecosystem function, those providing critical resources such as habitat and fisheries, and the regulatory status of the populations (e.g., threatened or endangered species). Although no site-specific studies have been performed, it is known that several receptor groups occur in and throughout the San Juan Islands and would be expected to use the uplands and or aquatic environs of the Jensen Shipyard. Species that could directly or indirectly be exposed to contaminated sediments include the benthic invertebrate community, fish, birds, and mammals. Reptiles and amphibians are unlikely to be present on site because there is no persistent freshwater habitat present. Further evaluation will be done to determine whether the group or a representative species should be identified as a Receptor(s) of Concern.

5.4.2.1 Benthic Assemblages

Benthic invertebrate communities in the San Juan Islands are composed of a diverse set of phyla (Mollusca, arthropoda, annelida, and Echinodermata), and can be classified as infaunal (living in sediment) and epifaunal (living on the sediment or other substrate). Benthic invertebrates are in contact with sediment during some or all of their life cycles, and tend to have limited mobility (particularly as adults).

The benthic community can be an indicator of ecosystem health and performs several important ecological functions. Burrowing benthic invertebrates support nutrient cycling and bioturbation, and the benthic community is an important food source for other invertebrates, fish, birds, and mammals.

No benthic community sampling has occurred at the Project site; however, it is likely that some benthic invertebrates that humans consume are present within the study area. There is evidence that bivalves (clams, mussels, oysters, etc.) may be present at intertidal and subtidal elevations within the Project site, while crustaceans (crab and shrimp) and other benthic invertebrates are likely present around subtidal areas of Shipyard Cove.

5.4.2.2 Fish

Fish can be classified as demersal (living on or near the sediment and feeding on benthic organisms), benthopelagic (living and feeding near the sediment as well as in the water column), and pelagic (living and feeding in open water). Fish species within the proposed study area are generally expected to be mobile predators and thus exposed to chemicals through the ingestion of prey, incidental ingestion while consuming prey, and direct contact with sediments (particularly demersal species).

Fish are a food source for other fish, larger invertebrates, birds, and mammals, including people. They also provide important recreation value.

No fish surveys have been performed in the proposed study area, nor has an extensive review of other information sources been performed; however, it is likely that fish species that humans consume or that serve other important ecosystem functions are present within the study areas.

5.4.2.3 Birds

The Project site consists of habitat that numerous bird species are expected to utilize. The Project site and surrounding areas are known to support numerous species, including those that depend on the diverse riparian, intertidal, and subtidal habitat present at Jensen's. Birds that are expected to utilize the Project site include passerine and upland bird species, raptors, shorebirds and wading birds, waterfowl, and seabirds. Bird species would be exposed to chemicals through similar mechanisms as fish, including ingestion of prey (benthic invertebrates, fish, small mammals, etc.), incidental ingestion of sediments while consuming prey, and direct contact with sediments and site soils

No bird surveys have been performed in the proposed study area, nor has an extensive review of other information sources been performed.

5.4.2.4 Mammals

The proposed study area includes habitat that is expected to be utilized by marine mammal species like harbor seal, California sea lion, harbor porpoise, and killer whale. Marine mammals would be expected to consume fish, squid, octopus, and crustaceans. Additionally, semi-aquatic terrestrial mammals like raccoon, muskrat, and river otter may be present on site or in the vicinity. These species consume fish, crustaceans, and bivalves. In addition to ingesting prey, mammals are also expected to be exposed to chemicals through incidental ingestion of and direct contact with sediments and site soils.

No mammal surveys have been performed in the proposed study area, nor has an extensive review of other information sources been performed.

5.4.2.5 Terrestrial Ecological Evaluation

A simplified terrestrial ecological evaluation (TEE) was performed as described in Section 8.1.2.1. The simplified TEE indicated that substantial wildlife exposure was unlikely; therefore, potential TEE exposures were not incorporated into the soil SLs and will not be considered further in the RI/FS.

5.4.2.6 Selection of Receptors of Potential Concern (ROCs)

Specific receptors of concern (ROCs) will be identified in consultation with Ecology based on subsequent work, anticipated to include identification of key species that utilize the Project site and exposure assessments to evaluate whether a direct pathway exists and is significant. For the purposes of this CSM, sediments are assumed to be the principal source of chemicals for all exposure scenarios, regardless of the actual exposure medium (sediment, tissue, surface water, porewater).

In order for a chemical to pose a risk to a ROC, a complete exposure pathway must exist and be significant. A complete exposure pathway consists of a direct pathway between a source and the ecological receptor via one or more exposure routes.

To focus future evaluations, four exposure pathway designations have been defined:

- Complete and significant: A direct link between the ROC and chemical exists and is considered to be a potentially significant exposure. Additional qualitative evaluation is recommended to determine whether quantitative risk evaluation is warranted.

- Complete and significance unknown: A direct link between the ROC and chemical exists, but insufficient information exists to determine whether the pathway is significant. Additional qualitative evaluation is recommended to determine whether quantitative risk evaluation is possible or if the pathway must be addressed in subsequent uncertainty analyses.
- Complete and insignificant: A direct link between the ROC and chemical exists; however, the overall exposure is considered to be low. No further analysis is proposed for these pathways.
- Incomplete: There is no direct link between the ROC and the chemical. No further evaluation of these pathways is proposed.

Complete and significant pathways for the benthic invertebrate community include sediment contact, sediment ingestion, prey ingestion, and surface water contact. For fish, key exposure pathways include prey ingestion and water contact. Sediment contact and incidental ingestion are complete pathways for some fish species, but are insignificant for others. Ingestion of prey, surface water, and sediments are all complete and significant exposure pathways for birds and mammals. Sediment and water contact are also considered complete pathways for birds and mammals; however, they are insignificant in comparison to other pathways because feathers and fur limit direct dermal contact.

Table 5-5 illustrates exposure pathways for potential ROCs. ROCs are general, because insufficient information has been collected to identify specific species.

Table 5-5. Exposure Pathways for Potential ROCs

Receptor	Exposure Pathway					
	Sediment Contact	Sediment Ingestion	Water Contact	Benthic Ingestion	Fish Ingestion	Other Ingestion
Infaunal Benthic Community	▨	▨	▨	▨	X	▨
Crabs	?	?	▨	▨	▨	?
Fish	?	?	▨	▨	▨	▨
Birds		▨		▨	▨	▨
Mammals		▨		▨	▨	

Pathway Key	
▨	Complete, significant
?	Complete, significance unknown
	Complete, insignificant
X	Incomplete

If additional risk analysis is required subsequently, a food web highlighting the connections between ROCs may be appropriate for the Project site. Given the simplicity of the Project site, however, a qualitative risk evaluation for ROCs may be appropriate.

5.5 Data Gaps Analysis

The paragraphs below summarize our conclusions regarding identified data gaps that need to be addressed to complete the Remedial Investigation phase.

5.5.1 Groundwater

Groundwater sampling conducted by WE in 2018 and CRETE in 2020 indicated arsenic and copper above SLs in the central uplands area (Figure 5) associated with monitoring wells MW-1 through MW-4. These wells are located 100 feet or more from the shoreline and shoreline soil sampling in the BLWA suggests soil impacts up to the shoreline, potentially impacting groundwater and creating a groundwater to sediment migration pathway. To evaluate this pathway, three groundwater monitoring wells will be installed along the BLWA shoreline near previous sample locations BLWA-4, BLWA-6, and BLWA-8. Figure 36 shows the location of the three new soil borings and monitoring wells. Additional soil data collected in conjunction with monitoring well installation at these locations will be used to confirm previous soil data with high concentrations of metals. Prior to performing groundwater sampling, a tidal study will be performed on a subset of the monitoring wells to assess tidal influence and the appropriate tidal lag times for sampling each well. Groundwater sampling will be performed for four consecutive quarters.

Groundwater samples will also be collected from direct push investigation locations to assess groundwater quality along the shoreline in the SWRA and at the AST, shop floor drain, and stormwater pond.

Groundwater samples will be analyzed for the groundwater COIs identified earlier in Section 5.

5.5.2 Soil Data

Soil samples will be collected and analyzed throughout the site for the soil COIs identified earlier in Section 5. The purpose of the soil data is to define the extent of soil impacts for future remedial action alternatives analysis and to allow assessment of the soil to groundwater and the surface soil erosion to sediment pathways. Analysis of dioxins and furans will be limited to selected surface soil samples where there is the potential for soil erosion directly to sediment, primarily the SRWA. TBT and pesticides, not previously evaluated in soil samples, will also be tested in surface soil in the SRWA. Due to the lack of PCB aroclor data and the likely presence of these compounds, PCB aroclors will be analyzed in multiple soil samples from throughout the site. Soil sampling is discussed below for each of the site area to be investigated. No additional data collection is proposed for the FDA or OPALCO areas.

5.5.2.1 BLWA

Six (6) soil borings will better characterize the presumed fill and contamination in the BLWA. Multiple soil samples at each boring location, and subsequently well location, will be used to characterize the fill across this area. One additional DPT soil boring with multiple subsurface soil samples will be collected on the raised platform north/northeast of previous boring location BLWA-3. If soil screening with a PID indicates potential gross contamination, then grab groundwater sample will be collected from the DPT tooling. All samples for metals, TPH-Dx, cPAHs, and PCBs. Three boring locations will be used as monitoring well locations to evaluate the extent of copper and lead impacts to groundwater and impacts to surface water.

Surface soil impacts from the BLWA may have been transported beyond the property boundary to Shipyard Cove Marina. Three (3) hand auger locations are proposed to better delineate the extent of surface soil impacts on this adjacent property.

5.5.2.2 SRWA

Metals and TPH impacts in the FDA are present to the east. The area between the SRWA and FDA remains a data gap to further delineating the metals, TPH, and cPAHs soil impacts along the eastern and southeastern portions of the SRWA. Approximate five (5) DPT borings (SRWA-8 through SRWA-12) in a stepped layout (Figure 36) will provide data needed to better define this area of contamination. One row of DPT borings along the lower foot of the hillside and one row of DPT borings midway up the hillside should provide adequate distribution of data to better define contamination in SRWA. If soil screening with PID indicates potential gross contamination at any DPT boring, then grab groundwater samples will be collected from the DPT tooling at the corresponding location.

Figure 36 shows the soil sampling locations for the SRWA needed to vertical characterize the SWRA. Approximately 3 DPT borings (SRWA-13 to SRWA-15) will be used to confirm and vertically and horizontally delineate cPAH, TPH, and metal concentrations and to provide PCB data. Surface soil samples will also be collected from these locations and will be selectively analyzed for PCBs, TBT, pesticides, and dioxins and furans. These locations are identified in the Upland SAP (Appendix C).

5.5.2.3 AST

Three DPT borings (Figure 36) will provide data needed to better define this area of contamination. The borings will form triangle around former AST-1 boring location. Soil samples will be collected based on PID and olfactory observations to define the extent of TPH impacts. Grab groundwater samples will be collected from the DPT tooling at each DPT location to provide data to better assess potential petroleum impacts to groundwater.

5.5.2.4 Shop Floor Drain

One DPT boring will be advanced immediately downgradient (Figure 36) of the floor drain and MW-1 to provide data to more fully characterize the petroleum and metals impacts in this immediate area. Soil samples will be collected every 2-ft to water depth. A grab groundwater sample will be collected from the DPT tooling.

5.5.2.5 Stormwater Pond

One DPT boring will be advanced immediately downgradient (Figure 36) of the stormwater pond to assess whether the stormwater pond has impacted soil or groundwater in this immediate area with metals present in the pond sediment and water. Soil samples will be collected every 2-ft to water depth. A grab groundwater sample will be collected from the DPT tooling.

5.5.2.6 Wooded Hillside Area Along Turn Point Road

The wooded hillside area south of the OPALCO pad area, the stormwater pond, and the shop building has not been investigated. No recognized environmental conditions were noted in the Phase I ESA (WE 2017) or subsequent investigation activities were conducted in this area. This area will be visually inspected for potential dumping and sources of soil and groundwater contamination. Any observations from the inspection that require follow-up investigation or sampling will be assessed at that time.

5.5.3 Sediment Data

At this time, only a limited number of surface sediment samples (22) have been collected for this location, and no data quality review has been completed. While these data provide a useful starting point for identifying a preliminary list of Contaminants of Potential Concern (COPCs), the dataset is not sufficiently robust to definitively establish the nature and extent of the contamination, or to allow identification of or elimination of other potential sources of the contamination; this therefore precludes definitive identification of Potential Cleanup Units. While the chemistry data indicate chemical exceedances of regulatory criteria, no biological testing of the sediments for toxicity or bioaccumulation potential has been conducted, which could confirm or override chemical concerns. All samples collected were restricted to surface sediments only (top 10 centimeter [cm]) and were generally within the immediate vicinity of Jensen's marina. Although dioxins/furans were evaluated at the north end of the travel lift and at the base of the historical western railway, they represent a data gap in other marine areas.

Several samples collected in intertidal areas (SRWA-1, SRWA-2, SRWA-3, SRWA-4, SRWA-5, and SRWA-6) were evaluated only as part of the upland dataset (WE, 2018d). These samples should also be included in the aquatic dataset and evaluated against marine sediment quality standards.

Historical wasting of debris and other material onto the uplands and directly into the water, and erosion of soils and material from the uplands via stormwater events, are visually evident as potential sources. WE established (WE, 2018a; WE, 2018b) that contamination exists in the upland soils; therefore, past or ongoing discharges to intertidal and subtidal sediments through groundwater flux may be a source, but have not been investigated. The presence of chemical contamination at depth, especially along the shoreline, can be inferred, but will require investigation to confirm. Accordingly, in addition to a quality review of the data, we recommend supplemental characterization of intertidal and subtidal sediments employing a mix of surface grabs and cores to establish the nature and extent of COPCs and to estimate the volume of material that may need to be remediated. The effort would also include the standard suite of biological toxicity tests. It is expected that sampling may require multiple mobilizations; therefore, SAP addendums may be prepared if supplemental sampling efforts are required.

Due to the extent of debris observed throughout intertidal elevations out to at least shallow subtidal depths, and also within the boathouse areas, debris expected to interfere with the collection of sediment grab samples and cores. The actual distribution and concentration of debris represents a logistical data gap.

Finally, the current segregation of upland data from aquatic data represents a data gap along the land/water interface. Integration of these data sets will present a more complete understanding of the nature and extent of COPCs across the land/water interface.

As part of the future remedial investigation, a supplemental sediment characterization is anticipated to address identified data gaps and refine the nature and extent of both debris and sediment contamination at the site. A sub-bottom profile survey is proposed prior to the initial sediment sampling effort to inform final selection of sample locations. Subsequently, surface sediment grab samples (sample depth of 0 – 10 cm) are proposed at seven (7) sampling stations and core samples (sample depth of 0 – 6 ft) are proposed at twelve (12) sampling stations located within the study area (Figure 37). We propose to reoccupy 10 previous sampling locations and sample nine new sampling locations around Jensen's. This effort is expected to:

- Delineate the nature and extent of debris throughout sampling areas.
- Establish vertical contamination profiles in areas where surface sediments exceed SQS.
- Include additional samples (depth and surface) along the eastern shoreline area.
- Delineate the vertical and horizontal extent of dioxins/furans beyond the surface concentrations measured along the central marina shoreline, which may correlate with observed PCB surface exceedances.
- Focus PCB analysis on areas showing benthic exceedances in surface sediments to facilitate subsequent background/human health evaluations.
- Delineate the vertical and horizontal extent of pesticides measured in surface sediments.

5.5.4 Tissue Data

Although tissue concentrations for fish and shellfish have been collected at other Puget Sound sites, no similar data have been collected at Jensen's. Previous sediment characterizations at the project site did not include bioaccumulation or toxicity testing, which could be useful in gauging the present level of risk to human and ecological health. As part of the supplemental sediment characterization, studies that could evaluate the bioavailability of selected COPCs include bioaccumulation studies and/or tissue sampling, which could be incorporated into a benthic survey. Data collected could be compared with tissue concentrations at other sites and inform decision-making regarding the need for additional collections; however, it is anticipated that final site conditions will meet SMS for non-bioaccumulative COPC, which is considered to be sufficiently protective. Bioaccumulative COPCs will be compared to natural background concentrations. If subsequent site evaluation suggests that SMS (non-bioaccumulative COPCs) or natural background (bioaccumulative COPCs) cannot be achieved, supplemental tissue analysis may be necessary.

5.5.5 Surface Water Data

A single outfall pipe was observed on the Project site, but there is no evidence of discharge or seepage. No other point source outfalls have been identified as discharging to the embayment where Jensen's Shipyard is located. Marine water quality throughout the San Juan archipelago is generally considered to be good, although no water quality studies have been conducted for this embayment associated with the marina operation of other shoreline activities outside of the project site property. Anticipated maintenance improvements to the marina and potential moorage space reconfigurations are expected to require establishment of baseline water quality parameters as part of the regulatory process, so although this is technically a data gap, it is a minor one. The need for collection of surface water quality data will be discussed with Ecology as part of the identification of required studies for remedial investigation or regulatory process.

5.5.6 Sediment Transport Data

Sediment transport and sedimentation rates in Shipyard Cove, particularly around the Project site, also represent a known data gap. Shipyard Cove is entirely open to Puget Sound, so tides, currents, and wind-generated waves are expected to be dynamic forces, which influence deposition and distribution of surface sediments. However, the Project site is generally sheltered from the east, west, and south by the shoreline, the adjacent Shipyard Cove Marina, and Brown Island. The Project site is exposed primarily to wind and wave energy coming from the north, which is expected to occur only during episodic events. Given the shallow depth of the embayment and the amount of regular boat activity, it is likely that propwash is an important factor in sediment transport and redistribution, particularly in the vicinity of the boat lift at Jensen's and the barge landing site on the adjacent property.

Wind-wave analysis is anticipated as part of the marina redevelopment planning process. This analysis will provide information about the magnitude and dominant direction of wind-generated waves and currents. As part of the supplemental sediment characterization effort, grain-size and contaminant patterns in surface samples will be evaluated, but at this time no additional studies are proposed to measure bedload velocity. If, in consultation with Ecology, additional characterization of sediment deposition and transport are determined to be necessary, potential studies could include investigating propwash scour, numeric modeling to predict sediment movement, placement of current meters to measure current velocity along the sediment bed, and deployment of sediment traps to measure sedimentation rates.

5.5.7 Regulated Building Materials

Building materials in the structures on-site may be sources of contamination to surface soil. A regulated building materials survey will be performed for all of the structures. The survey of the old boat building structure will be performed prior to other investigation tasks near the SRWA to assess whether any changes to the sampling program are warranted based on the building materials survey.

5.5.8 Historic and Cultural Resources

The San Juan archipelago is very well known to have been utilized by native peoples. The presence of known or unknown cultural resources along this area of shoreline is a critical, but anticipated data gap that will require a literature review and survey. A site-wide cultural resources evaluation is anticipated as part of this RI.

5.5.9 Climate Change Vulnerability

The PoFH evaluated SLR and shoreline resiliency in the 2020 Master Plan (L-E and RM 2020). The 100-year SLR estimate for the project site ranges from 1.9 to 2.4 feet (under low and high greenhouse gas scenarios) with 50% probability. The RIFS will describe how remedial alternatives may be affected by changes to the seismic stability of the shoreline, sea level rise, tidal pumping, and increased storm intensity.

6. FIELD INVESTIGATIONS, DATA COLLECTION, AND OTHER INVESTIGATIONS AND ANALYSES

6.1 Soil and Groundwater Investigation

The soil and groundwater investigation will be performed using standard operating procedures that are consistent with MTCA and EPA requirements. Details of the sampling and analytical methods for soil and groundwater are provided in the Uplands Sampling and Analysis Plan (Upland SAP).

Twenty (20) borehole and three (3) surface sample locations are proposed to address data gaps throughout the site (Figure 36). The majority of these boreholes will be completed using direct-push drilling equipment, although had augers may be advanced in shallow borehole areas with limited access. Three of these borehole locations are proposed to be completed as monitoring wells along the shoreline of the BLWA. Soil samples will be collected from multiple depth intervals at each borehole and sample locations will include areas with elevated PID readings or other olfactory evidence of contamination. Many of these soil samples will be archived and may be analyzed depending on the results of other soil sample analyses. The subset of soil COIs to be analyzed at each borehole is based on previous data and nearby sources as indicated in the Upland SAP.

Groundwater grab samples will be collected from temporary wells at some direct push location to provide an indication of groundwater quality. The three (3) new groundwater monitoring wells, as well as the existing monitoring wells, will be sampled and tested. The subset of groundwater COIs to be analyzed at each temporary or permanent well is based on previous data and nearby sources as indicated in the Upland SAP. The permanent monitoring wells will be sampled during a negative tide cycle at a predetermined lag time from low tide. A tidal study will be performed for a subset of the permanent monitoring wells to establish the appropriate lag time at which to sample each well such that the groundwater in the well at the time of sampling is close to its lowest elevation during the tidal cycle. Groundwater monitoring wells will be sampled for four consecutive quarters.

6.2 Sediment Investigation

The sediment remedial investigation will generally follow guidance provided in the current SCUM. Sampling procedures and collection will follow current Puget Sound Estuary Program (PSEP) protocols. Details of the sampling and analytical methods are included in the In-Water Sampling and Analysis Plan (In-Water SAP). If supplemental sediment sampling is required, a SAP addendum may be prepared.

Debris appears to be present throughout intertidal elevations out to at least shallow subtidal depths, and also within the boathouse areas. These are the areas where the sediment investigation is required to delineate the nature and extent of contaminants of potential concern (COPCs); however, debris is expected to interfere with the collection of sediment grab samples and cores. Prior to initiating sediment sample collection, a sub-bottom profile survey using a high-resolution, low frequency sub-bottom sonar is proposed to measure the distribution and concentration of debris. These data will be used to identify specific locations where sediment grab samples and cores may be collected.

To meet the remedial investigation objectives, surface sediment grab samples (sample depth of 0 – 10 cm) are proposed at seven (7) sampling stations and core samples (sample depth of 0 – 6 ft) are proposed at twelve (12) sampling stations located within the study area (Figure 37). We propose to reoccupy 10 previous sampling locations and sample nine new sampling locations around Jensen's. Samples will be analyzed for known contaminants of potential concern (COPCs) and conventional sediment parameters. Should samples exceed the numerical chemical concentration criteria identified in

WAC 173-204-320, samples for potential bioassays may be collected during a future sampling event to evaluate sediment toxicity against biological effects criteria. Should the sediment sampling suggest that the final site conditions cannot achieve SMS, then supplemental tissue analyses may be conducted as a subsequent phase of the remedial investigation.

6.3 Other Investigations and Analyses

Prior to initiation of major site-disturbing activities, a site-wide cultural resources evaluation will be performed by a qualified cultural resources consultant to inform inadvertent discovery plans, remedial investigation activities, interim actions, and site cleanup.

Finally, Ecology requires that a climate change vulnerability analysis be performed; therefore, the RIFS will describe how remedial alternatives may be affected by changes to the seismic stability of the shoreline, sea level rise, tidal pumping, and increased storm intensity.

7. DATA MANAGEMENT AND ANALYSIS

This section provides an overview of the QA/QC checks, which consist of measurements performed in the field and laboratory. Details of the upland data management and analysis methods are provided in the Quality Assurance Project Plan (Upland QAPP), Attachment A of the Upland SAP (CRETE 2021). Details of the sediment data management and analysis methods are provided in the Quality Assurance Project Plan (In-Water QAPP), Attachment A of the In-Water SAP (L-E 2021).

Guidelines for minimum samples for field QA/QC sampling and laboratory analysis are summarized in Table 7-1.

Table 7-1. Guidelines for Minimum QA/QC Samples for Field Sampling and Laboratory Analysis.

Field			Laboratory				
Media	**Field Duplicate**	**Rinsate Blank**	**Matrix Duplicate**[a]	**Matrix Spike**	**MSD**[b]	**Method Blank**	**LCS**[c]
Sediment	1 in 20[d]	1 in 20	1 in 20	1 in 20	1 in 20	1 in 20	1 in 20
Soil	1 in 20[d]	1 in 20	1 in 20	1 in 20	1 in 20	1 in 20	1 in 20
Groundwater	1 in 20[d]	1 in 20	1 in 20	1 in 20	1 in 20	1 in 20	1 in 20

Notes:

[a] Matrix duplicate analyzed for metals.

[b] MSD analyzed for organic analyses.

[c] Laboratory Control Sample.

[d] All frequencies of 1 in 20 indicate 1 per batch, when the batch is less than 20 samples.

7.1 Overview of In-Water Data Analyses

The full quality assurance program is detailed in the In-Water SAP and QAPP. Sediment samples will be collected from locations identified in Section 6. The QC samples specified in Table 7-1 will be evaluated to verify accuracy and precision of laboratory results and ensure the quality of the sampling effort and the analytical data for this project.

7.2 Overview of Upland Data Analyses

The full quality assurance program is detailed in the Upland QAPP. Soil and groundwater samples will be collected from upland locations identified in Section 6. The QC samples specified in Table 7-1 will be evaluated to verify accuracy and precision of laboratory results and ensure the quality of the sampling effort and the analytical data for this project.

7.3 Overview of Data Validation and Quality Assurance Methods

The project QA/QC coordinator will conduct an independent internal quality assurance review. The internal review of analytical data will follow QA1 review procedures (PTI 1989) and will be documented using checklists to identify verified quality control procedures. This internal review will validate external reviews of chemistry data performed by EcoChem, Inc. (EcoChem), and bioassay and/or bioaccumulation data sets (if required) performed by EcoAnalysts, Inc. (EcoAnalysts).

A QA1 chemistry data review evaluates field collection and handling; completeness; data presentation; reporting limits (the practical quantitation limit [PQL] shall not be greater than the SQS of the SMS.); and the acceptability of test results for method blanks, certified reference materials, analytical replicates, matrix spikes, and surrogate recoveries. A QA1 review of bioassay data covers similar field and reporting elements and evaluates the acceptability of test results for positive controls, negative controls, reference sediment, replicates, and experimental conditions (temperature, salinity, pH, dissolved oxygen). Detailed guidance on QA1 review procedures is provided in PTI (1989) and is available from Ecology.

All chemistry and conventionals data will undergo a quality assurance review and data validation by EcoChem, Inc. (EcoChem). EcoChem validation shall include a minimum Stage 2b validation for all chemical data. Ten percent of the dioxin/furan congener data will undergo Stage 4 validation, in addition to the Stage 2b validation. Validation will be conducted using the most recent EPA (EPA 2005, 2008, 2009, 2010) guidelines. EcoAnalysts will perform a QA1 review of bioassay data.

The analytical laboratory will provide full-level, Stage 4 chemistry data packages that will allow for examination of the complete analytical process from calculation of instrument and MSDs, RLs, final dilution volumes, samples sizes, and wet-to-dry ratios to quantification of calibration compounds and all analytes detected in blanks and environmental samples.

8. DEVELOPMENT OF PROPOSED CLEANUP STANDARDS AND SITE BOUNDARIES

8.1 Methods to Develop Proposed Cleanup Standards

SLs were developed in this RIWP to select COIs for further evaluation during the RI. The RI/FS report will further evaluate these COIs to develop COCs and Indictor Hazardous Substances, consistent with MTCA. Table 8-1 provides a brief description of these terms and how they are and will be used during the RI/FS process.

Table 8-1. Selection of Hazardous Substances to Be Evaluated

Term	How List is Formed
Constituent of Interest (COI)	Greater than 5% detection frequency and at least one detected value over the SL. Plus compounds anticipated to be present but not previously analyzed. Documented in this RIWP.
Constituent of Concern (COC)	Detected exceedances of SLs where RI data verify exposure pathway is complete. Soil COIs selected based on protection of groundwater will be evaluated using empirical groundwater data. To be documented in RI/FS report.
Indicator Hazardous Substance	COCs for which effectiveness of remedial alternatives evaluated in the FS will be evaluated. Subject of long-term monitoring, if part of remedy. To be documented in the RI/FS report.

8.1.1 Groundwater

Groundwater SLs (Table 8-2) are based on protection of surface water (marine aquatic life and human health via fish consumption) and on protection of site users via indoor air (from volatilization and inhalation). Where relevant, the SLs have been adjusted upward based on PQLs or natural background concentrations. The data collected in the RI will be used to confirm or narrow the final groundwater COI list to the Site groundwater COCs.

8.1.1.1 Groundwater Non-Potability

Groundwater potability was reviewed for applicability of human consumption of groundwater as a potential exposure pathway. Site groundwater satisfies the MTCA non-potability criteria, and therefore, human consumption of groundwater is not an exposure pathway of concern. Protection of drinking water is not applicable to this Site because the shallow groundwater is not potable. It is expected to remain non-potable in the future under MTCA and local regulations because:

- Neither the Site nor groundwater in its vicinity is a current source of drinking water.
- Under WAC 173-340-720(2)(b), neither the Site nor groundwater in its vicinity is a potential future source of drinking water because groundwater contains natural background levels of specific conductivity above the state and local secondary maximum contaminant level of 0.7 milliSiemens/centimeter (mS/cm) (WAC 246-290-310(3)(a) and San Juan County code 8.06.260.
- Site groundwater will not migrate into groundwater that is a current or potential source of drinking water
- A domestic supply well would not be placed in the vicinity of the Site (WAC-173-340-720(2)(d)). State and local codes prohibit the construction of drinking water wells in the vicinity of the Site via WAC 246-290-130(1) which requires drinking water supplies to come from the highest quality source (which at the Site is the municipal water supply system) and via WAC 290-135(2)(b) which specifies a minimum 100-foot drinking water well setback from surface water, roads, utilities, and buildings.

8.1.1.2 Total Petroleum Hydrocarbons

The TPH SL for groundwater will be further evaluated during the RI. The NWTPH-Dx analysis for diesel-range organics (DRO) and oil-range organics (ORO) is subject to interference from naturally occurring organic material in the soil matrix, from the presence of polar organic TPH biodegradation byproducts, and from sea water intrusion. This interference will be assessed by collecting non-TPH impacted background groundwater samples that could quantify interference by naturally occurring organic material or sea water intrusion. All groundwater samples that are analyzed for NWTPH-Dx, will be analyzed both with and without silica gel cleanup; no acid cleanup will be performed on any NWTPH-Dx groundwater samples. Silica gel cleanup is commonly used to remove these types of interference. NWTPH-Dx sample chromatograms will also be evaluated versus standard chromatograms so assess the types of material that are removed by silica gel cleanup. Depending on the results of this analysis, the appropriate NWTPH-Dx analytical method and the potential use of a TPH background groundwater concentration will be evaluated. Additional sample locations may need to be added to the RI program to fully assess background conditions.

8.1.2 Soil

Soil SLs (Table 8-3) are protective of direct human contact and surface water (marine aquatic life and human fish consumers in the event that soil leaches to groundwater and the groundwater discharges to adjacent surface water bodies). The soil SL for non-polar organic COIs that addresses soil leaching to groundwater was calculated using the MTCA default fraction organic carbon.

During the RI, multiple lines of evidence related to exposure pathways and additional empirical data will be used to confirm or narrow the list of final soil COIs to the Site COCs.

8.1.2.1 Terrestrial Ecological Evaluation

A preliminary simplified TEE was performed for the Site. The following is a scored Simplified TEE according to WAC 173-340-7492(2)(a)(ii). Approximately 2.5-acres of contiguous, undeveloped land (up to 1.5-acres at the site, but only up to 1 acre bounding site to the east). Per Table 749-1:

1. Points per contiguous, undeveloped acreage: 9 points
2. The area is industrial or commercial (zoned as rural industrial). 3 points
3. Low to intermediate habitat quality of the site. 2 points
4. Undeveloped land is unlikely to attract wildlife. 2 points
5. Dioxins and furans soil detections. 1 point
6. Summation of Items 2 through 5: 8 points. This score is not higher than Item 1 score and therefore the simplified TEE may be ended under WAC 173-340-7492 (2)(a)(ii).

The preliminary simplified TEE indicated that substantial wildlife exposure was unlikely; therefore, potential TEE exposures were not incorporated into the soil SLs. The final TEE will be presented in the RI/FS, incorporating data collected during the RI.

8.1.3 Sediment

Initial in-water sediment SLs are based on primarily marine benthic criteria, which are protective of human health. Sediment cleanup standards will be established for each contaminant of concern (CoC) on the site. The methods to develop proposed cleanup standards will generally follow guidance provided in the current SCUM. After the Remedial Investigation field work is complete, final sediment cleanup objectives (SCO) and final cleanup screening levels (CSL) will be established for each CoC. The sediment cleanup level for each CoC will then be established at the SCO, the CSL, or a level in between.

The final SCO will be the highest value of natural background, practical quantitation limits, or risk-based value for each CoC. The risk-based value for comparison to natural background and PQL is the lowest of one of the following:

a. The SCO benthic criteria.
b. The SCO human health criteria, which includes:
    i. 10^{-6} risk level for individual carcinogens.
    ii. 10^{-5} risk level for multiple carcinogens or exposure pathways.
    iii. Hazard quotient of 1 for individual non-carcinogens.
    iv. Hazard index of 1 for multiple non-carcinogens.
c. The higher ecological trophic level species criteria.
d. Other applicable laws.

The final CSL will be the highest of one of regional background, practical quantitation limits, or risk-based value for each CoC.

a. The CSL benthic criteria.
b. The CSL human health criteria, which includes:
    i. 10^{-5} risk level for individual or multiple carcinogens and exposure pathways.
    ii. Hazard quotient of 1 for individual non-carcinogens.
    iii. Hazard index of 1 for multiple non-carcinogens.
c. The higher ecological trophic level species criteria.
d. Other applicable laws.

The sediment cleanup level or sediment cleanup standard for each CoC will initially be established at the SCO. If it is not technically possible to achieve and maintain the cleanup level at the SCO or if the cleanup will result in net adverse environmental impacts the cleanup level will be adjusted upwards of the SCO but no higher than the CSL.

8.2 Methods to Establish Site Boundaries Based on Proposed Cleanup Standards

After the proposed cleanup standards for each CoC have been developed, the site boundaries can be finalized. The methods to establish site boundaries will generally follow guidance provided in the current SCUM. Maps will be prepared that clearly identify areas of the site that exceed the SCO, CSL, and site-specific sediment cleanup levels for each CoC.

Initial surface sediment data suggests that sediment contamination is generally contained within the central shoreline and shallow subtidal areas of the Project site. Existing data show that surface sediments along Jensen’s lease boundary do not exceed SMS criteria. Because no obvious transport mechanisms have been identified that would cause exchange of potential contaminants between Jensen’s and adjacent properties, there is no obvious rationale to expand the study area beyond the immediate Marina Footprint. For this reason, the proposed study area boundary is defined by the Marina Footprint, which also encompasses areas where surface sediment exceedances of SMS criteria were measured, and subtidal areas at the outer extent of Jensen’s existing marina infrastructure (Figure 1). Subsequent sediment characterization efforts are anticipated to focus both on evaluating the depth of contamination and further refining the horizontal distribution of chemical contaminants.

9. PROJECT ADMINISTRATION

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10. SCHEDULE

The immediate project schedule is likely to be driven by interim actions, which we propose to associate with required maintenance actions. As described previously, a substantial amount of required maintenance was deferred by the previous owner. Several components of the existing marina infrastructure are likely to fail if maintenance is deferred much longer. Failure of this infrastructure will not only handicap marina operations, but will also exacerbate the spread of COPCs in the aquatic environment through the accelerated deterioration of creosote-treated structures and sloughing of contaminated upland soils into intertidal areas.

The existing travel lift pier required to haul vessels in and out of the water is at immanent risk of failure. The creosote-treated piling that support the structure are in an advanced state of decay and the ecology-block shoreline revetment is failing. Several piles have already failed and substantial deterioration is visually evident in many others. The existing revetment is being undermined and upland soils are beginning to spill into the intertidal zone. The PoFH implemented temporary emergency maintenance work in 2020, which resulted in jacketing the existing travel lift pier piling. This temporary emergency action is intended to extend the life of the travel lift pier by approximately 5-years, after which the travel lift pier will be decommissioned and operations transferred to another location at Jensen's. The travel lift pier is located in an area where preliminary surface sediment sampling (WE, 2018c) detected several COPCs that exceed regulatory criteria (TBT, PCBs, metals, PAHs, dioxins/furans). The required infrastructure replacement provides a timely and cost-effective opportunity to reduce site risks by addressing known COPCs.

Additionally, a substantial amount of the existing subtidal marina infrastructure is in a similar state of disrepair as the travel lift pier. Creosote-treated piling are in an advanced state of decay, including several that have already failed. Many of the walkways are supported by degraded open-cell Styrofoam floats. The PoFH is currently developing plans to complete substantial maintenance and redevelopment of the existing marina infrastructure.

To inform an interim action associated with required decommissioning of the travel lift pier, priority investigations include integration of the upland and aquatic data sets, additional sediment sampling to define the nature and extent of contamination, and completion of a cultural resources assessment. In addition to the sediment sampling that would facilitate travel lift decommissioning, completion of marina redevelopment plans may also require an expedited wind-wave analysis.

We do not anticipate that the remaining work plan elements must be expedited with the same degree of urgency. We proposed to develop a detailed Work Plan Schedule in consultation with Ecology, with a focus on the availability and schedule for MTCA funding.

10.1 Remedial Investigation Schedule

Summer/fall 2020 – MTC building remedial investigation sampling
Summer 2022 – Cultural resources evaluation
Summer 2022 – Uplands remedial investigation sampling
Summer 2023 – In-water remedial investigation sampling

10.2 Remedial Investigation/Feasibility Study Deliverables Schedule

The initial project schedule described in the AO Scope of Work is summarized below.

RI/FS Deliverables	Completion Times
Agency Review Draft RI Work Plan	Submitted
Final RI Work Plan including Final SAP, QAPP, and HASP	Submitted
Completion of RI/FS Field Work	24 months following completion of the Final SAP, QAPP and HASP
Agency Review Draft RI/FS Report	180 days following receipt of laboratory data
Agency Review Draft Final RI/FS Report	45 calendar days following receipt of Ecology comments on Agency Review Draft RI/FS Report
Public Review Draft RI/FS Report	45 calendar days following resolution of Ecology comments and receipt of Ecology's written request for Public Review Draft RI/FS Report
Agency Review preliminary Draft Cleanup Action Plan (DCAP)	90 calendar days following submission of the Public Review Draft RI/FS

11. REFERENCES

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Tables

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Table 5-1 - Summary of Uplands Soil Data
Jensen's Shipyard and Marina
Port of Friday Harbor

Sample ID	Date	TPH (mg/kg)			Metals (EPA-6020/7471) (mg/kg)								Dioxins and Furans (EPA-1613B) (ug/kg)	Semi-Volatile Organic Compounds (SVOCs) (EPA-8270 SIM) (mg/kg)
		NWTPH-Dx Diesel Range	NWTPH-Dx Oil-Range	Dx	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	TCDD;2,3,7,8-	Total cPAH Equivalent (TEQ)
Soil Screening Level Vadose and Surficial Soils		2,000	2,000	2,000	7.3 ^{A}	1.09 ^{C}	48.2 ^{A}	36.4 ^{A}	1120 ^{C}	0.209 ^{B}	48 ^{A}	100.7 ^{C}	0.0000625 ^{B}	0.01 ^{B}
Soil Screening Level Saturated Soils		2,000	2,000	2,000	7.3 ^{A}	1 ^{B}	48.2 ^{A}	36.4 ^{A}	56.0 ^{C}	0.1 ^{B}	48 ^{A}	85.1 ^{A}	0.0000625 ^{B}	0.01 ^{B}
Surface Rail Work Area (SRWA)														
SRWA-1 3-6in	1/24/2018	**180**	**1,100**	**1,280**	**30**	**0.54**	**29**	**2,400**	**920**	**13**	NA	**840**	NA	**0.725**
SRWA-2 3-6in	1/24/2018	**91**	**220**	**311**	**14**	ND(<0.5)	**18**	**1,100**	**1,000**	**6.3**	NA	**330**	NA	**0.186**
SRWA-3 0-6in	1/24/2018	**3,900**	**940**	**4,840**	**17**	ND(<0.5)	**21**	**690**	**90**	**0.54**	NA	**580**	NA	**0.304**
SRWA-4 6in	8/1/2018	**79**	**190**	**269**	**54**	**0.39**	**35**	**2,000**	**1,800**	**11**	NA	**450**	NA	**0.661**
SRWA-4 3.5ft	8/1/2018	ND(<25)	ND(<50)	ND	**7.7**	ND(<0.22)	**24**	**35**	**15**	**0.098**	NA	**64**	NA	ND(<0.02)
SRWA-5 2-6in	8/1/2018	ND(<25)	**72**	**72**	**12**	**0.32**	**20**	**420**	**940**	**0.33**	NA	**460**	NA	**0.230**
SRWA-5 3.5 ft	8/1/2018	ND(<25)	ND(<50)	ND	**4.2**	**1.5**	**11**	**43**	**21**	**0.04**	NA	**58**	NA	**0.074**
SRWA-5 5ft	8/1/2018	ND(<25)	ND(<50)	ND	**5.1**	ND(<0.23)	**20**	**16**	**3.6**	ND(<0.02)	NA	**55**	NA	ND(<0.02)
SRWA-6 2-6in	8/1/2018	**120**	**640**	**760**	**16**	**0.64**	**36**	**220**	**1,200**	**2.8**	NA	**1,100**	NA	**1.446**
SRWA-6 3ft	8/1/2018	ND(<25)	ND(<50)	ND	**5**	ND(<0.21)	**20**	**11**	**11**	ND(<0.02)	NA	**32**	NA	ND(<0.02)
SRWA-7 2-6in	8/1/2018	**170**	**690**	**860**	**9.1**	**2.6**	**25**	**920**	**160**	**0.23**	NA	**400**	NA	**0.077**
SRWA-7 3ft	8/1/2018	**40**	**230**	**270**	**4.3**	**0.38**	**19**	**63**	**110**	**0.1**	NA	**140**	NA	**0.215**
MW-3 2-6in	8/1/2018	ND(<25)	**280**	**280**	**13**	**0.74**	**29**	**400**	**190**	**1.3**	NA	**310**	**0.132**	**0.114**
MW-3 5.5ft	8/1/2018	ND(<25)	ND(<50)	ND	**5.6**	ND(<0.21)	**28**	**82**	**25**	**0.16**	NA	**110**	NA	**0.018**
Boat Lift Work Area (BLWA)														
BLWA-1 0-3in	1/24/2018	**160**	**470**	**630**	**12**	**1.3**	**35**	**6,700**	**700**	**0.81**	NA	**950**	NA	NA
BLWA-2 0-3in	1/24/2018	**170**	**300**	**470**	**7.1**	**0.94**	**20**	**6,100**	**350**	**0.39**	NA	**1,700**	NA	NA
BLWA-3 2-6in	7/30/2018	ND(<25)	ND(<50)	ND	**3.5**	**0.2**	**28**	**180**	**150**	**0.032**	NA	**99**	NA	**0.529**
BLWA-3 2ft	7/30/2018	ND(<25)	ND(<50)	ND	**3**	ND(<0.2)	**15**	**32**	**3**	**0.028**	NA	**29**	NA	ND(<0.02)
BLWA-4 2-6"	7/30/2018	ND(<25)	**81**	**81**	**5.2**	**0.43**	**21**	**680**	**150**	**0.17**	NA	**260**	NA	**0.098**
BLWA-4 5ft	7/30/2018	ND(<25)	ND(<50)	ND	**3.9**	ND(<0.19)	**17**	**86**	**540**	**0.18**	NA	**110**	NA	**0.061**
BLWA-5 2-6in	7/30/2018	**91**	**180**	**271**	**10**	**0.81**	**29**	**1,100**	**270**	**0.36**	NA	**390**	NA	**0.529**
BLWA-5 2ft	7/30/2018	ND(<25)	ND(<50)	ND	**3.1**	ND(<0.19)	**15**	**28**	**3.2**	**0.038**	NA	**31**	NA	ND(<0.02)
BLWA-6 2-6in	7/30/2018	**95**	**260**	**355**	**9.7**	**1.2**	**31**	**9,300**	**760**	**1.1**	NA	**1,400**	NA	**0.706**
BLWA-6 2ft	7/30/2018	**350**	**710**	**1,060**	**150**	**2.6**	**78**	**3,500**	**3,400**	**0.31**	NA	**3,800**	NA	**0.015**
BLWA-6 5ft	7/30/2018	**1,400**	**940**	**2,340**	**3.7**	ND(<0.19)	**18**	**84**	**560**	**0.11**	NA	**72**	NA	ND(<0.02)
BLWA-6 10ft	7/30/2018	ND(<25)	ND(<50)	ND	**4.6**	ND(<0.19)	**11**	**20**	**1.9**	ND(<0.02)	NA	**47**	NA	ND(<0.02)
BLWA-7 2-6in	7/30/2018	ND(<25)	**180**	**180**	**13**	**1.8**	**30**	**2100**	**340**	**0.92**	NA	**630**	NA	**0.250**
BLWA-7 2ft	7/30/2018	ND(<25)	ND(<50)	ND	**3.7**	ND(<0.19)	**21**	**50**	**3**	ND(<0.02)	NA	**39**	NA	ND(<0.02)
BLWA-7 5ft	7/30/2018	ND(<25)	ND(<50)	ND	NA	NA	**NA**	NA	NA	NA	NA	NA	NA	NA
BLWA-8 2-6in	7/30/2018	ND(<25)	**56**	**56**	**5.1**	**0.48**	**19**	**1100**	**470**	**0.18**	NA	**350**	NA	**0.122**
BLWA-8 2ft	7/30/2018	ND(<25)	**290**	**290**	**6.2**	**0.23**	**23**	**170**	**200**	**0.12**	NA	**110**	NA	**0.043**
BLWA-8 5ft	7/30/2018	ND(<25)	**98**	**98**	NA	NA	**NA**	NA	NA	NA	NA	NA	NA	NA
BLWA-9 2-6in	7/30/2018	**61**	**160**	**221**	**5.7**	**0.96**	**25**	**2900**	**310**	**1.5**	NA	**690**	NA	**0.863**
BLWA-9 2ft	7/30/2018	ND(<25)	ND(<50)	ND	**3.3**	ND(<0.19)	**18**	**49**	**11**	**0.048**	NA	**92**	NA	ND(<0.02)
BLWA-9 5ft	7/30/2018	ND(<25)	ND(<50)	ND	NA	NA	**NA**	NA	NA	NA	NA	NA	NA	NA
MW-2 6in	7/30/2018	**32**	**160**	**192**	**7.2**	**2.3**	**27**	**2,100**	**230**	**0.64**	NA	**540**	NA	**0.119**
MW-2 7ft	7/30/2018	ND(<25)	ND(<50)	ND	**6.2**	**0.67**	**12**	**24**	**29**	**0.024**	NA	**37**	NA	**0.065**
Former Dumping Area (FDA)														
FDA-1 2ft	1/24/2018	ND(<25)	ND(<50)	ND	**3.5**	ND(<0.5)	**41**	**16**	**6.4**	**0.028**	NA	**30**	NA	NA
FDA-2 0-6in	1/24/2018	ND(<25)	ND(<50)	ND	**8.7**	ND(<0.5)	**21**	**79**	**52**	ND(<0.02)	NA	**270**	NA	NA
FDA-3 2.5ft	1/24/2018	ND(<25)	**420**	**420**	**3.5**	ND(<0.5)	**22**	**29**	**190**	**0.16**	NA	**220**	NA	NA
MW-5 2-6in	7/31/2018	ND(<25)	**96**	**96**	**4.9**	**0.7**	**39**	**140**	**120**	**0.1**	NA	**190**	NA	**0.070**
MW-5 10ft	7/31/2018	ND(<25)	ND(<50)	ND	**2.4**	ND(<0.22)	**18**	**14**	**2.1**	ND(<0.02)	NA	**26**	NA	ND(<0.02)
Former Underground Storage Tank (UST)														
UST-1 5ft	1/24/2018	ND(<25)	ND(<50)	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
UST-2 3ft	1/24/2018	ND(<25)	ND(<50)	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Former Above Ground Storage Tank (AST)														
AST-1 2ft	7/30/2018	**8,000**	**10,000**	**18,000**	**3.3**	ND(<0.2)	**17**	**40**	**27**	**0.037**	NA	**100**	NA	**0.015**
Shop Floor Drain And Outfall														
SFD-1 3.5ft	1/24/2018	**190**	ND(<50)	**190**	**2.2**	ND(<0.50)	**19**	**56**	**2.9**	ND(<0.02)	NA	**100**	NA	NA
SFD-2 3.5ft	1/24/2018	ND(<25)	ND(<50)	ND	**1.9**	ND(<0.50)	**12**	**29**	**1.9**	**0.021**	NA	**29**	NA	NA
MW-1 12ft	7/30/2018	ND(<25)	ND(<50)	ND	**3.4**	ND(<0.2)	**18**	**32**	**4.4**	ND(<0.02)	NA	**30**	NA	ND(<0.02)
MW-1 15ft	7/30/2018	ND(<25)	ND(<50)	ND	**2.1**	ND(<0.2)	**12**	**23**	**1.8**	ND(<0.02)	NA	**24**	NA	ND(<0.02)
Former Orcas Power and Light Company (OPALCO) Pad														
OPALCO Pad 1-4in	1/24/2018	ND(<25)	**130**	**130**	**7.1**	**2.2**	**40**	**1,100**	**530**	**0.15**	NA	**2,300**	NA	NA
OPALCO-2 2-6in	7/31/2018	ND(<25)	ND(<50)	ND	**4.8**	**0.92**	**17**	**68**	**54**	**0.026**	NA	**2,600**	NA	**0.030**
OPALCO-2 5ft	7/31/2018	ND(<25)	ND(<50)	ND	**3.2**	ND(<0.19)	**16**	**45**	**2.1**	ND(<0.02)	NA	**250**	NA	ND(<0.02)
OPALCO-3 2-6in	7/31/2018	ND(<25)	ND(<50)	ND	**7.1**	**1.1**	**30**	**1,300**	**990**	**0.34**	NA	**720**	NA	**0.096**
OPALCO-3 4ft	7/31/2018	ND(<25)	ND(<50)	ND	**4.1**	ND(<0.19)	**16**	**44**	**4.5**	**0.025**	NA	**39**	NA	ND(<0.02)
OPALCO-4 2-6in	7/31/2018	ND(<25)	ND(<50)	ND	**5.5**	ND(<0.19)	**18**	**120**	**50**	**0.67**	NA	**74**	NA	**0.036**
OPALCO-4 5ft	7/31/2018	ND(<25)	ND(<50)	ND	**3.3**	ND(<0.19)	**15**	**34**	**2.2**	ND(<0.02)	NA	**31**	NA	ND(<0.02)
MW-4 2-6in	7/31/2018	ND(<25)	**120**	**120**	**7.9**	0.79	**43**	**590**	**390**	**0.22**	NA	**620**	**0.0217**	**0.111**
MW-4 11ft	7/31/2018	ND(<25)	ND(<50)	ND	**8.4**	ND(<0.23)	**64**	**31**	**3.4**	ND(<0.02)	NA	**45**	NA	ND(<0.02)
Ship Yard Cove (SYC)														
SYC-1 2-6in	7/31/2018	ND(<25)	**120**	**120**	**4**	ND(<0.19)	**24**	**42**	**19**	**0.026**	NA	**74**	NA	**0.015**
SYC-1 2ft	7/31/2018	ND(<25)	ND(<50)	ND	**4.2**	ND(<0.19)	**21**	**26**	**6.6**	**0.026**	NA	**54**	NA	ND(<0.02)
SYC-2 2-6in	7/31/2018	ND(<25)	**130**	**130**	**4.2**	**0.21**	**21**	**48**	**46**	**0.036**	NA	**87**	NA	ND(<0.02)
SYC-2 2ft	7/31/2018	ND(<25)	ND(<50)	ND	**4.2**	ND(<0.19)	**22**	**37**	**8.3**	**0.022**	NA	**46**	NA	ND(<0.02)
SYC-3 2-6in	7/31/2018	ND(<25)	**70**	**70**	**6.3**	**0.4**	**29**	**99**	**57**	**0.063**	NA	**1,000**	NA	ND(<0.02)
SYC-3 3ft	7/31/2018	ND(<25)	ND(<50)	ND	**3.9**	ND(<0.19)	**14**	**33**	**2.9**	ND(<0.02)	NA	**34**	NA	ND(<0.02)
SYC-4 2-6in	7/31/2018	ND(<25)	**140**	**140**	**6.9**	**0.32**	**22**	**140**	**63**	**0.27**	NA	**140**	NA	**0.037**
SYC-4 2ft	7/31/2018	ND(<25)	ND(<50)	ND	**4.6**	ND(<0.19)	**22**	**63**	**51**	**0.23**	NA	**76**	NA	**0.038**
Misc. Upgradient Area														
MW-6 2-6in	7/31/2018	ND(<25)	ND(<50)	ND	**4**	ND(<0.19)	**19**	**28**	**13**	**0.027**	NA	**65**	NA	ND(<0.02)
MW-6 40ft	7/31/2018	ND(<25)	ND(<50)	ND	**3**	ND(<0.2)	**14**	**16**	**1.5**	ND(<0.02)	NA	**23**	NA	ND(<0.02)
Eastern Uplands Undeveloped Area - Test Pits														
IOSA-TP1-1-1020	10/19/2020	NA	NA	NA	**2.4**	<1	NA	**11**	**5.01**	<1	**15.4**	**28**	NA	NA
IOSA-TP2-1-1020	10/19/2020	NA	NA	NA	**2.51**	<1	NA	**10**	**5.78**	<1	**7.4**	**16**	NA	NA
IOSA-TP3-1-1020	10/19/2020	NA	NA	NA	**2.84 ca**	<1	NA	**61**	**56.4**	<1	**11.9**	**208**	NA	NA
IOSA-TP3-3-1020	10/19/2020	NA	NA	NA	**1.85**	<1	NA	**14**	**4.29**	<1	**10.9**	**23**	NA	NA
IOSA-TP4-1-1020	10/19/2020	NA	NA	NA	**2.33**	<1	NA	**19**	**12.2**	<1	**10.5**	**71**	NA	NA
IOSA-TP5-1-1020	10/19/2020	NA	NA	NA	**2.88 ca**	<1	NA	**57**	**248**	<1	**13.9**	**287**	NA	NA
IOSA-TP5-3-1020	10/19/2020	NA	NA	NA	**2.58 ca**	<1	NA	**30**	**46.4**	<1	**15.9**	**95**	NA	NA
IOSA-TP5-5-1020	10/19/2020	<50	<250	ND	**3.92**	<1	NA	**37**	**80.7**	<1	**13.6**	**115**	NA	NA
IOSA-TP6-1-1020	10/19/2020	NA	NA	NA	**2.4**	<1	NA	**34**	**241**	<1	**9.43**	**182**	NA	NA
IOSA-TP6-3-1020	10/19/2020	NA	NA	NA	**3.67 ca**	<1	NA	**15.1 J**	**3.21**	<1	**16.6**	**19.6 J**	NA	NA
IOSA-TP7-1-1020	10/19/2020	NA	NA	NA	**2.03**	<1	NA	**20**	**20.8**	<1	**9.81**	**35**	NA	NA
IOSA-TP8-1-1020	10/19/2020	NA	NA	NA	**2.21**	<1	NA	**13**	**8.14**	<1	**9.04**	**40**	NA	NA

NOTES:

^{a} - Screening level is natural background.

b - Screening level is practical quantitation limit (PQL).

c - Screening level is calculated soil protective of groundwater.

ND - indicates analyte was not detected at level above reporting limit (shown in parentheses)

NA - indicates sample was not analyzed for the constituent

BOLD - indicates that the concentration in the sample exceeds the respective detection limit (quantified value)

Pink shaded cell indicates that the concentration in the sample exceeds the above listed applicable saturated soil screening level

Tan shaded cell indicates that the concentration in the sample exceeds the above listed applicable surface or vadose soil screening level

Table 5-2 - Summary of Groundwater Data
Jensen's Shipyard and Marina
Port of Friday Harbor

		Lowest Screening Level	Screening Level Source	Well ID	MW-1		MW-2 [e]		MW-3		MW-4		MW-5		MW-6		# Samples	# Detections	# Non-Detections	Detect Frequency	# Screening Level Exceedances
				Date	8/28/18	2/19/20	8/28/18	2/19/20	8/28/18	2/19/20	8/28/18	2/19/20	8/29/18	2/19/20	8/29/18	2/19/20					
Water Quality Parameters																					
	Specific Conductivity			mS/cm	0.364	0.856	5.854	8.158	4.839	6.611	0.351	0.885	0.513	0.422	0.513	0.352					
Dissolved Metals (EPA 200.8, 245.1)																					
	Arsenic	5	Natural Background	ug/L	**12**	**9.56**	1 U	**7.63 J / 8.68 J**	**2.3**	**7.81 J**	**1.1**	**2.06**	**1.2**	1 U	1 U	1 U	13	9	4	69.23%	5
	Cadmium	7.9	Aquatic Life - CWA	ug/L	1 U	1 U	1 U	1 UJ / 1UJ	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	13	0	13	0.00%	0
	Chromium	50	Aquatic Life - CWA/173	ug/L	2 U	**1.52**	2 U	**1.83 J / 2.17**	**4.9/5.0**	**2.56**	2 U	**1.88**	2 U	1 U	2 U	1 U	13	6	7	46.15%	0
	Copper	3.1	Aquatic Life - CWA/173	ug/L	**8**	**3.74**	2 U	2.5 UJ / 2.5 U	**3.2**	**21.6**	**3.2**	**2.65**	2 U	**3.07**	2 U	2.5 U	13	7	6	53.85%	5
	Lead	5.6	Aquatic Life - CWA	ug/L	1 U	1 U	1 U	1 U / 1 UJ	1 U	**1.71**	1 U	1 U	1 U	1 U	1 U	1 U	13	1	12	7.69%	0
	Mercury	0.2	PQL	ug/L	2 U	0.2 U	2 U	0.2 U / 0.2 UJ	2 U	0.2 U	2 U	0.2 U	2 U	0.2 U	2 U	0.2 U	13	0	13	0.00%	0
	Nickel	8.2	Aquatic Life - CWA/173	ug/L	NA	**1.57**	NA	**4.38 J / 4.60**	NA	**2.68**	NA	**7.05**	NA	**2.61**	NA	**2.04**	7	7	0	100.00%	0
	Zinc	81	Aquatic Life - CWA/173	ug/L	**3.2**	5 U	2.5 U	5 UJ / 5U	**9.8**	**47.8**	**3**	5 U	2.5 U	5 U	2.5 U	**5.97**	13	5	8	38.46%	0
Total Petroleum Hydrocarbons (NWTPH-Dx) and BTEX (8021 and 8260)																					
	NWTPH-Gx Gasoline Range	800	Method A, benzene present	ug/L	50 U	NA	**200**	NA	50 U	NA	50 U	NA	50 U	NA	50 U	NA	6	1	5	16.67%	0
	NWTPH-Dx Diesel Range			ug/L	**180**	160 x	**210**	110 x/120 x	130 U	50 U	130 U	50 U	130 U	50 U	130 U	50 U	13	2	11	15.38%	0
	NWTPH-Dx Diesel Range with SGC			ug/L	NA	50 U	NA	50 U/50 U	NA	50 U	NA	50 U	NA	50 U	NA	50 U	7	0	7	0.00%	0
	NWTPH-Dx Oil Range			ug/L	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	13	0	13	0.00%	0
	NWTPH-Dx Oil Range with SGC			ug/L	NA	250 U	NA	250 U/250 U	NA	250 U	NA	250 U	NA	250 U	NA	250 U	7	0	7	0.00%	0
	NWTPH-Dx	500	Method A	ug/L	**180**	**160**	**210**	110/120	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	13	2	11	15.38%	0
	NWTPH-Dx with SGC	500	Method A	ug/L	NA	250 U	NA	250 U/250 U	NA	250 U	NA	250 U	NA	250 U	NA	250 U	7	0	7	0.00%	0
	EPA 8021 Benzene	0.02	PQL	ug/L	1 U	0.35 U	1 U	0.35 U	1 U	0.35 U	1 U	0.35 U	1 U	0.35 U	1 U	0.35 U	12	0	12	0.00%	0
	EPA 8021 Toluene	0.245	PQL	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	12	0	12	0.00%	0
	EPA 8021 Ethylbenzene	0.02	PQL	ug/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	12	0	12	0.00%	0
	EPA 8021 Xylenes	0.0977	PQL	ug/L	3 U	2 U	3 U	2 U	3 U	2 U	3 U	2 U	3 U	2 U	3 U	2 U	12	0	12	0.00%	0
cPAH Semi-Volatile Organic Compounds (EPA 8270D, 8270 SIM)																					
	Naphthalene [b]	8.9	Protective of Indoor Air	ug/L	0.02 U	1 U	0.02 U	1 U	0.02 U	1 U	0.02 U	1 U	0.02 U	1 U	0.02 U	1 U	12	0	12	0.00%	0
	Benzo(a)pyrene			ug/L	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	6	0	6	0.00%	0
	Benzo(a)anthracene			ug/L	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	6	0	6	0.00%	0
	Benzo(b)fluoranthene			ug/L	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	6	0	6	0.00%	0
	Benzo(k)fluoranthene			ug/L	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	6	0	6	0.00%	0
	Chrysene			ug/L	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	6	0	6	0.00%	0
	Dibenz(a,h)anthracene			ug/L	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	6	0	6	0.00%	0
	Indeno[1,2,3-cd]pyrene			ug/L	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	6	0	6	0.00%	0
	cPAH Equivalent (TEq) [c]	0.02	PQL	ug/L	0.015	NA	0.015	NA	0.015	NA	0.015	NA	0.015	NA	0.015	NA	6	0	6	0.00%	0
Volatile Organic Compounds (8260)																					
	All 8260 Compounds			ug/L	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	6	0	6	0.00%	NA
Total Organic Carbon (SM 5310C)				ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	**4.66**	NA	**3.64**	NA	NA	NA	NA	NA

[a] - Cleanup level dependent on BTEX concentrations

[b] - Sum of naphthalene, 1-methyl naphthalene, and 2-methylnaphthalene

[c] - cPAH level calculated using Toxicity equivalency methodology provided in WAC 173-340-708(8)

[d] - Method A cleanup level of Benzo(a)pyrene

[e] - Second value from duplicate sample MW-7A-021920

ND - indicates analyte(s) were not detected at level above corresponding reporting limit

NA - indicates value not available; not analyzed; indicates that there is no MTCA Method A target cleanup level

BOLD - indicates that the concentration in the sample exceeds the respective detection limit (quantified value)

Blue shaded cell indicates that the concentration in the sample exceeds the above listed applicable screening level.

TEq - Toxicity Equivalency to benzo(a)pyrene, calculated by multiplying result by appropriate TEF.

ug/L - micrograms per liter

mS/cm - milliSiemens per centimeter

U - indicates that the value is a laboratory reporting limit

J - reported concentration is an estimate.

SGC - Silica Gel Cleanup

PQL - Practical Quantitation Limit

CWA/173 - Surface Water for Human Health CWA §304 and/or 173-201A WAC

Table 8-2 - Screening Levels - Groundwater

Port of Friday Harbor, Jensen's Marina

		Screening Level (SL)		ISL Derivation Steps (right to left)														
				Select Highest Concentration for SL			Protection of Indoor Air: Method B - Groundwater to Indoor Air		Protection of Human Health from Seafood Consumption and Protection of Aquatic Life: Use Lowest Federal ARAR. If no Sufficiently Protective Federal ARAR, use the Lowest MTCA Method B Value.[b]									
Parameter Group	**Chemical**	**Value (ug/L)**	**Derived from:**	**PQL (ug/L)**	**Natural Background (ug/L)**	**Minimum from Surface Water and Groundwater to Air Pathways Criterias (ug/L)**	**Noncancer (ug/L)**	**Cancer (ug/L)**	**Retained Surface Water Screening Level (ug/L)**	**Surface Water Method B Noncancer (µg/L)**	**Surface Water Method B Cancer (µg/L)**	**Surface Water Aquatic Life Marine/Acute 173-201A WAC (µg/L)**	**Surface Water Aquatic Life Marine/Acute CWA §304 (µg/L)**	**Surface Water Aquatic Life Marine/Chronic 173-201A WAC (µg/L)**	**Surface Water Aquatic Life Marine/Chronic CWA §304 (µg/L)**	**Surface Water Human Health Marine Water 173-201A WAC (µg/L)**	**Surface Water Human Health Marine Water 40 CFR 131.45 (µg/L)**	**Surface Water Human Health Marine Water CWA §304 (µg/L)**
cPAH	Benzo(a)anthracene			0.02		0.00016			0.00016							0.021	0.00016	0.0013
	Benzo(a)pyrene; cPAH TEQ	0.02	PQL	0.02		0.000016			0.000016	26.000	0.035					0.0021	0.000016	0.00013
	Benzo(b)fluoranthene			0.02		0.00016			0.00016							0.021	0.00016	0.0013
	Benzo(k)fluoranthene			0.02		0.0016			0.0016							0.21	0.0016	0.013
	Chrysene			0.02		0.016			0.016							2.1	0.016	0.13
	Dibenz(a,h)anthracene			0.02		0.000016			0.000016							0.0021	0.000016	0.00013
	Indeno(1,2,3-cd)pyrene			0.02		0.00016			0.00016							0.021	0.00016	0.0013
Dioxins/Furans	Tetrachlorodibenzo-p-dioxin mixture	0.0000000051	SW-HH-CWA			0.0000000051			0.0000000051							0.000000064	0.000000014	0.0000000051
Metals	Arsenic	5	NB (Method A)	1	5	0.098			0.098	18	0	69	69	36	36	10	0.14	0.14
	Cadmium	7.9	SW-AL-CWA	1		7.9			7.9	41		42	33	9.3	7.9			
	Chromium, Total	1	PQL	1		0.00000			0.00000									
	Chromium (III)	240,000	SW-Method B			240,000			240,000	240,000								
	Chromium (VI)	50	SW-AL-173/CWA	0.045		50			50	490		1,100	1,100	50	50			
	Copper	3.1	SW-AL-173/CWA	2		3.1			3.1	2,900		4.8	4.8	3.1	3.1			
	Lead	5.6	SW-AL-CWA	1		5.6			5.6			210	140	8.1	5.6			
	Mercury	0.2	PQL	0.2		0.025	0.83		0.025			1.8	1.8	0.025	0.94			
	Nickel	8.2	SW-AL-173/CWA	1		8.2			8.2	1,100		74	74	8.2	8.2	190	100	4,600
	Zinc	81	SW-AL-173/CWA	2.5		81			81	17,000		90	90	81	81	2,900	1,000	26,000
PCBs	Total PCBs	0.1	PQL	0.1		0.000007			0.000007		0.0001	10		0.03	0.03	0.00017	0.000007	0.000064
SVOCs/PAHs	1-Methylnaphthalene	0.2	PQL	0.2														
	2-Methylnaphthalene	0.2	PQL	0.2														
	Acenaphthene	30	SW-HH-40CFR	0.02		30			30	640						110	30	90
	Anthracene	100	SW-HH-40CFR	0.02		100			100	26,000						4,600	100	400
	Fluorene	10	SW-HH-40CFR	0.02		10			10	3,500						610	10	70
	Naphthalene	8.9	Prot. of Indoor Air	0.2		8.9	170	8.9	4,900	4,900								
	Pyrene	8	SW-HH-40CFR	0.02		8			8	2,600						460	8	30
TPH [a]	TPH, diesel range organics	50	Method A	50														
	TPH, heavy oil	250	Method A	250														
	TPH, mineral oil		Method A															
	TPH, gasoline range organics, benzene present	100	PQL	100														
VOC	Benzene	1.6	SW-HH-173	0.35/1 [c]		1.6	100	2.4	1.6	2,000	23					1.6		16
	Toluene	130	SW-HH-173	1		130	15,000		130	19,000						410	130	520
	Ethylbenzene	31	SW-HH-40CFR	1		31	2,800		31	6,900						270	31	130
	o-Xylene	320	Prot. of Indoor Air	3		320	320											
	m-Xylene	320	Prot. of Indoor Air	1		320	320											

NOTES:

1. All values are based on February 2021 CLARC tables (except for background values and PQLs).
2 SLs are based on non-potable groundwater exposures.
3 The selected SL is based on the MTCA Method B cleanup level approach (WAC 173-340-720(4)(b)).
The SL is the minimum of the aquatic life protection ARAR (blue), the human health fish consumption value (orange), and the indoor air protection value (gray) , compared against the PQL and natural background.
If an human health federal ARAR ARAR does not exist, the MTCA Method B default standard formula value is used for the retained surface water protection value (orange).
4 Blank cells indicate where a PQL was not necessary to adjust the SL, natural background was not available, or ARARs/MTCA criteria were not available in Ecology's CLARC database.
5 Arsenic natural background level is MTCA Method A.
6 PQLs are based on values provided by Friedman & Bruya (April 2021).
7 Protection of indoor air SLs from February 2021 CLARC Tables and in concurrence with Ecology 2009. Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action. Publication No. 09-09-047. October 2009
8 SL codes: AL = aquatic life; B = MTCA Method B Surface Water; C = MTCA Method C Indoor Air; Ca = carcinogen; CWA = Clean Water Act; HH = human health; NB = natural background; NC = non-carcinogen; NTR = National Toxics Rule; PQL = practical quantitation limit; SW = surface water.
a. TPH SLs are MTCA Method A.
b. MTCA value only shown when there is no federal human health seafood consumption ARAR.
c. First value is by Method 8260D / Second value is Method 8021B

Table 8-3 - Screening Levels - Soil
Port of Friday Harbor, Jensen's Marina

		Saturated Soil Screening Level (SL)		SL Derivation Steps (right to left)						
				Select Highest Concentration as SL			Select Lowest Concentration as Minimum MTCA Level			
Parameter Group	**Chemical**	**Value**	**Derived from:**	**Natural Background**	**PQL**	**Minimum MTCA Level - from blue**	**Saturated Soil Protective of GW - Calculated**	**Vadose Soil Protective of GW - Calculated**	**Direct Contact - Method C Carcinogen**	**Direct Contact - Method C Non-carcinogen**
cPAH (mg/kg)	Benzo(a)anthracene				0.01	0.000000	0.000000	0.00000		
	Benzo(a)pyrene; cPAH TEQ	0.01	PQL		0.01	0.0000059	0.0000059	0.0000840	130	1100
	Benzo(b)fluoranthene				0.01	0.0000000	0.0000000	0.0000000		
	Benzo(k)fluoranthene				0.01	0.0000000	0.0000000	0.0000000		
	Chrysene				0.01	0.00	0.00	0.0		
	Dibenz(a,h)anthracene				0.01	0.0000000	0.0000000	0.0000000		
	Indeno(1,2,3-cd)pyrene				0.01	0.0000000	0.0000000	0.0000000		
Dioxins (mg/kg)	TCDD;2,3,7,8- (TEQ)	0.0000625	PQL		0.0000625	0.00000000000146	0.00000000000146	0.0000000000204	0.0017	0.0041
Metals (mg/kg)	Arsenic	7.3	NB	7.3	1	0.146	0.146	2.92	88	1,100
	Cadmium	1	PQL	0.8	1	0.055	0.055	1.0902		3500
	Chromium (III)	240,069	GW Prot	48.2	1	240069	240,069	4800960		5,300,000
	Chromium (VI)	48.2	NB	48.2	0.5	0.964	0.964	19.2		11,000
	Copper	36.4	NB	36.4		0.069	0.069	1.3764	880	140,000
	Lead	56.0	GW Prot	16.8	1	56	56	1120	Method A Industrial - 1,000	
	Mercury	0.1	PQL	0.07	1 / 0.1	0.010	0.010	0.209	Method A Industrial - 2.0	
	Nickel	48	NB	48		0.0024	0.0024	0.0328		70,000
	Zinc	85.1	NB	85.1		5.05	5.045	100.764		1,100,000
PCBs (mg/kg)	Total PCBs	1	Method A		0.02	0.0022	0.0022	0.0444	4	25
SVOCs/PAHs (mg/kg)	1-Methylnaphthalene	0.010	PQL		0.01	0.00013	0.00013	0.0024	4,500	250000
	2-Methylnaphthalene	0.010	PQL		0.01	0.00027	0.00027	0.00497		14,000
	Acenaphthene	0.023	GW Prot		0.01	0.023	0.023	0.4155		210,000
	Anthracene	0.0318	GW Prot		0.01	0.0318	0.0318	0.4641		1,100,000
	Fluoranthene	0.3	GW Prot			0.3	0.3	5.9		140,000
	Fluorene	0.01	PQL		0.01	0.0065	0.0065	0.1126		140,000
	Naphthalene	0.01	PQL		0.01	0.00596	0.00596	0.1041		70,000
	Pyrene	0.02	PQL		0.01	0.0191	0.0191	0.3306		110,000
TPH (mg/kg)^{b}	TPH, diesel range organics	2,000	Method A		50					
	TPH, heavy oils	2,000	Method A		250					
	TPH, mineral oil	4,000	Method A							
	TPH, gasoline range organics, benzene present	30	Method A		5					
VOCs (mg/kg)	Benzene	0.02	PQL		0.02	0.0043	0.0043	0.0847923	2,400	14,000
	Toluene	0.245	GW Prot		0.02	0.245	0.245	4.7412907		280,000
	Ethylbenzene	0.02	PQL		0.02	0.017	0.017	0.3056559		350,000
	o-Xylene	0.0600	PQL		0.06	0.0153	0.0153	0.2370600		700,000
	n-propylbenzene	350000	Method C			350000				350,000
	1,3,5-trimethylbenzene	35000	Method C			35000				35,000
	1,2,4-trimethylbenzene	35000	Method C			35000				35,000
	sec-butylbenzene	350000	Method C			350000				350,000
	n-butylbenzene	180000	Method C			180000				180,000

NOTES:

1. All values are based on February 2021 CLARC tables (except for background values and PQLs).
2 A simplified terrestrial ecological evaluation indicates that the Site does not pose a threat to terrestrial ecological receptors.
3 The SL (green) is the lowest of the Method C and groundwater protection columns (blue) under WAC 173-340-7491(1)(b), adjusted upward to the higher of the PQL or natural background (purple).
4 "Soil protective of groundwater" is a calculated value using MTCA equations below and the groundwater SL from Table 3-3.
MTCA Equation 747-1 was used with default values and saturated conditions.
MTCA Equation 747-2 used the default Koc and the site-specific soil fraction organic carbon (foc) of 0.3%.
5 Blank cells indicate where a PQL was not necessary to adjust the SL, natural background was not available, or ARARs/MTCA criteria were not available in Ecology's CLARC database.
6 Metals natural background values are Puget Sound 90th Percentiles from Table 1 of Ecology 1994. Natural Background Soil Metals Concentrations in Washington State. Publication #94-115. October 1994.
7 Dioxin/furan natural background level (on a TEQ basis) is from Ecology 2010. Natural Background for Dioxins/Furans in WA Soils. Technical Memorandum #8. August 9, 2010.
8 PQLs are based on values provided by Friedman & Bruya (April 2021).
9 SL codes: GW Prot = Soil Protective of Groundwater; NB = natural background; PQL = practical quantitation limit.
a. The Toxics Substance Control Act provides an ARAR for total PCBs: 10 mg/kg. This value was used in this table because it is lower than the Method C - Carcinogen value of 66 mg/kg.
b. TPH SLs are MTCA Method A. When benzene is not present, 100 mg/kg may be used as the TPH-gasoline SL.
c. PQL value dependent on analytical method. Values are Method 6020 / Method 1631.

Figures

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Appendix A

Statistical Evaluation of Soil and Groundwater Data

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Table A. Statistical Summary - 2018 Upland Soil Sample Results - Jensen's Shipyard

Sample ID	**# Samples**	**# Detections**	**# Non Dection**	**Detect Frequency**	**Max Detected Value**	**Shop Floor Drain-1 3.5ft**	**Shop Floor Drain-2 3.5ft**	**OPALCO Pad 1-4in**	**OPALCO-2 2-6in**	**OPALCO-2 5ft**	**OPALCO-3 2-6in**	**OPALCO-3 4ft**	**OPALCO-4 2-6in**	**OPALCO-4 5ft**	**SYC-1 2-6in**	**SYC-1 2ft**	**SYC-2 2-6in**	**SYC-2 2ft**	**SYC-3 2-6in**	**SYC-3 3ft**	**SYC-4 2-6in**	**SYC-4 2ft**
Date						1/24/2018	1/24/2018	1/24/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018
TPH (mg/kg)																						
NWTPH-Gx Volatile Range	10	2	8	20%	84	ND(<3.0)	ND(<3.0)	ND(<3.0)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWTPH-Dx Diesel Range	68	16	52	24%	8000	190	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)
NWTPH-Dx Oil-Range	68	30	38	44%	10000	ND(<50)	ND(<50)	130	ND(<50)	ND(<50)	ND(<50)	ND(<50)	ND(<50)	ND(<50)	120	ND(<50)	130	ND(<50)	70	ND(<50)	140	ND(<50)
EPA-8021 Benzene	11	0	11	0%	ND	ND(<0.03)	ND(<0.03)	ND(<0.03)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA-8021 Toluene	11	0	11	0%	ND	ND(<0.05)	ND(<0.05)	ND(<0.05)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA-8021 Ethylbenzene	11	0	11	0%	ND	ND(<0.05)	ND(<0.05)	ND(<0.05)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA-8021 Xylenes	11	0	11	0%	ND	ND(<0.20)	ND(<0.20)	ND(<0.20)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals (EPA-6020/7471) (mg/kg)																						
Arsenic	63	62	1	98%	150	2.2	1.9	7.1	4.8	3.2	7.1	4.1	5.5	3.3	4	4.2	4.2	4.2	6.3	3.9	6.9	4.6
Cadmium	63	28	35	44%	2.6	ND(<0.50)	ND(<0.50)	**2.2**	0.92	ND(<0.19)	1.1	ND(<0.19)	ND(<0.19)	ND(<0.19)	ND(<0.19)	ND(<0.19)	0.21	ND(<0.19)	0.4	ND(<0.19)	0.32	ND(<0.19)
Chromium	63	62	1	98%	78	19	12	40	17	16	30	16	18	15	24	21	21	22	29	14	22	22
Copper	63	62	1	98%	9300	56	29	1,100	68	45	1,300	44	120	34	42	26	48	37	99	33	140	63
Lead	63	62	1	98%	3400	2.9	1.9	**530**	54	2.1	**990**	4.5	50	2.2	19	6.6	46	8.3	57	2.9	63	51
Mercury	63	48	15	76%	13	ND(<0.02)	0.021	0.15	0.026	ND(<0.02)	0.34	0.025	0.67	ND(<0.02)	0.026	0.026	0.036	0.022	0.063	ND(<0.02)	0.27	0.23
Zinc	63	62	1	98%	3800	100	29	2,300	2,600	250	720	39	74	31	74	54	87	46	1,000	34	140	76
PCBs (EPA-8082) (mg/kg)																						
Total PCBs	7	2	5	27%	0.35	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)	ND(<0.10)	ND(<0.10)	ND(<0.10)	ND(<0.10)	NA	NA	NA	NA	NA	NA	NA	NA
Dioxins and Furans (EPA-1613B) (ug/kg)																						
Chlorinated dibenzo-p-dioxins TEQ	1	1	0	100%	0.13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semi-Volatile Organic Compounds (SVOCs) (EPA-8270 SIM) (mg/kg)																						
Naphthalene	55	6	49	11%	0.14	NA	NA	NA	ND(<0.02)	ND(<0.02)	0.04	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
2-Methylnaphthalene	55	9	46	16%	1.20	NA	NA	NA	ND(<0.02)	ND(<0.02)	0.032	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
1-Methylnaphthalene	55	7	48	13%	0.91	NA	NA	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Acenaphthylene	55	12	43	22%	0.26	NA	NA	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Acenaphthene	55	3	52	5%	0.13	NA	NA	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Fluorene	55	2	53	4%	0.13	NA	NA	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Phenanthrene	55	26	29	47%	1.20	NA	NA	NA	0.034	ND(<0.02)	0.24	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Anthrancene	55	19	36	35%	0.37	NA	NA	NA	ND(<0.02)	ND(<0.02)	0.044	ND(<0.02)	0.024	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Fluoranthene	55	32	23	58%	2.20	NA	NA	NA	0.072	ND(<0.02)	0.34	ND(<0.02)	0.059	ND(<0.02)	0.02	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.031	ND(<0.02)	0.045	0.049
Pyrene	55	32	23	58%	1.90	NA	NA	NA	0.055	ND(<0.02)	0.21	ND(<0.02)	0.041	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.03	ND(<0.02)	0.04	0.048
Benzo[A]Anthracene	55	23	32	42%	1.20	NA	NA	NA	ND(<0.02)	ND(<0.02)	0.095	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.022	0.024
Chrysene	55	19	36	35%	1.30	NA	NA	NA	ND(<0.02)	ND(<0.02)	0.16	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.024	0.03
Benzo[B]Fluoranthene	55	27	28	49%	1.40	NA	NA	NA	0.039	ND(<0.02)	0.17	ND(<0.02)	0.057	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.054	0.043
Benzo[K]Fluoranthene	55	1	54	2%	0.28	NA	NA	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Benzo[A]Pyrene	55	28	27	51%	1.10	NA	NA	NA	0.022	ND(<0.02)	0.061	ND(<0.02)	0.024	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.025	0.027
Indeno[1,2,3-Cd]Pyrene	55	27	28	49%	0.80	NA	NA	NA	ND(<0.02)	ND(<0.02)	0.045	ND(<0.02)	0.035	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.026	0.021
Dibenz[A,H]Anthracene	55	12	43	22%	0.20	NA	NA	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Benzo[G,H,I]perylene	55	30	25	55%	0.95	NA	NA	NA	ND(<0.02)	ND(<0.02)	0.06	ND(<0.02)	0.041	ND(<0.02)	0.025	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.043	0.026
Total cPAH Equivalent (TEQ)	55	32	23	58%	1.45	NA	NA	NA	0.030	ND(<0.02)	0.096	ND(<0.02)	0.036	ND(<0.02)	0.015	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.037	0.038

[a] - Cleanup level dependent on BTEX concentrations

[b] - indicates sum of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene

[c] - indicates cleanup level is dependant on Chromium(VI) concentrations.

[d] - indicates Method B direct contact cleanup level

ND - indicates analyte was not detected at level above reporting limit (shown in parentheses)

NA - indicates sample was not analyzed for the constituent

BOLD - indicates that the concentration in the sample exceeds the MTCA Method A or Method B target cleanup levels

Table A. Statistical Sum

Sample ID	**MW-4 2-6in**	**MW-4 11ft**	**MW-5 2-6in**	**MW-5 10ft**	**MW-6 2-6in**	**MW-6 40ft**	**BLWA-1 0-3in**	**BLWA-3 2-6in**	**BLWA-3 2ft**	**BLWA-4 2-6"**	**BLWA-4 5ft**	**BLWA-5 2-6in**	**BLWA-5 2ft**	**BLWA-6 2-6in**	**BLWA-6 2ft**	**BLWA-6 5ft**	**BLWA-6 10ft**	**BLWA-7 2-6in**	**BLWA-7 2ft**	**BLWA-7 5ft**	**BLWA-8 2-6in**
Date	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	7/31/2018	1/24/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018
TPH (mg/kg)																					
NWTPH-Gx Volatile Range	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<3.0)	ND(<3.0)	NA	NA	NA	NA
NWTPH-Dx Diesel Range	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	160	ND(<25)	ND(<25)	ND(<25)	ND(<25)	91	ND(<25)	95	350	1,400	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)
NWTPH-Dx Oil-Range	120	ND(<50)	96	ND(<50)	ND(<50)	ND(<50)	470	ND(<50)	ND(<50)	81	ND(<50)	180	ND(<50)	260	710	940	ND(<50)	180	ND(<50)	ND(<50)	56
EPA-8021 Benzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.03)	ND(<0.03)	NA	NA	NA	NA
EPA-8021 Toluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.05)	ND(<0.05)	NA	NA	NA	NA
EPA-8021 Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.05)	ND(<0.05)	NA	NA	NA	NA
EPA-8021 Xylenes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.20)	ND(<0.20)	NA	NA	NA	NA
Metals (EPA-6020/7471) (mg/kg)																					
Arsenic	7.9	8.4	4.9	2.4	4	3	12	3.5	3	5.2	3.9	10	3.1	9.7	**150**	3.7	4.6	13	3.7	NA	5.1
Cadmium	0.79	ND(<0.23)	0.7	ND(<0.22)	ND(<0.19)	ND(<0.2)	1.3	0.2	ND(<0.2)	0.43	ND(<0.19)	0.81	ND(<0.19)	1.2	**2.6**	ND(<0.19)	ND(<0.19)	1.8	ND(<0.19)	NA	0.48
Chromium	43	64	39	18	19	14	35	28	15	21	17	29	15	31	78	18	11	30	21	NA	19
Copper	590	31	140	14	28	16	**6,700**	180	32	680	86	1,100	28	**9,300**	**3,500**	84	20	2100	50	NA	1100
Lead	**390**	3.4	120	2.1	13	1.5	**700**	150	3	150	**540**	**270**	3.2	**760**	**3,400**	**560**	1.9	**340**	3	NA	**470**
Mercury	0.22	ND(<0.02)	0.1	ND(<0.02)	0.027	ND(<0.02)	0.81	0.032	0.028	0.17	0.18	0.36	0.038	1.1	0.31	0.11	ND(<0.02)	0.92	ND(<0.02)	NA	0.18
Zinc	620	45	190	26	65	23	950	99	29	260	110	390	31	1,400	3,800	72	47	630	39	NA	350
PCBs (EPA-8082) (mg/kg)																					
Total PCBs	0.1	ND(<0.10)	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dioxins and Furans (EPA-1613B) (ug/																					
Chlorinated dibenzo-p-dioxins TEQ	**0.0217**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semi-Volatile Organic Compounds (SV																					
Naphthalene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	0.031	ND(<0.02)	0.14	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)
2-Methylnaphthalene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	0.093	ND(<0.02)	0.13	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.45	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)
1-Methylnaphthalene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	0.039	ND(<0.02)	0.095	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.91	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)
Acenaphthylene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.095	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.031	ND(<0.02)	0.14	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.031	ND(<0.02)	NA	ND(<0.02)
Acenaphthene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.13	ND(<0.02)	0.027	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)
Fluorene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.13	ND(<0.02)	0.042	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)
Phenanthrene	0.15	ND(<0.02)	0.031	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.1	ND(<0.02)	0.12	0.025	0.86	ND(<0.02)	0.35	ND(<0.02)	0.71	ND(<0.02)	0.091	ND(<0.02)	NA	0.07
Anthrancene	0.045	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.17	ND(<0.02)	0.027	0.022	0.24	ND(<0.02)	0.27	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.058	ND(<0.02)	NA	ND(<0.02)
Fluoranthene	0.24	ND(<0.02)	0.096	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	1	ND(<0.02)	0.17	0.14	0.79	ND(<0.02)	1.2	0.066	ND(<0.02)	ND(<0.02)	0.34	ND(<0.02)	NA	0.13
Pyrene	0.17	ND(<0.02)	0.088	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	1.9	ND(<0.02)	0.14	0.086	0.79	ND(<0.02)	0.86	0.081	ND(<0.02)	ND(<0.02)	0.25	ND(<0.02)	NA	0.12
Benzo[A]Anthracene	0.095	ND(<0.02)	0.048	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.82	ND(<0.02)	0.067	0.036	0.45	ND(<0.02)	0.5	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.081
Chrysene	0.092	ND(<0.02)	0.053	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	1	ND(<0.02)	ND(<0.02)	0.098	0.59	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.13
Benzo[B]Fluoranthene	0.17	ND(<0.02)	0.09	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.83	ND(<0.02)	0.16	0.14	0.6	ND(<0.02)	**1.4**	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.59	ND(<0.02)	NA	0.18
Benzo[K]Fluoranthene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)
Benzo[A]Pyrene	0.076	ND(<0.02)	0.05	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	**0.33**	ND(<0.02)	0.065	0.037	**0.38**	ND(<0.02)	**0.46**	ND(<0.02)	ND(<0.02)	ND(<0.02)	**0.16**	ND(<0.02)	NA	0.083
Indeno[1,2,3-Cd]Pyrene	0.058	ND(<0.02)	0.039	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.17	ND(<0.02)	0.068	0.036	0.28	ND(<0.02)	0.42	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.22	ND(<0.02)	NA	0.078
Dibenz[A,H]Anthracene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.064	ND(<0.02)	0.024	ND(<0.02)	0.091	ND(<0.02)	0.13	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.066	ND(<0.02)	NA	0.028
Benzo[G,H,I]perylene	0.07	ND(<0.02)	0.048	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	0.17	ND(<0.02)	0.08	0.041	0.34	ND(<0.02)	0.43	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.25	ND(<0.02)	NA	0.093
Total cPAH Equivalent (TEQ)	**0.111**	ND(<0.02)	0.070	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	**0.529**	ND(<0.02)	0.098	0.061	**0.529**	ND(<0.02)	**0.706**	0.015	ND(<0.02)	ND(<0.02)	**0.250**	ND(<0.02)	NA	**0.122**

[a] - Cleanup level dependent on BTEX concentra

[b] - indicates sum of naphthalene, 1-methylnaph

[c] - indicates cleanup level is dependant on Chro

[d] - indicates Method B direct contact cleanup le

ND - indicates analyte was not detected at level

NA - indicates sample was not analyzed for the

BOLD - indicates that the concentration in the

Table A. Statistical Sum

Sample ID	**BLWA-8 2ft**	**BLWA-8 5ft**	**BLWA-9 2-6in**	**BLWA-9 2ft**	**BLWA-9 5ft**	**AST-1 2ft**	**MW-1 12ft**	**MW-1 15ft**	**MW-2 6in**	**MW-2 7ft**	**FDA-1 2ft**	**FDA-2 0-6in**	**FDA-3 2.5ft**	**UST-1 5ft**	**UST-2 3ft**	**SRWA-1 3-6in**	**SRWA-2 3-6in**	**SRWA-3 0-6in**	**SRWA-4 6in**	**SRWA-4 3.5ft**
Date	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	7/30/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	8/1/2018	8/1/2018
TPH (mg/kg)																				
NWTPH-Gx Volatile Range	NA	NA	NA	NA	NA	NA	32	ND(<3.0)	NA	NA	NA	NA	NA	ND(<3.0)	ND(<3.0)	NA	NA	84	NA	NA
NWTPH-Dx Diesel Range	ND(<25)	ND(<25)	61	ND(<25)	ND(<25)	**8,000**	ND(<25)	ND(<25)	32	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	ND(<25)	180	91	**3,900**	79	ND(<25)
NWTPH-Dx Oil-Range	290	98	160	ND(<50)	ND(<50)	**10,000**	ND(<50)	ND(<50)	160	ND(<50)	ND(<50)	ND(<50)	420	ND(<50)	ND(<50)	1,100	220	940	190	ND(<50)
EPA-8021 Benzene	NA	NA	NA	NA	NA	ND(<0.03)	ND(<0.03)	ND(<0.03)	NA	NA	NA	NA	NA	ND(<0.03)	ND(<0.03)	NA	NA	ND(<0.03)	NA	NA
EPA-8021 Toluene	NA	NA	NA	NA	NA	ND(<0.05)	ND(<0.05)	ND(<0.05)	NA	NA	NA	NA	NA	ND(<0.05)	ND(<0.05)	NA	NA	ND(<0.05)	NA	NA
EPA-8021 Ethylbenzene	NA	NA	NA	NA	NA	ND(<0.05)	ND(<0.05)	ND(<0.05)	NA	NA	NA	NA	NA	ND(<0.05)	ND(<0.05)	NA	NA	ND(<0.05)	NA	NA
EPA-8021 Xylenes	NA	NA	NA	NA	NA	ND(<0.20)	ND(<0.20)	ND(<0.20)	NA	NA	NA	NA	NA	ND(<0.20)	ND(<0.20)	NA	NA	ND(<0.20)	NA	NA
Metals (EPA-6020/7471) (mg/kg)																				
Arsenic	6.2	NA	5.7	3.3	NA	3.3	3.4	2.1	7.2	6.2	3.5	8.7	3.5	NA	NA	**30**	14	17	**54**	7.7
Cadmium	0.23	NA	0.96	ND(<0.19)	NA	ND(<0.2)	ND(<0.2)	ND(<0.2)	**2.3**	0.67	ND(<0.5)	ND(<0.5)	ND(<0.5)	NA	NA	0.54	ND(<0.5)	ND(<0.5)	0.39	ND(<0.22)
Chromium	23	NA	25	18	NA	17	18	12	27	12	41	21	22	NA	NA	29	18	21	35	24
Copper	170	NA	2900	49	NA	40	32	23	2,100	24	16	79	29	NA	NA	2,400	1,100	690	2,000	35
Lead	200	NA	**310**	11	NA	27	4.4	1.8	230	29	6.4	52	190	NA	NA	**920**	**1,000**	90	**1,800**	15
Mercury	0.12	NA	1.5	0.048	NA	0.037	ND(<0.02)	ND(<0.02)	0.64	0.024	0.028	ND(<0.02)	0.16	NA	NA	**13**	**6.3**	0.54	**11**	0.098
Zinc	110	NA	690	92	NA	100	30	24	540	37	30	270	220	NA	NA	840	330	580	450	64
PCBs (EPA-8082) (mg/kg)																				
Total PCBs	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.35	NA	NA
Dioxins and Furans (EPA-1613B) (ug/																				
Chlorinated dibenzo-p-dioxins TEQ	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semi-Volatile Organic Compounds (SV																				
Naphthalene	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	NA	NA	NA	NA	0.12	0.0071	ND(<0.10)	ND(<0.02)	ND(<0.02)
2-Methylnaphthalene	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	NA	0.4	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	NA	NA	NA	NA	0.0067	0.0041	1.2	ND(<0.02)	ND(<0.02)
1-Methylnaphthalene	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	NA	0.78	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	NA	NA	NA	NA	0.0052	0.0052	0.9	ND(<0.02)	ND(<0.02)
Acenaphthylene	ND(<0.02)	NA	0.13	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.033	ND(<0.02)	NA	NA	NA	NA	NA	0.095	0.077	ND<0.00002)	0.16	ND(<0.02)
Acenaphthene	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	NA	NA	NA	NA	0.012	ND(<0.00002)	ND<0.00002)	ND(<0.02)	ND(<0.02)
Fluorene	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	NA	NA	NA	NA	ND(<0.12)	ND(<0.12)	ND(<0.12)	ND(<0.02)	ND(<0.02)
Phenanthrene	0.029	NA	0.13	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.1	0.021	NA	NA	NA	NA	NA	0.25	0.13	0.62	0.24	ND(<0.02)
Anthrancene	ND(<0.02)	NA	0.076	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.066	ND(<0.02)	NA	NA	NA	NA	NA	0.11	0.053	ND	0.1	ND(<0.02)
Fluoranthene	0.073	NA	0.52	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.29	0.075	NA	NA	NA	NA	NA	0.67	0.21	0.62	0.71	ND(<0.02)
Pyrene	0.052	NA	0.4	ND(<0.02)	NA	1.3	ND(<0.02)	ND(<0.02)	0.18	0.072	NA	NA	NA	NA	NA	0.65	0.21	0.57	0.73	ND(<0.02)
Benzo[A]Anthracene	0.035	NA	0.32	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.05	NA	NA	NA	NA	NA	0.4	0.11	0.21	0.54	ND(<0.02)
Chrysene	0.032	NA	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.045	NA	NA	NA	NA	NA	0.53	0.12	0.34	0.5	ND(<0.02)
Benzo[B]Fluoranthene	0.055	NA	1.2	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.38	0.06	NA	NA	NA	NA	NA	0.81	0.2	0.43	0.59	ND(<0.02)
Benzo[K]Fluoranthene	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	NA	NA	NA	NA	NA	0.28	ND(<0.11)	ND(<0.00002)	ND(<0.02)	ND(<0.02)
Benzo[A]Pyrene	0.029	NA	**0.61**	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.064	0.048	NA	NA	NA	NA	NA	**0.52**	**0.14**	**0.22**	**0.5**	ND(<0.02)
Indeno[1,2,3-Cd]Pyrene	0.028	NA	0.8	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.11	0.035	NA	NA	NA	NA	NA	0.4	0.12	0.15	0.32	ND(<0.02)
Dibenz[A,H]Anthracene	ND(<0.02)	NA	**0.2**	ND(<0.02)	NA	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.035	ND(<0.02)	NA	NA	NA	NA	NA	0.11	ND(<0.10)	ND(<0.00002)	0.098	ND(<0.02)
Benzo[G,H,I]perylene	0.035	NA	0.95	ND(<0.02)	NA	0.46	ND(<0.02)	ND(<0.02)	0.12	0.04	NA	NA	NA	NA	NA	0.57	0.19	0.17	0.41	ND(<0.02)
Total cPAH Equivalent (TEQ)	0.043	NA	**0.863**	ND(<0.02)	NA	0.015	ND(<0.02)	ND(<0.02)	**0.119**	0.065	NA	NA	NA	NA	NA	**0.725**	**0.186**	**0.304**	**0.661**	ND(<0.02)

[a] - Cleanup level dependent on BTEX concentra

[b] - indicates sum of naphthalene, 1-methylnaph

[c] - indicates cleanup level is dependant on Chro

[d] - indicates Method B direct contact cleanup le

ND - indicates analyte was not detected at level

NA - indicates sample was not analyzed for the

BOLD - indicates that the concentration in the

Table A. Statistical Sum

Sample ID	**SRWA-5 2-6in**	**SRWA-5 3.5 ft**	**SRWA-5 5ft**	**SRWA-6 2-6in**	**SRWA-6 3ft**	**SRWA-7 2-6in**	**SRWA-7 3ft**	**MW-3 2-6in**	**MW-3 5.5ft**
Date	8/1/2018	8/1/2018	8/1/2018	8/1/2018	8/1/2018	8/1/2018	8/1/2018	8/1/2018	8/1/2018
TPH (mg/kg)									
NWTPH-Gx Volatile Range	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWTPH-Dx Diesel Range	ND(<25)	ND(<25)	ND(<25)	120	ND(<25)	170	40	ND(<25)	ND(<25)
NWTPH-Dx Oil-Range	72	ND(<50)	ND(<50)	640	ND(<50)	690	230	280	ND(<50)
EPA-8021 Benzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA-8021 Toluene	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA-8021 Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPA-8021 Xylenes	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals (EPA-6020/7471) (mg/kg)									
Arsenic	12	4.2	5.1	16	5	9.1	4.3	13	5.6
Cadmium	0.32	1.5	ND(<0.23)	0.64	ND(<0.21)	**2.6**	0.38	0.74	ND(<0.21)
Chromium	20	11	20	36	20	25	19	29	28
Copper	420	43	16	220	11	920	63	400	82
Lead	**940**	21	3.6	**1,200**	11	160	110	190	25
Mercury	0.33	0.04	ND(<0.02)	**2.8**	ND(<0.02)	0.23	0.1	1.3	0.16
Zinc	460	58	55	1,100	32	400	140	310	110
PCBs (EPA-8082) (mg/kg)									
Total PCBs	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dioxins and Furans (EPA-1613B) (ug/									
Chlorinated dibenzo-p-dioxins TEQ	NA	NA	NA	NA	NA	NA	NA	**0.132**	NA
Semi-Volatile Organic Compounds (SV									
Naphthalene	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.036	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
2-Methylnaphthalene	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.022	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
1-Methylnaphthalene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Acenaphthylene	0.037	ND(<0.02)	ND(<0.02)	0.26	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.022	ND(<0.02)
Acenaphthene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Fluorene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Phenanthrene	0.14	0.057	ND(<0.02)	1.2	ND(<0.02)	0.074	0.091	0.071	ND(<0.02)
Anthrancene	0.051	ND(<0.02)	ND(<0.02)	0.37	ND(<0.02)	0.024	0.023	0.026	ND(<0.02)
Fluoranthene	0.34	0.13	ND(<0.02)	2.2	ND(<0.02)	0.15	0.3	0.15	0.033
Pyrene	0.33	0.12	ND(<0.02)	1.9	ND(<0.02)	0.16	0.29	0.14	0.028
Benzo[A]Anthracene	0.18	0.065	ND(<0.02)	1.2	ND(<0.02)	ND(<0.02)	0.17	0.076	ND(<0.02)
Chrysene	0.19	ND(<0.02)	ND(<0.02)	1.3	ND(<0.02)	ND(<0.02)	0.18	0.11	ND(<0.02)
Benzo[B]Fluoranthene	0.24	ND(<0.02)	ND(<0.02)	1.3	ND(<0.02)	ND(<0.02)	0.23	0.15	0.042
Benzo[K]Fluoranthene	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Benzo[A]Pyrene	**0.17**	0.06	ND(<0.02)	**1.1**	ND(<0.02)	0.065	**0.16**	0.081	ND(<0.02)
Indeno[1,2,3-Cd]Pyrene	0.12	0.042	ND(<0.02)	0.62	ND(<0.02)	0.079	0.11	0.071	ND(<0.02)
Dibenz[A,H]Anthracene	0.035	ND(<0.02)	ND(<0.02)	**0.2**	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)	ND(<0.02)
Benzo[G,H,I]perylene	0.15	0.05	ND(<0.02)	0.68	ND(<0.02)	0.13	0.15	0.1	0.022
Total cPAH Equivalent (TEQ)	**0.230**	0.074	ND(<0.02)	**1.446**	ND(<0.02)	0.077	**0.215**	**0.114**	0.018

[a] - Cleanup level dependent on BTEX concentra

[b] - indicates sum of naphthalene, 1-methylnaph

[c] - indicates cleanup level is dependant on Chro

[d] - indicates Method B direct contact cleanup le

ND - indicates analyte was not detected at level

NA - indicates sample was not analyzed for the

BOLD - indicates that the concentration in the

Table B. Statistical Summary -Full List VOC and SVOC - Soil Sample Results - Jensen's Shipyard

Sample ID		# Samples	# Detections	# Non Dection	Detect Frequency	Max Value	Shop Floor Drain-1	Shop Floor Drain-2	OPALCO Pad	BLWA-1	BLWA-2	FDA-1	FDA-2	FDA-3	UST-1	UST-2	SRWA-1	SRWA-2	SRWA-3
Date							1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018	1/24/2018
Volatile Organic Compounds (VOCs) (EPA-8260)																			
Dicholordifluoromethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Chloromethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Vinyl Chloride	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Bromomethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Chloroethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Carbon Tetrachloride	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Trichlorofluoromethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Carbon Disulfide	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Acetone	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.05)
1,1-Dichloroethene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Methylene Chloride	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.02)
Acrylonitrile	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.05)
Methyl T-Buyl Ether	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Trans-1,2-Dichloroethene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,1-Dichloroethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
2-Butanone	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.05)
Cis-1,2-Dichloroethene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
2,2-Dichloropropane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Bromochloromethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Chloroform	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,1,1-Trichloroethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,1-Dichloropropene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,2-Dichloroethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Trichloroethene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,2-Dichloropropane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Dibromomethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Bromodichloromethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Trans-1,3-Dichloropropene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
4-Methyl-2-Pentanone	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.05)
Cis-1,3-Dichloropropene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,1,2-Trichloroethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
2-Hexanone	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.05)
1,3-Dichloropropane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Tetrachloroethylene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Dibromochloromethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,2-Dibromoethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.005)
Chlorobenzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,1,1,2-Tetrachloroethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Styrene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Bromoform	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Isopropylbenzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,1,2,2-Tetrachloroethane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,2,3-Trichloropropane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)

Table B. Statistical Summary -Full List VOC and SVOC - Soil Sample Results - Jensen's Shipyard

Sample ID		# Samples	# Detections	# Non Dection	Detect Frequency	Max Value	Shop Floor Drain-1	Shop Floor Drain-2	OPALCO Pad	BLWA-1	BLWA-2	FDA-1	FDA-2	FDA-3	UST-1	UST-2	SRWA-1	SRWA-2	SRWA-3
Bromobenzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
N-Propyl Benzene	mg/kg	2	1	1	50%	0.017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.017
2-Chlorotoluene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,3,5-Trimethylbenzene	mg/kg	2	1	1	50%	0.240	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.24
4-Chlorotoluene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
T-Buyl Benzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,2,4-Trimethylbenzene	mg/kg	2	1	1	50%	0.610	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.61
S-Butyl benzene	mg/kg	2	1	1	50%	0.033	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.033
P-Isopropyltoluene	mg/kg	2	1	1	50%	0.033	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.033
1,3-Dichlorobenzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,4-Dichlorobenzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
N- Butylbenzene	mg/kg	2	1	1	50%	0.055	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.055
1,2-Dichlorobenzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,2-Dicholorbenzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,2-Dibromo 3-Chloropropane	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.05)
1,2,4-Trichlorobenzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Hexochlorobutadiene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
Naphthalene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)
1,2,3-Trichlorobenzene	mg/kg	2	0	2	0%	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.01)

Table B. Statistical Summary -Full List VOC and SVOC - Soil Sample Results - Jensen's Shipyard

Sample ID		**# Samples**	**# Detections**	**# Non Dection**	**Detect Frequency**	**Max Value**	**Shop Floor Drain-1**	**Shop Floor Drain-2**	**OPALCO Pad**	**BLWA-1**	**BLWA-2**	**FDA-1**	**FDA-2**	**FDA-3**	**UST-1**	**UST-2**	**SRWA-1**	**SRWA-2**	**SRWA-3**
Semi-Volatile Organic Compounds (SVOCs) (EPA-8270/8270 SIM)																			
Pyridine	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.20)	ND(<0.20)	ND(<0.20)
N-Nitrosodimethylamine	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
Phenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.12)
Aniline	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.17)	ND(<0.17)	ND(<0.23)
Bis(2-Choloroethyl) Ether	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.11)
2-Chlorophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
1,3-Dichlorobenzene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.11)
1,4-Dichlorobenzene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.12)
Benzyl alcohol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.11)	ND(<0.11)	ND(<0.14)
1,2-Dichlorobenzene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
2-Methylphenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.13)
Bis(2-Chloroisopropyl)Ether	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.12)	ND(<0.12)	ND(<0.16)
3&4-Methylphenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.13)	ND(<0.13)	ND(<0.17)
N-Nitroso-Di-N-Propylamine	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.15)	ND(<0.15)	ND(<0.20)
Hexacholorethane	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.11)
Nitrobenzene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
Isophorone	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
2-Nitrophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.25)	ND(<0.25)	ND(<0.25)
2-4-Dimethylphenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
Benzoic Acid	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<1.0)	ND(<1.0)	ND(<1.0)
Bis(2-Chloroethoxy)Methane	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
2,4-Dichlorophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
1,2,4-Trichlorobenzene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.12)
Naphthalene	mg/kg	4	2	2	50%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.12	0.0071	ND(<0.10)
4-Chlororaniline	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.20)	ND(<0.20)	ND(<0.26)
2,6-Dichlorophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.13)
Hexachlorobutadiene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.18)
4-Chloro-3-Methylphenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.11)
2-Methylnaphthalene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0067	0.0041	1.2
1-Methylnaphthalene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0052	0.0052	0.9
Hexochlorocyclopentadiene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.50)	ND(<0.50)	ND(<0.50)
2,4,6-Trichlorophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.11)
2,4,5-Trichlorophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.12)	ND(<0.12)	ND(<0.17)
2-Chloronaphthalene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
2-Nitroaniline	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.25)	ND(<0.25)	ND(<0.25)
Acenaphthylene	mg/kg	4	2	2	50%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.095	0.077	ND<0.00002)
Dimethylphthalate	mg/kg	4	2	2	50%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.29	0.64	ND(<0.14)
2,6-Dinitrotoluene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.25)	ND(<0.25)	ND(<0.25)
Acenaphthene	mg/kg	4	1	3	25%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.012	ND(<0.00002)	ND<0.00002)
3-Nitroaniline	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.25)	ND(<0.25)	ND(<0.25)
2,4-Dinitrophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.25)	ND(<0.25)	ND(<0.25)
4-Nitrophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.50)	ND(<0.50)	ND(<0.50)
Dibenzofuran	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.14)
2,4-Dinitrotoluene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.25)	ND(<0.25)	ND(<0.25)

Table B. Statistical Summary -Full List VOC and SVOC - Soil Sample Results - Jensen's Shipyard

Sample ID		**# Samples**	**# Detections**	**# Non Dection**	**Detect Frequency**	**Max Value**	**Shop Floor Drain-1**	**Shop Floor Drain-2**	**OPALCO Pad**	**BLWA-1**	**BLWA-2**	**FDA-1**	**FDA-2**	**FDA-3**	**UST-1**	**UST-2**	**SRWA-1**	**SRWA-2**	**SRWA-3**
2,3,4,6-Tetrachlorophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.25)	ND(<0.25)	ND(<0.25)
Diethylphthalate	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.14)
Fluorene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.12)	ND(<0.12)	ND(<0.12)
4-Chlorophenyl-Phenylether	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.13)	ND(<0.13)	ND(<0.17)
4-Nitroaniline	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.25)	ND(<0.25)	ND(<0.32)
4,6-Dinitro-2-Methylphenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.15)	ND(<0.15)	ND(<0.29)
N-Nitrosodiphenylamine	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.11)	ND(<0.11)	ND(<0.15)
Azobenzene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.15)
4-Bromophenyl-Phenylether	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.13)
Hexachlorobenzene	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.50)	ND(<0.50)	ND(<0.10)
Pentachlorophenol	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.10)	ND(<0.10)	ND(<0.10)
Phenanthrene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.25	0.13	0.62
Anthrancene	mg/kg	4	2	2	50%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.11	0.053	ND
Carbazole	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.20)	ND(<0.20)	ND(<0.27)
Di-N-Butylphthalate	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.13)	ND(<0.13)	ND(<0.13)
Fluoranthene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.67	0.21	0.62
Pyrene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.65	0.21	0.57
Butylbenzylphthalate	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.12)	ND(<0.12)	ND(<0.16)
3,3-Dichlorobenzidine	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.51)	ND(<0.51)	ND(<0.68)
Benzo[A]Anthracene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.4	0.11	0.21
Chrysene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.53	0.12	0.34
Bis(2-ethylhexyl)phthalate	mg/kg	4	1	3	25%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.13)	ND(<0.13)	0.21
Di-N-Octylphthalate	mg/kg	4	0	4	0%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND(<0.12)	ND(<0.12)	ND(<0.16)
Benzo[B]Fluoranthene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.81	0.2	0.43
Benzo[K]Fluoranthene	mg/kg	4	1	3	25%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.28	ND(<0.11)	ND(<0.00002)
Benzo[A]Pyrene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**0.52**	**0.14**	**0.22**
Indeno[1,2,3-Cd]Pyrene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.4	0.12	0.15
Dibenz[A,H]Anthracene	mg/kg	4	1	3	25%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.11	ND(<0.10)	ND(<0.00002)
Benzo[G,H,I]perylene	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.57	0.19	0.17
Total cPAH Equivalent (TEq)	mg/kg	4	3	1	75%		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**0.7253**	**0.1862**	**0.3044**

[a] - Cleanup level dependent on BTEX concentrations

[b] - indicates sum of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene

[c] - indicates cleanup level is dependant on Chromium(VI) concentrations.

ND - indicates analyte was not detected at level above reporting limit (shown in parentheses)

NA - indicates sample was not analyzed for the constituent

BOLD - indicates that the concentration in the sample exceeds the MTCA Method A or Method B target cleanup levels

TEq - Toxicity Equivalency to benzo(a)pyrene, calculated by multiplying result by appropriate TEF. For ND values, the TEF was multiplied by one half the reporting limit

TEF - Toxicity Equivalency Factor (WAC 173-340-900 table 708.2)

Table C. Statistical Summary - 2020 Soil Analytical Results
IOSA/Marine Trade Center (MTC) Development Area - Port of Friday Harbor

Sample ID	Sample Depth (feet bgs)	NWTPH-Dx (mg/kg)			Metals (mg/kg)						
		DRO	ORO	Total	Arsenic	Cadmium	Copper	Lead	Mercury	Nickel	Zinc
Test Pit Samples Collected October 19, 2020											
IOSA-TP1-1-1020	1	NA	NA	NA	2.4	<1	**11.1**	**5.01**	<1	**15.4**	**27.5**
IOSA-TP2-1-1020	1	NA	NA	NA	2.51	<1	**9.72**	**5.78**	<1	**7.4**	**16.4**
IOSA-TP3-1-1020	1	NA	NA	NA	2.84 ca	<1	**60.9**	**56.4**	<1	**11.9**	**208**
IOSA-TP3-3-1020	3	NA	NA	NA	1.85	<1	**13.7**	**4.29**	<1	**10.9**	**23**
IOSA-TP4-1-1020	1	NA	NA	NA	2.33	<1	**18.5**	**12.2**	<1	**10.5**	**70.8**
IOSA-TP5-1-1020	1	NA	NA	NA	2.88 ca	<1	**56.9**	**248**	<1	**13.9**	**287**
IOSA-TP5-3-1020	3	NA	NA	NA	2.58 ca	<1	**30.1**	**46.4**	<1	**15.9**	**95.1**
IOSA-TP5-5-1020	5	<50	<250	<250	3.92	<1	**37**	**80.7**	<1	**13.6**	**115**
IOSA-TP6-1-1020	1	NA	NA	NA	2.4	<1	**33.9**	**241**	<1	**9.43**	**182**
IOSA-TP6-3-1020	3	NA	NA	NA	3.67 ca	<1	**15.1 J**	**3.21**	<1	**16.6**	**19.6 J**
IOSA-TP7-1-1020	1	NA	NA	NA	2.03	<1	**19.8**	**20.8**	<1	**9.81**	**34.7**
IOSA-TP8-1-1020	1	NA	NA	NA	2.21	<1	**12.9**	**8.14**	<1	**9.04**	**40.2**
Summary Statistics											
# Samples		1	1	1	12	12	12	12	12	12	12
# Dectections		0	0	0	8	0	11	12	0	12	11
# Non Dections		1	1	1	4	12	1	0	12	0	1
% Dections		0%	0%	0%	67%	0%	92%	100%	0%	100%	92%
Max Dection Value		ND	ND	ND	3.9	ND	61	248	ND	16.6	287

NOTES:

Bold indicates a detected concentration

NA - Not analyzed

ND - Not detected

ca - The calibration results for the analyte were outside of acceptance criteria. The value reported is an estimate

Appendix B

2018 Sediment Data Summary

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Port of Friday Harbor
Jensen's Surface Sediments
Summary: 2018 SMS Exceedances

Sample Location	TOC (%)	Metals (mg/kg dw)	TBT (ug/kg dw)	Organics (ug/kg dw)	Phthalates (ug/kg dw)	Pesticides (DMMP) (ug/kg)	PCBs (mg/kg OC)	PAHs (mg/kg OC)	Dioxins/Furans (ng/kg dw TEQ)	Chlorinated Organics (mg/kg OC)	Work Needed
SED-1	1.37		3.8			Heptachlor (< 4.2 Ui) Chlordane (2.8 J)	1.2	LPAH = 19.6 HPAH = 154	N/A	1,2,4-Trichlorobenzene (< 2.0 U) Hexachlorobenzene (< 2.6 U)	Core: Pest Bound: SED-3, -18, -19, -20
SED-2	0.80		1.3 J				<0.6 U	LPAH = 81.6 HPAH = 115	N/A	1,2,4-Trichlorobenzene (< 3.3 U) 1,2-Dichlorobenzene (< 3.0 U) Hexachlorobenzene (< 4.1 U)	N/A
SED-3	1.88		7.5	Benzyl alcohol (< 58 U)		Heptachlor (< 2.6 Ui) Chlordane (5.3 J)	1.8	LPAH = 9.8 HPAH = 93	N/A	1,2,4-Trichlorobenzene (< 1.6 U) Hexachlorobenzene (< 2.1 U)	Core: SVOCs, Pest Bound: SED-1, -20, -21, -22
SED-4	1.81		3.8				0.4 JP	LPAH = 17.3 HPAH = 75	N/A	1,2,4-Trichlorobenzene (< 1.5 U) Hexachlorobenzene (< 1.9 U)	N/A
SED-5	1.92		25	Benzyl alcohol (< 65 U)		Heptachlor (< 3.1 Ui) Chlordane (4.9 JP)	2.9	LPAH = 4.0 HPAH = 55	N/A	1,2,4-Trichlorobenzene (< 1.8 U) Hexachlorobenzene (< 2.3 U)	Core: Pesticides, SVOCs Bound: SED-21, -22, -23, -24
SED-6	2.21		10	Benzyl alcohol (< 66 U)			1.2	LPAH = 9.4 HPAH = 67	N/A	1,2,4-Trichlorobenzene (< 1.6 U) Hexachlorobenzene (< 2.0 U)	N/A
SED-7	1.41		75				1.6 JP	LPAH = 11.8 HPAH = 111	N/A	1,2,4-Trichlorobenzene (< 0.9 U) Hexachlorobenzene (< 1.2 U)	Core: TBT, SVOCs Bound: SED-8
SED-8	2.54		210			Chlordane (< 4.8 UiJ)	5.8	LPAH = 42.4 HPAH = 533	N/A	1,2,4-Trichlorobenzene (< 1.1 U) Hexachlorobenzene (< 1.3 U)	Core: TBT, SVOCs, Pest, PCBs, Dioxins Bound: SED-7, SED-25, SED-9
SED-9	4.29	Copper (578)	300	Benzyl alcohol (68 J) N-nitrosodiphenylamine (<43 U)	Butylbenzyl (70 J) Dimethyl (190)	Heptachlor (< 2.2 Ui) Dieldrin (5.3) Chlordane (< 5.0 UiJ)	252 ug/kg dw	HPAH (20.6 mg/kg dw) Fluoranthene (5.5 mg/kg dw) Pyrene (3.2 mg/kg dw) Benz(a)anthracene (1.9 mg/kg dw) Chrysene (4.1 mg/kg dw) Benzofluoranthenes (3.4 mg/kg dw)	80.3 J	1,2,4-Trichlorobenzene (< 35 ug/kg dw U) Hexachlorobenzene (< 44 ug/kg dw U) Hexachlorobutadiene (< 40 ug/kg dw U)	Core: Metals, TBT, SVOCs, Pest, PCBs, Dioxins Bound: SED-8, -25, -26, -10
SED-10	1.26	Copper (1370) Mercury (1.45) Zinc (589)	4000			Dieldrin (< 4.8 Ui) 4,4'-DDD (19) Chlordane (< 7.5 JP)	51.6 P	Acenaphthene (17.5) Phenanthrene (182.5) HPAH (1678) Fluoranthene (436.5) Benz(a)anthracene (134.9) Chrysene (182.5) Benzofluoranthenes (282.5) Benzo(a)pyrene (134.9) Indeno(1,2,3-c,d)pyrene (95.2) Dibenzo(a,h)anthracene (22.2) Benzo(g,h,i)perylene (111.1)	92.8 J	1,2,4-Trichlorobenzene (< 2.1 U) Hexachlorobenzene (< 2.6 U)	Core: Metals, TBT, SVOCs, Pest, PCBs, Dioxins Bound: SED-9, -25, -26, -11
SED-11	2.69	Mercury (.44)	53			Chlordane (< 4.6 UiJ)	8.7 P	LPAH = 12.0 HPAH = 123	N/A	1,2,4-Trichlorobenzene (< 1.0 U) Hexachlorobenzene (< 1.2 U)	Core: Metals, SVOCs, Pest, PCBs, Dioxins Bound: SED-10, -26, -12
SED-12	1.03		9.3				3.4 J	LPAH = 11.7 HPAH = 119	N/A	1,2,4-Trichlorobenzene (< 2.5 U) 1,2-Dichlorobenzene (< 2.3 U) Hexachlorobenzene (< 3.2 U)	Grab: Dioxins Bound: SED-11
SED-13	1.98	Copper (1380) Mercury (.85) Zinc (928)	4000			Dieldrin (< 4.7 Ui) 4,4'-DDD (36) Chlordane (12 J)	59.6 P	Fluoranthene (171.7) Indeno(1,2,3-c,d)pyrene (48.0) Benzo(g,h,i)perylene (55.6)	72.3 J	1,2,4-Trichlorobenzene (< 1.3 U) Hexachlorobenzene (< 1.7 U)	Bound: SED-10, -11
SED-14	1.87 J		91			N/A	24.8 J	LPAH = 22.0 J HPAH = 140 J	N/A		Core: TBT, SVOCs, Pest, PCBs Bound: SED-23, -24, -25, -26
SED-15	2.08 J		48.8			N/A	1.8 J	LPAH = 12.2 J HPAH = 95 J	N/A		N/A
SED-16	3.30 J		36.9			N/A	1.5 J	LPAH = 32.5 J HPAH = 302 J	N/A		N/A
SED-17	0.49 J		4.31			N/A	7 ug/kg dw	LPAH = 0.1 mg/kg dw HPAH = 0.4 mg/kg dw	N/A		N/A

Appendix C

Upland Sampling and Analysis Plan
Upland Quality Assurance Project Plan
Upland Health and Safety Plan

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Upland Area
Sampling and Analysis Plan

Port of Friday Harbor
Jensen's Marina

Project Number: 040-001

Prepared for:
The Port of Friday Harbor

June 2022

Prepared by:

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Upland Area
Sampling and Analysis Plan

Port of Friday Harbor
Jensen’s Marina

Project Number: 040-001

Prepared for:
The Port of Friday Harbor

Prepared by:

Rusty Jones

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Reviewed by:

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Grant Hainsworth, P.E.

June 2022

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1 Introduction

This document presents the Sampling and Analysis Plan (SAP) for completing the remedial investigation across the uplands portions at the Port of Friday Harbor's (Port) Albert Jensen and Sons, Inc. Boatyard and Marina (Site), shown on Figure 1. This field work is being performed between the State of Washington, Department of Ecology (Ecology) and the Port of Friday Harbor (Port) under Agreed Order No. DE 18071. Soil and groundwater data will be collected from uplands areas to inform identified data gaps and refine the nature and extent of contamination exceeding preliminary Model Toxics Control Act (MTCA) cleanup levels, preliminary Sediment Management Standards (SMS) cleanup standards, and other regulatory requirements. This SAP was developed to provide details for additional soil and groundwater data collection details and procedures needed to fill data gaps outlined in the Remedial Investigation Work Plan (RIWP).

1.1 Site Conditions

The site is located on the southern shore of Shipyard Cove of the Salish Sea, on San Juan Island, San Juan County. The site is located entirely within Shipyard Cove, a relatively shallow embayment that faces northward on the eastern side of San Juan Island. Turn Point Road directly connects the site to the City of Friday Harbor, approximately 1.5 miles to the northwest.

Structures on the site include a storage building, machine shop, office/retail building, derelict boat building structure, and an oil storage building/shed. Surfaces of the site are largely unpaved, with gravel as the primary ground surface in the boat work areas, and grass, shrubs, and trees covering the undeveloped land portions along much of Turn Point Road and the eastern third of the site. Marina features on the site include a pier, bulkhead, boat lift, and marine railway into the water. Other features include a lined stormwater detention pond, paved laydown area, and parking. Site layout and features are presented in Figure 1.

The site elevation ranges from sea level along the northern shoreline to approximately 55 to 60 feet above sea level near Turn Point Road to the south. This topography generally slopes north towards Friday Harbor, as indicated by the United States Geological Survey 7.5' topographic quadrangle maps dated 2020. The median elevation of the site is approximately 16 feet above mean sea level. The sloped shoreline and the surrounding upland ground surface consisting of unpaved soils with limited precipitation infiltration and surface runoff down towards the shoreline.

1.2 Upland Areas

The site has been divided into key subareas. This section provides an overview of the subareas which are identified on Figure 1. Detailed information regarding each subarea and summary of existing data is found in the RIWP.

- **Ship Rail Work Area:** The ship rail work area (SRWA) includes rail lines east of the pier and the old boat building structure. The SRWA has a lower elevation than the surrounding uplands, including high intertidal elevations with abundant pickleweed.
- **Boat Lift Work Area:** The boat lift work area (BLWA) is an approximately 100-foot wide area along the shoreline, immediately west of the SRWA and extending west to the western property line. The adjacent shoreline, from west to east, includes the small fill area that projects into the water, the berm area with an outfall, the boat pullout, the old overwater deck, and the marina pier.
- **Former Dumping Area:** The former dumping area (FDA) is located to the east of the SRWA along the shoreline.
- **Former Above Ground Storage Tank:** It is suspected that an Above Ground Storage Tank (AST) was formerly located south of the central former shop building. There is no documentation regarding the size or contents of the former AST.
- **Shop Floor Drain and Outfall:** The shop building includes a 3-inch diameter floor drain near the northwest corner of the building. The drain was used to dispose of liquids from the machine shop.
- **Stormwater Pond:** The stormwater detention pond is located in the southwest portion of the property, west of the shop building.
- **Former Orcas Power and Light Company Pad:** A former Orcas Power and Light Company (OPALCO) storage area is located in the western portion of the site. The pad is the building foundation of an OPALCO building that burnt down.
- **Wooded Hillside Area Along Turn Point Road:** The wooded hillside area is south of the OPALCO pad area, the stormwater pond, and the shop building.

2 Upland Subareas and Sampling Program

Soil samples are proposed to assess the data gaps and more fully delineate contaminated soils across the uplands areas of the property. Additional groundwater data will be collected to refine the understanding of site conditions. The Quality Assurance Project Plan (QAPP) is included in Attachment A. Proposed sample locations are shown on Figure 1 and sample methods are detailed Section 3 and Section 4. The Standard Operating Procedures (SOPs) included in Attachment B. A site-specific Health and Safety Plan (HASP) is included in Attachment C.

2.1 Boat Lift Work Area

Six (6) soil borings will better characterize the presumed fill and contamination in the BLWA. Multiple soil samples at each boring location, and subsequently well location, will be used to characterize the fill across this area. One additional direct push technology (DPT) soil boring with multiple subsurface soil samples will be collected on the raised platform north/northeast of previous boring location BLWA-3. If soil screening with a photoionization detector (PID) indicates potential gross contamination, then a grab groundwater sample will be collected from the DPT tooling. All borehole locations will have at least one soil sample analyzed for metals, diesel range total petroleum range hydrocarbons (TPH-Dx), carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and polychlorinated biphenyls (PCBs). The three shoreline boring locations will be used as monitoring well locations to evaluate the extent of copper and lead impacts to groundwater and impacts to surface water.

Surface soil metals impacts from the BLWA may have been transported beyond the property boundary to Shipyard Cove Marina. Three (3) hand auger locations are proposed to better delineate the extent of surface soil metals impacts on this adjacent property.

The sampling analysis program is shown on Table 1 and sample locations are shown on Figure 1.

2.2 Surface Railway Work Area

Metals and TPH impacts in the FDA are present to the east. The area between the SRWA and FDA remains a data gap to further delineating the metals, TPH, and PAH soil impacts along the eastern and southeastern portions of the SRWA. Approximate five (5) DPT borings (SRWA-8 through SRWA-12) in a stepped layout (Figure 1) will provide data needed to better define this area of contamination. The sampling analysis program is shown on Table 1. One row of DPT borings along the lower foot of the hillside and one row of DPT borings midway up the hillside should provide adequate distribution of data to better define contamination in SRWA. If soil screening with PID indicates potential gross contamination at any DPT boring, then grab groundwater samples will be collected from the DPT tooling at the corresponding location.

Figure 1 shows the soil sampling locations for the SRWA needed to vertical characterize the SWRA. Approximately 3 DPT borings (SRWA-13 to SRWA-15) will be used to confirm and vertically and horizontally delineate cPAHs, TPH, and metal concentrations and to provide PCB data. Surface soil samples will also be collected from these locations and will be selectively analyzed for PCBs, cPAHs, tributyltin (TBT), pesticides, and dioxins and furans as indicated on Table 1.

2.3 Former AST Area

Three DPT borings (Figure 1) will provide data needed to better define this area of contamination. The borings will form triangle around former AST-1 boring location. Soil samples will be collected based on PID and olfactory observations to define the extent of TPH impacts. Grab groundwater samples will be collected from the DPT tooling at each DPT location to provide data to better assess potential petroleum impacts to groundwater. The sampling analysis program is shown on Table 1.

2.4 Shop Floor Drain

One DPT boring will be advanced immediately downgradient (Figure 1) of the floor drain and MW-1 to provide data to more fully characterize the petroleum and metals impacts in this immediate area. Soil samples will be collected every 2-ft to water depth (approximately 7 to 8 feet bgs). A grab groundwater sample will be collected from the DPT tooling. The sampling analysis program is shown on Table 1.

2.5 Stormwater Pond

One DPT boring will be advanced immediately downgradient (Figure 1) of the stormwater pond to assess whether the stormwater pond has impacted soil or groundwater in this immediate area with metals present in the pond sediment and water. Soil samples will be collected every 2-ft to water depth. A grab groundwater sample will be collected from the DPT tooling. The sampling analysis program is shown on Table 1.

2.6 Wooded Hillside Area Along Turn Point Road

The wooded hillside area south of the OPALCO building pad area (shown on Figure 1), will be visually inspected for potential dumping and sources of soil and groundwater contamination. Any observations from the inspection that require follow-up investigation or sampling will be assessed at that time.

3 Monitoring Well Installation

Three new groundwater monitoring wells (MW-7, MW-8, and MW-9), shown on Figure 1, will be installed at the site. Each well location boring will be continuously logged to record lithology and determine appropriate screen depth. Wells will be screened with a 10 foot screen, and screened depth will be based on field determination of water table elevation at each monitoring well location and proximity to the shoreline. Wells will likely be screened from 3 to 13 feet bgs to 5 to 15 ft bgs. The new monitoring wells will be identified at MW-7, MW-8, and MW-9, corresponding to the nomenclature of the existing six monitoring wells at the site. Figure 1 shows the planned locations. Soil samples will be collected at monitoring well boring location following the soil sampling procedures outlined in Section 2.1.

Monitoring wells will be constructed by a licensed drilling contractor in the state of Washington, in accordance with the Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC). Oversight of drilling and well installation activities will be conducted by an environmental professional familiar with environmental sampling and construction of resource protection wells. Monitoring well installation will be completed per SOP-7220 (Attachment B). The monitoring wells will be constructed with 2-inch-diameter, flush-threaded, Schedule 40 PVC pipe. The shallow wells will be constructed with 10-foot screens set at a depth to intersect the groundwater table. Based on existing site borings, it is expected that wells will be screened in a gravelly sand and screens will be constructed of a 0.010-inch machine-slotted casing. A filter pack material consisting of pre-washed, pre-sized number 2/12 or 10/20 silica sand will be placed from the bottom of the well to approximately one to two feet above the top of the screen. If geology indicates that the formation is significantly silty, the filter pack material will be adjusted to 20/40 silica sand. Filter pack material will be placed slowly and carefully to avoid bridging of material. A bentonite seal will be placed above the filter sand pack material to within about 1.5 feet of ground surface. Bentonite-cement will be used to backfill the boring to grade for placement of the protective cover. The well names and the identification numbers assigned by Ecology will be marked on the well identification tags supplied by Ecology and will be attached to each well casing following well installation. The monitoring wells will be developed after construction to remove formation material from the well borehole and the filter pack prior to groundwater level measurement and sampling. Well development will be completed per SOP-502 (Attachment B). All new monitoring wells will be surveyed as detailed in Section 5.5.

4 Tidal Study

Following installation of the three new monitoring wells, a 72-hour tidal study will be completed using 3 existing site wells and the 3 new wells, for a total of 6 wells. These wells were selected since they are within 100 feet of surface water and are the only wells likely to have tidal influence. The tidal study will be performed during a period when the lower low tides are negative. The pressure transducers and data loggers (Rugged TROLL 100 Data Logger or similar) will be placed in the assigned wells (MW-2, MW-3, MW-5, MW-7, MW-8, MW-9) shown on Figure 1). The transducers will be installed near the bottom of the screened interval in the well and secured to the top of the well to ensure no movement during the tidal study. Prior to deployment, each transducer data logger will be calibrated and programmed to collect and record pressure measurements every 3 to 5 minutes for at least 72 hours. Water level measurements will also be collected using an electronic water level meter at the initiation of and immediately after the completion of the tidal study to confirm the transducer measurements. The results of the tidal study will indicate if wells are responding to tidal fluctuations. Groundwater does not respond instantaneously to tidal fluctuation, but rises and falls at a consistent amount of time after the rise and fall of the tides. This is known as the lag time – the time difference between a tidal fluctuation in the waterway and the tidal fluctuation in the groundwater. Tidal efficiency is a common way to represent the influence of the tides on a groundwater well; it is the fluctuation of a well as a percentage of the waterway water level fluctuation.

If wells are found to be tidally influenced, tidal efficiencies will be calculated for existing wells and may be extrapolated for future wells. This information will be used to determine the optimal time to collect groundwater samples so that groundwater sampling is timed with groundwater outflow and ensures your sample is more representative of groundwater and not seawater. This information will also be used to refine the groundwater flow direction at the site.

5 Sampling Procedures

5.1 Soil Sampling Procedures

Figure 1 provides a layout of soil boring locations and monitor well installation locations for data collection as detailed in the RIWP. Locations may be adjusted in the field due to potential utility conflicts, driller concerns, or access issues. If locations are to be moved more than 20 feet from the locations shown in the RIWP, the Field Manager will confer with the Project Manager regarding the change in location. Soil samples will be collected following the procedures outlined in SOP-400, presented in Attachment B.

Soil will be field screened (with a PID and visual and olfactory observations) and if field screening indicates potential soil contamination, then samples will be collected at depths where screening indicates hydrocarbon, solvent, or other potential contamination. Samples will be collected based on the sampling program presented on Table 1. Depths of each sample will be noted on the soil boring log. Soil samples will be collected using gloved hands and laboratory-supplied, laboratory grade sample containers.

Prior to any soil boring or ground disturbance activities conducted at the site, a formal underground public utility locate request will be submitted through the Washington 811 utility locate request service and a private utility locating service will used to identify any private utilities in the proposed soil boring and monitoring well installation locations.

Samples will be submitted to the laboratory on standard turn around. Select samples may be submitted to the lab and analysis placed on hold pending the results of other samples. Analyses will be completed by the methods in Quality Assurance Project Plan (QAPP) Tables 2 and 3, included as Attachment A.

5.2 Groundwater Sampling Procedures

After wells are installed (discussed in Section 3), developed, surveyed and the results of the tidal study have been evaluated, a site wide groundwater sampling event will be completed. Prior to sampling, water level measurements will be collected from each well. Groundwater samples will be collected following the procedures outlined in SOP-2502, presented in Attachment B. Quarterly groundwater sampling will be performed for four consecutive quarters.

All groundwater samples will be collected using low-flow groundwater sampling methodology based on groundwater sampling guidance and comments from Ecology and the U.S. Environmental Protection Agency under RCRA. The groundwater sampling procedure involves purging groundwater from the monitoring well prior to sampling at a flow rate less than 250 milliliters per minute (mL/min.). During the purging, groundwater quality parameters, including temperature, pH, turbidity, dissolved oxygen, oxidation/reduction potential (ORP), and specific conductivity, will be monitored approximately every 3 minutes, and purging will be conducted until these parameters stabilize within criteria outlined in SOP-2502. Once the water quality parameters have stabilized, groundwater samples will be collected using a flow rate of less than 250 mL/min. Groundwater samples will be collected from the 6 existing wells (MW-1, MW-2, MW-3, MW-4, MW-5, MW-6) and the newly installed wells (MW-7, MW-8, and MW-9).

Groundwater samples will be analyzed for dissolved and total metals (As, Cd, Cr, Cu, Pb, Hg, Zn). Five monitoring wells (MW-1, MW-2, MW-7, MW-8, MW-6) will be analyzed for NWTPH-Gx and NWTPH-Dx, with and without silica gel cleanup; sulfuric acid cleanup will not be used. Samples will be submitted to the laboratory on standard turn around. One duplicate sample will be collected from one of the randomly selected new shoreline monitoring wells (MW-7, MW-8, or MW-9). Groundwater samples will be analyzed on standard turnaround time. Analyses will be completed by the methods in QAPP Tables 2 and 3, included in Attachment A.

For monitoring wells with field measured low-flow stabilized specific conductivity values greater that 2,000 microSiemens per centimeter, salt water influence is likely. For these monitoring wells, split groundwater samples will be submitted to Friedman and Bruya (F&B) and Brooks Applied Labs (BAL) for chemical analysis under chain of custody. Groundwater samples submitted to BAL will be analyzed for dissolved metals (arsenic, cadmium, chromium, copper, lead, and zinc) following EPA Method 1638. EPA Method 1638 uses inductively coupled plasma dynamic reaction cell mass spectrometry (ICP-DRC-MS) and is modified with Closed-Vessel Hotblock Digestion. This method allows for low detection limits even with dilution. The split samples submitted to F&B will be analyzed for total and dissolved metals (arsenic, cadmium, chromium, copper, lead, and zinc) by EPA Method 6020B with triple quadrupole (QQQ) mass spectrometry. The purpose of this split sample methodology is to evaluate if representative future metals results can be obtained by the more common and cost-effective QQQ method. Split groundwater samples will only be collected for the first quarter groundwater sampling event.

Grab groundwater samples will also be collected from direct push investigation locations to assess groundwater quality along the shoreline in the SWRA, at the AST, shop floor drain, stormwater pond, and possibly the BLWA. These sample locations and analysis program are summarized on Table 1 and locations are shown on Figure 1. These samples will be collected as grab samples from temporary wells installed during drilling. After groundwater samples are collected the temporary wells will be removed and the location abandoned by the driller. Split groundwater samples will not be collected from temporary wells.

5.3 Equipment Decontamination

Field equipment and supplies include sampling equipment (gloves, tubing, etc.) and utensils (e.g., bowls, spoons, etc.), decontamination supplies, sample containers, coolers, log books and field forms, personal protection equipment (PPE), and personal gear. Protective wear (e.g., hard hats, gloves) are described in the HASP (Attachment C). Sample containers, coolers, and packaging material will be supplied by the analytical laboratory.

All non-dedicated sampling equipment, such as stainless-steel sampling equipment, will be washed with Alconox/Liquinox detergent and rinsed with distilled water prior to use and between sampling stations. The following decontamination steps will be performed on stainless-steel bowls and spoons used for homogenizing prior to use at each station:

- Wash with Alconox/Liquinox
- Double rinse with distilled/deionized water
- Final rinse with distilled/deionized water.

Soil samples will be collected using gloved hands and disposable soil plunging devices provided by the laboratory (Method 5035). Gloves will be changed between each sample. Reusable sampling equipment, if used, such as stainless steel spoons and bowls shall be decontaminated between sample locations.

All drilling equipment will be decontaminated between each location. New temporary wells will be used at each DPT groundwater location, or the Geoprobe© groundwater sampling tools will be decontaminated between each location.

5.4 Field Logs

All field activities and observations will be noted in a field log book or corresponding field form at the time they occur. The field log book will be a bound document, and separate individual field and sample log forms will be compiled with the field log book. Information will include personnel, date, time, sample location, sampler, sampling equipment, types and number of samples collected, weather conditions, concurrent Project activities, health and safety meetings conducted (tailgate meeting), and general observations. Any changes that occur at the Project (e.g., personnel, responsibilities, deviations from this plan) and the reasons for these changes will be documented in the field log book. The Field Manager is responsible for ensuring that the field log book and all field data forms are correct. Log books will remain intact with unremoved pages, written legibly and used objective, accurate language. Log book corrections will be made by drawing a single line through the original entry allowing the original entry to be read. The corrected entry will be written alongside the original and corrections will be initialed and dated.

5.5 Sample Location Surveying

Geoprobe locations will be recorded with a handheld global positioning system (GPS) device and monitoring well locations will be surveyed in the field. The ground surface elevation of each sample location will be recorded by the GPS device. For each new monitoring wells, a licensed Washington state surveyor will record the horizontal and vertical datums in Washington State Plane North (North American Datum of 1983 [NAD 83]) and foot mean lower low water (MLLW), respectively, for the top of well casing and the immediately adjacent ground surface. The elevation of the top of casing on the northern side of the casing will be surveyed and a mark will be placed on the casing where the elevation was recorded so that depth-to-water-table measurements are recorded relative to this point with a known elevation.

5.6 Waste Management

Any investigation-derived waste (IDW), including waste/wastewater generated during decontamination of equipment, will be collected and managed in appropriate waste containers such as 55-gallon steel drums. Soil waste is expected to be generated, as not all soil removed from each soil boring will be containerized as sample media. Monitoring well installation will generate soil cuttings that will be captured and transferred to drums during the drilling and monitoring well installation process. Well development and well sampling activities will generate well purge water will be containerized in drums. All waste will be appropriately characterized in accordance with applicable regulations based on the laboratory analytical results and historical knowledge. IDW stored in drums will remain at the site until the completion of the investigation, where any and all IDW will be disposed of at facilities approved by the Port and in accordance with applicable regulations.

6 Schedule and Reporting

Field activities are planned to be completed in the summer and fall of 2022. After completion of all tasks, data review and validation, results will be included in the Remedial Investigation (RI) and Feasibility Study (FS) which will be submitted to Washington Department of Ecology and new soil and groundwater data collected will be submitted to Ecology's Environmental Information Management System (EIM) database.

Tables

Table 1
Soil Boring Target Sample Depths and Analyses
Jensen's Shipyard and Marina
Port of Friday Harbor

Sample Location [1]	Target Sample Depth(s) feet bgs [2]	Rationale	Installation Methods	Analysis	Media
SWP-1	2 to 3, 5 to 6, Groundwater	Downgradient delineation of stormwater pond sediment impacts. Sediment impacts to groundwater.	DPT	Metals[3]	Soil and Groundwater
SRWA-8	0 to 1, 2 to 3, 4 to 5	Horizontal and vertical delineation of metals, cPAH, and TPH impacts. TBT, D/F, and pesticides in surface soil sample only.	DPT	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil
SRWA-9	0 to 1, 2 to 3, 4 to 5	Horizontal and vertical delineation of metals, cPAH, and TPH impacts. TBT, D/F, and pesticides in surface soil sample only.	DPT	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil and Possible Groundwater[4]
SRWA-10	0 to 1, 2 to 3, 4 to 5	Horizontal and vertical delineation of metals, cPAH, and TPH impacts. TBT, D/F, and pesticides in surface soil sample only.	DPT	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil and Possible Groundwater[4]
SRWA-11	0 to 1, 2 to 3, 4 to 5	Horizontal step-out location for delineation. Samples assignment pending analysis of SWRA-8, -9, -10.	DPT	Metals, PCBs	Soil and Possible Groundwater[4]
SRWA-12	0 to 1, 2 to 3, 4 to 5	Horizontal step-out location for delineation. Samples assignment pending analysis of SWRA-8, -9, -10.	DPT	Metals, PCBs	Soil and Possible Groundwater[4]
SRWA-13	0 to 0.5, 0.5 to 1, 2 to 3	Delineate intertidal impacts to in-water sediments. TBT, D/F, and pesticides in surface soil samples only.	DPT or Split-Spoon/HSA	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil
SRWA-14	0 to 0.5, 0.5 to 1, 2 to 3		DPT or Split-Spoon/HSA	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil
SRWA-15	0 to 0.5, 0.5 to 1, 2 to 3		DPT or Split-Spoon/HSA	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil
AST-2	0 to 1, 2 to 3, 4 to 5; Per observations during installation	Horizontal and vertical delineation of TPH soil concentrations in former AST area. AST-1 sample area. Groundwater samples may be collected based on soil screening.	DPT	TPH-Dx, TPH-Gx, Metals	Soil and Possible Groundwater[4]
AST-3	0 to 1, 2 to 3, 4 to 5; Per observations during installation		DPT	TPH-Dx, TPH-Gx, Metals	Soil and Possible Groundwater[4]
AST-4	0 to 1, 2 to 3, 4 to 5; Per observations during installation		DPT	TPH-Dx, TPH-Gx, Metals	Soil and Possible Groundwater[4]
BLWA-10	0 to 1, 2 to 3, 4 to 5; Per observations during installation	Horizontal and vertical delineation of metals, cPAH, and TPH impacts in fill soils. TBT, D/F, and pesticides in surface soil sample only.	DPT	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil
BLWA-11	0 to 1, 2 to 3, 4 to 5; Per observations during installation	Horizontal and vertical delineation of metals, cPAH, and TPH impacts in soils/fill materials.	DPT	Metals, TPH-Dx, TPH-Gx, PCBs, cPAHs	Soil and Possible Groundwater[4]
BLWA-12	0 to 1, 2 to 3, 4 to 5; Per observations during installation	Horizontal and vertical delineation of metals, cPAH, and TPH impacts in soils/fill materials.	DPT	Metals, TPH-Dx, TPH-Gx, PCBs, cPAHs	Soil and Possible Groundwater[4]
BLWA-13	0 to 1, 2 to 3, 4 to 5; Per observations during installation	Horizontal and vertical delineation of metals, cPAH, and TPH impacts in soils/fill materials.	DPT	Metals, TPH-Dx, TPH-Gx, PCBs, cPAHs	Soil and Possible Groundwater[4]
SFD-4	0 to 1, 2 to 3, 4 to 5, 6 to 7	Downgradient of shop floor drains and AST. Step out location	DPT	TPH-Dx, TPH-Gx, Metals	Soil and Groundwater
SYC-5	0 to 1	Delineation of metal concentrations in soils. Wooded hillside along southern property boundary.	Hand Auger	Metals	Soil
SYC-6	0 to 1	Delineation of metal concentrations in soils. Wooded hillside along southern property boundary.	Hand Auger	Metals	Soil
SYC-7	0 to 1	Delineation of metal concentrations in soils. Wooded hillside along southern property boundary.	Hand Auger	Metals	Soil
MW-7	2 to 3, 4 to 5, Groundwater	Vertical delineation of metals in soils/fill materials. Vadose zone assessment. BLWA-4 sample area. TBT, D/F, and pesticides in groundwater sample only.	DPT or Split-Spoon/HSA	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil and Groundwater
MW-8	2 to 3, 4 to 5, Groundwater	Vertical delineation of metals in soils/fill materials. Confirm BLWA-6 historical results. TBT, D/F, and pesticides in groundwater sample only.	DPT or Split-Spoon/HSA	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil and Groundwater
MW-9	0 to 1, 2 to 3, 4 to 5; Per observations during installation.	Vertical delineation of metals in soils/fill materials. BLWA-8 sample area. Evaluate fill and TPH impacts to sediments. TBT, D/F, and pesticides in surface soil and groundwater samples only.	DPT or Split-Spoon/HSA	Metals, TPH-Dx, TPH-Gx, TBT, PCBs, D/F, Pesticides, cPAHs	Soil and Groundwater

Notes:

[1] Sample ID nomenclature outlined in QAPP.

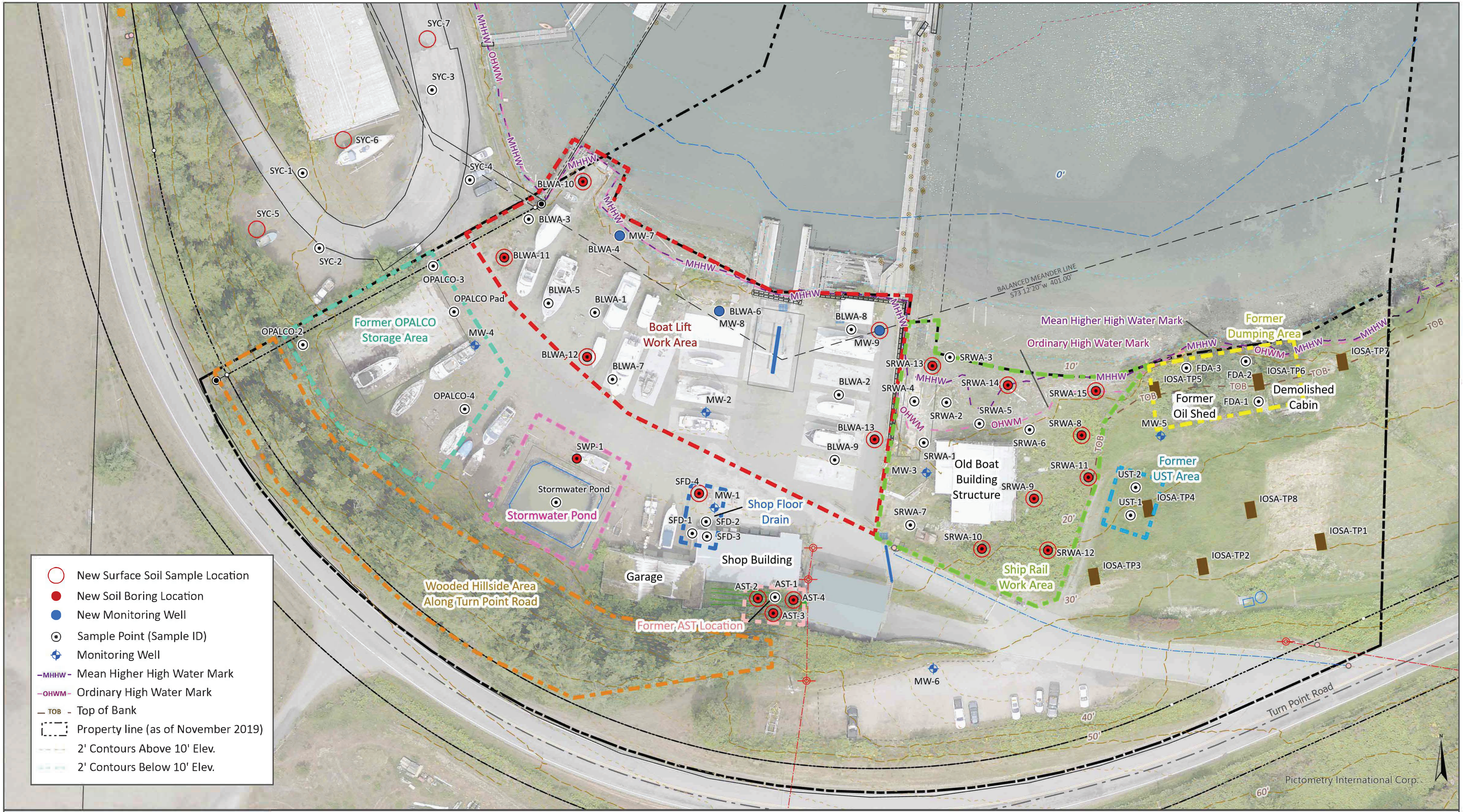
[2] Physical sample locations will depend on the soil profile and core recovery. Some target sample depth intervals may be archived pending initial results of other sample intervals. Additional/alternate sample intervals may be collected based on core observations during soil boring installation.

[3] The metals list includes arsenic, cadmium, chromium, copper, lead, mercury, and zinc.

[4] Grab groundwater sample dependent on soil core observations. At least one groundwater sample from each site investigation area is expected.

Ft bgs – feet below sediment/ground surface
DPT - direct push technology (Geoprobe or similar)
HSA - hollow stem auger
cPAHs - carcinogenic polycyclic aromatic hydrocarbons
TPH - total petroleum hydrocarbons
TBT - tributyltin
PCBs - polychlorinated biphenyl Aroclors™
D/F - dioxin and furan congeners per WAC 173-340-900 Table 708-1
pesticides - organochloride pesticides by EPA Method 8081

Figures



Filename: /Friday Harbor/GIS/UplandGIS/RIWP_Proposed_Locations202201 User: Springborn Version date: 2/6/2022

Port of Friday Harbor
Jensen and Sons Boatyard and Marina

Data Sources:
Crete Consulting, Inc. (2021), San Juan Surveying (2019), San Juan County (2019),
Shannon and Wilson, Inc. (2019), Whatcom Environmental (2018)

0 30 60 120
Feet

Remedial Investigation Work Plan
Figure 1 . Remedial Investigation Sample Locations

LEON Environmental, LLC
CRETE CONSULTING, INC.

Attachment 1

Quality Assurance Project Plan

Upland Area
Sampling and Analysis Plan

Attachment A
Quality Assurance Project Plan

Port of Friday Harbor
Jensen's Marina

Project Number: 040-001

Prepared for:
The Port of Friday Harbor

June 2022

Prepared by:

CRETE
CONSULTING, INC.

Table of Contents

List of Tables

1 Introduction

This Quality Assurance Project Plan (QAPP) presents the project organization, objectives, activities, and quality assurance (QA) procedures to be implemented during data collection activities to support the uplands area investigation at the Port of Friday Harbor (Port) Jensen's Marina (site), shown on Figure 1 of the Uplands Sampling and Analysis Plan (SAP).

The field work will provide additional data to further define the potential soil contamination at the site. Work will focus on the areas of potential contamination in the immediate vicinity, future developments at the site, namely the proposed IOSA facility along the eastern end of the site and the proposed work bay on the western end of the site.

The QAPP was prepared following Ecology Guidance for Quality Assurance Project Plans (Lombard and Kirchmer 2004).

The remainder of this QAPP is organized into the following sections:

- Section 2 – Project Management
- Section 3 – Data Generation and Acquisition
- Section 4 – Assessments and Oversite
- Section 5 – Data Validation and Usability
- Section 6 – References

This QAPP is serves as an Attachment to the Uplands Sampling Analysis Plan, which details the soil and groundwater sample collection procedures.

2 Project Management

This section identifies key project personnel, describes the rationale for conducting the monitoring studies, identifies the studies to be performed and their respective schedules, outlines project data quality objectives and criteria, lists training and certification requirements for sampling personnel, and describes documentation and record-keeping procedures.

2.1 Project Description

This QAPP and SAP pertain to the following tasks that are part of the larger remedial investigation to be conducted, as described in the Remedial Investigation Work Plan (RIWP), The SAP details the fieldwork and the QAPP describes the goals and objectives of this work are defined:

- Laboratory analyses
- Data validation and management
- Data analysis and report preparation

Laboratory Analyses
Analyses will be completed using methods listed in Table 1. Unique analytical procedures are described in Section 5. Laboratory data reports will be provided in portable document format (PDF), and electronic data deliverables (EDDs) will be provided in a text or Excel file format suitable for import into the Ecology EIM database.

Data Validation and Management
Data verification will be completed by the Quality Assurance Officer for data generated in the field and laboratory. The accuracy and completeness of the final data will be verified by the Quality Assurance Officer. Following verification, data collected during the RI will be uploaded to Ecology's EIM system.

Data Analysis and Report Preparation
The data collected under the RIWP will provide the information needed to complete the RI/FS. The results of those efforts will be documented in the RI/FS Report.

2.2 Project Organization

This project is being led by Leon Environmental and the Port. The Project Manager for Leon Environmental is Peter Leon. The Port Project Manager is Todd Nicholson. The CRETE Consulting (CRETE) Project Manager is Grant Hainsworth who is the direct line of communication between CRETE, Leon Environmental, and the Port, and is responsible for implementing activities described in this QAPP. Grant will also be responsible for producing all project deliverables on behalf of CRETE, and performing the administrative tasks needed to ensure timely and successful completion of these studies.

The organizational structure for the additional data collection activities will consist of the following key members: Field Manager (CRETE), Site Safety Officer (CRETE), Quality Assurance Officer (CRETE), and Data Validator (CRETE). Additional members of the project team include, but are not limited to the laboratories, design team sub-consultants, and subcontractors.

Friedman & Bruya will perform most of the chemical analyses of the soil and groundwater samples collected by CRETE Consulting, Inc. Tributyltin analyses will be performed by Eurofins, dioxin and furan analyses will be performed by Frontier Analytical, and analyses of high salinity groundwater will be performed by Brooks Applied Labs (BAL).

2.3 Project Definition and Background

The Draft Conceptual Site Model and Data Gaps Report (Shannon and Wilson, 2019), Remedial Investigation Work Plan (RIWP), and Uplands SAP identified several data gaps such as additional soil data and known extent of buried debris or dump materials. The objectives and background information to address these needs are provided in the SAP.

2.4 Data Quality Objectives and Criteria

The overall data quality objective (DQO) for this project is to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality. Data quality assurance criteria are summarized in Table 2.

2.4.1 Precision

Field precision is estimated by collecting field duplicate samples at a frequency specified in this QAPP for each matrix collected and measured. Laboratory precision and accuracy can be measured through the analysis of matrix spike/matrix spike duplicate (MS/MSD) samples, laboratory duplicate samples and/or laboratory control samples/duplicates (LCS/ LCSD). The laboratory will perform the analysis of one set of MS/MSD, LCS/LCSD and/or duplicate field samples per matrix measured at a frequency of one sample per 20 samples. Field and analytical precision will be evaluated by the relative percent difference (RPD) between field duplicate samples, laboratory duplicate samples; laboratory accuracy and precision will be determined by the spike recoveries and the RPDs of the MS/MSD and LCS/LCSD samples, respectively.

$$\mathrm{RPD} = \frac{\mathrm{ABS}(R1-R2)}{(R1+R2)/2} \times 100$$

Where:
R1 = Sample result or recovery for spiked compound
R2 = Duplicate sample result or recovery for spiked compound duplicate

Field chemistry duplicate precision will be screened against an RPD of 50 percent for soil samples. However, no data will be qualified based solely on field homogenization duplicate precision. If the RPD exceeds 50 percent, the higher concentration between the parent and duplicate sample will be used.

2.4.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Accuracy may be expressed as a percentage of the true or reference value for reference material, or as a percent recovery in those analyses where reference materials are not available and spiked samples are analyzed. The equations used to express accuracy are as follows.

1. For reference materials:

   Percent of true value = (measured value/true value) x 100

2. For spiked samples:

   Percent recovery = (SQ - NQ)/(S) x 100

   SQ = quantity of spike or surrogate found in sample
   NQ = quantity found in native (unspiked) sample
   S = quantity of spike or surrogate added to native sample

2.4.3 Representativeness

Representativeness is the degree to which data from the project accurately represent a particular characteristic of the environmental matrix which is being tested. Representativeness of samples is ensured by adherence to standard field sampling protocols and standard laboratory protocols. The design of the sampling scheme and number of samples should provide a representativeness of each matrix or product of the chemical processes being sampled.

2.4.4 Comparability

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. For this investigation, comparability of data will be established through the use of program-defined general methods and reporting formats and the use of common, traceable calibration and reference materials from the National Institute of Standards and Technology or other established sources.

2.4.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

Completeness =
(number of valid measurements/ total number of data points planned) x 100

Completeness will be calculated per matrix. The DQO for completeness for all components of this project is 90%. Data that have been qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

2.5 Special Training/Certifications

Specific training requirements for performing fieldwork, which may bring employees in contact with hazardous materials, are as follows:

- All 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 managing or supervising work on site will also have successfully completed 8-hours of manager/supervisor training meeting the requirements of OSHA 29 CFR1910.120(e)(4).
- 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 may be required.
- Personnel performing the sampling work must have extensive knowledge, skill, and demonstrated experience in the execution of the sampling methods.
- Drilling and well installation will be performed by a licensed drilling contractor in the State of Washington.

2.6 Documentation and Records

Field investigators (including subcontractors) will maintain field notes in a bound notebook and all documents, records, and data collected will be kept in a case file in a secure records filing area. All Laboratory deliverables (both hard copy and electronic) with verifiable supporting documentation shall be submitted by the lab to the QA Officer. The following documents will be archived at the Laboratory: 1) signed hard copies of sampling and chain-of-custody records; and 2) electronic and hard copy of analytical data including extraction and sample preparation bench sheets, raw data and reduced analytical data. The laboratory will store all laboratory documentation for sample receipt, sample login, sample extraction, cleanup and analysis and instrument output documentation per laboratory’s Standard Operating Procedure (SOP) or QA Manual.

Copies of all analytical reports will be retained in the laboratory files, and at the discretion of the QA Officer, the data will be stored on computer disks for a minimum of 1 year. After one year, or whenever the data become inactive, the files will be transferred to archives in accordance with standard laboratory procedure. Data may be retrieved from archives upon request.

Copies of all sub-consultant field notes, field logs, sample collection logs, and field photographs will be sent to the Field Manager within 2 weeks of completion of the field task.

2.7 Field Quality Control Requirement

Field quality control samples are useful in identifying problems resulting from sample collection or sample processing in the field related to analytical samples. The field QC samples to be collected include field duplicates and sampling equipment rinsate blanks (if non dedicated sample equipment is used).

For soil sampling, a minimum of one duplicate sample will be collected from the material homogenized from one field sample and submitted for the same analyses as the field samples to evaluate heterogeneity attributable to sample handling. A minimum of one field duplicate will be submitted per 20 samples. The RPD for homogenate duplicate samples will be within 50% for soil.

At least one equipment rinsate sample will be collected after decontamination for every 20 soil samples collected. Equipment rinsate blanks will be collected for each type of sampling equipment that comes into contact with sample material. Duplicate and equipment rinsate samples will be analyzed for the same constituents as the environmental samples.

For direct push and monitoring well groundwater sampling, a minimum of one field duplicate will be submitted per 20 samples. The RPD for duplicate samples will be within 50% for groundwater.

3 Data Generation and Acquisition

3.1 Sample Process Design

The rationale for the sampling design and assumptions for locating and selecting environmental samples is detailed in the RIWP and Uplands SAP. The methods and procedures for collection of field samples are also provided in the Uplands SAP. All sampling will be conducted following standard procedures documented in the Uplands SAP.

3.2 Analytical Sampling Methods, Handling and Custody

3.2.1 Samples

All soil samples will be submitted for analysis described in Table 1. Collected samples for chemistry will be thoroughly homogenized and distributed to sample containers. Anthropogenic debris and large gravel will be removed prior to distribution to sample containers; removed materials will be noted in the field logbooks.

All sample containers will be labeled on the outside in indelible ink with the sample identification number, date and time collected, and analysis to be performed. Requirements for sample containers and storage conditions are provided in Table 1. All sample containers will be commercially available, pre-cleaned jars will have screw-type lids so that they are adequately sealed. Lids of the glass containers will have Teflon^{TM} inserts to prevent sample reaction with the plastic lid and to improve the quality of the seal. Samples for TPH-GRO and BTEX will be collected directly into the laboratory jars using EPA Method 5035.

3.2.2 Sampling Handling

Sample containers will be filled to minimize head space, and will be appropriately labeled and stored prior to shipment or delivery to the laboratory. Reusable sampling equipment such as stainless-steel spoons and bowls shall be decontaminated between sample locations.

Samples must be packed to prevent damage to the sample container and labeled to allow sample identification. All samples must be packaged so that they do not leak, break, vaporize or cause cross-contamination of other samples. Each individual sample must be properly labeled and identified. A chain-of-custody record must accompany each shipping container (see Section 3.2.3). When refrigeration is required for sample preservation, samples must be kept cool during the time between collection and final packaging.

All samples must be clearly identified immediately upon collection. Each sample bottle will be labelled and will include the following information:

- Client and project name
- A unique sample description
- Sample collection date and time.

Additionally, the sample bottle label may include:

- Sampler's name or initials
- Indication of addition of preservative, if applicable
- Analyses to be performed.

After collection, the samples will be maintained under chain-of-custody procedures as described below.

3.2.3 Chain of Custody

Chain-of-custody procedures are intended to document sample possession from the time of collection to disposal. Chain-of-custody forms must document transfers of sample custody. A sample is considered to be under custody if it is in one's possession, view, or in a designated secure area. The chain-of-custody record will include, at a minimum, the following information:

- Client and project name
- Sample collector's name
- Company's 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
- Addition of preservative, if applicable
- Requested turn-around times
- Date and method of shipment.

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 subsequent packaging procedures will be followed. If an on-site lab is being used, a chain-of-custody must be completed but the following packing procedures do not apply. All samples will be stored appropriately by the laboratory.

3.3 Analytical Quality Control

Laboratory Quality Control Requirements

Internal quality control procedures are designed to ensure the consistency and continuity of data. A routine QC protocol is an essential part of the analytical process. The minimum requirements for each analytical run follow. Additional description of laboratory QA/QC procedures can be found in the laboratory’s QA Manual. A project narrative detailing analytical results must accompany all data packages submitted by the laboratory.

- **Initial and continuing calibration:** A calibration standard will be analyzed each time an instrument is calibrated. The instruments used to perform the various analyses will be calibrated and the calibrations verified as required by the respective EPA methodologies. For example, a standard five-point initial calibration will be utilized to determine the linearity of response with the gas chromatograph/electron capture detection. Once calibrated, the system must be verified every 12 hours. All relative response factors, as specified by the analytical method, must be greater than or equal to 0.05. All relative standard deviations, as specified by the analytical method, must be less than or equal to 30 percent for the initial calibration and less than or equal to 25 percent for the continuing calibration.
- **Laboratory control sample:** The laboratory control sample (LCS) will consist of a portion of analyte-free water or solid phase sample that is spiked with target analytes of known concentration. The LCS will be processed through the entire method procedure and the results examined for target analyte recovery (accuracy). Precision evaluations will be generated using a laboratory control sample duplicate (LCSD). The LCS and LCSD results will be used as a fall-back position by the laboratory in cases where the matrix spike has failed to achieve acceptable recovery and/or precision. Inability to obtain acceptable LCS results will be directly related to an inability to generate acceptable results for any sample. One LCS/LCSD pair will be analyzed for each extraction batch.
- **Method blank analysis:** The method blank is utilized to rule out laboratory-introduced contamination by reagents or method preparation. Compounds detected in the blank will be compared in concentration to those found in the samples. Any concentration of common laboratory contaminants (i.e., phthalates, acetone, methylene chloride, or 2-butanone) in a sample at less than 10 times that found in the blank will be considered a laboratory contaminant. For other contaminants, any compounds detected at less than five times that found in the blank will be considered laboratory contamination (EPA, 2013). Values reported for the method blanks are expected to be below the detection limits for all compounds, except the common laboratory contaminants. Deviations from this must be explained in the laboratory project narrative(s). One method blank will be analyzed for each extraction/digestion batch
- **Matrix spike analysis:** A matrix spike (MS) is the addition of a known amount of target analyte to a sample. Analysis of the sample that has been spiked and comparison with the results from unspiked sample (background) will give information about the ability of the test procedure to generate a correct result from the sample (accuracy). Precision evaluations will be generated using a matrix spike duplicate (MSD). One matrix spike and matrix duplicate will be analyzed per sample delivery group (SDG) or per 20 samples. A SDG is defined as no more than 20 samples or a group of samples received at the laboratory within a two-week period
- **Surrogate evaluations (organic analyses):** Surrogate recovery is a quality control measure limited to use in organics analysis. Surrogates are compounds added to every sample at the beginning of the sample preparation to monitor the success of

the sample preparation on an individual sample basis (accuracy). Although some methods have established surrogate recovery acceptance criteria that are part of the method or contract compliance, for the most part, acceptable surrogate recoveries need to be determined by the laboratory. Recoveries of surrogates will be calculated for all samples, blanks and quality control samples. Acceptance limits will be listed for each surrogate and sample type and will be compared against the actual result

- **Laboratory management review:** The QA Officer(s) will review all analytical results prior to final external distribution (preliminary results will be reported before this review). If the QA Officer(s) finds the data meet project quality requirements, the data will be released as "final" information. Data which are not acceptable will be held until the problems are resolved, or the data will be flagged appropriately.

3.4 Instrument/Equipment Testing, Inspection and Maintenance

The primary objective of an instrument/equipment testing, inspection, and maintenance program is to help ensure the timely and effective completion of a measurement effort by minimizing the downtime of crucial sampling and/or analytical equipment due to expected or unexpected component failure.

Testing, inspection, and maintenance will be carried out on all field and laboratory equipment in accordance with manufacturer's recommendations and professional judgment. Analytical laboratory equipment preventative testing, inspection, and maintenance will be addressed in the laboratories' QA manual, which will be kept on file at the contracted laboratory.

As appropriate, schedules and records of calibration and maintenance of field equipment will be maintained in the field notebook. Equipment that is out of calibration or is malfunctioning will be removed from operation until it is recalibrated or repaired.

3.5 Instrument/Equipment Calibration and Frequency

Measuring and test equipment used during environmental data collection activities will be subject to calibration requirements. These requirements are summarized below:

- Identification. Either the manufacturer's serial number or the calibration system identification number will be used to uniquely identify measuring and test equipment. This identification, along with a label indicating when the next calibration is due, will be attached to the equipment. If this is not possible, records traceable to the equipment will be readily available for reference.
- Standards. Measuring and test equipment will be calibrated, whenever possible, against reference standards having known valid relationships to nationally recognized standards (e.g., National Institute of Standards and Technology) or

accepted values of natural physical constraints. If national standards do not exist, the basis for calibration will be described and documented.

- Frequency. Measuring and test equipment will be calibrated at prescribed intervals and/or prior to use. Frequency will be based on the type of equipment, inherent stability, manufacturers' recommendations, intended use, and experience. All sensitive equipment to be used at the project site or in the laboratory will be calibrated or checked prior to use.
- Records. Calibration records (certifications, logs, etc.) will be maintained for all measuring and test equipment used on the project.

If measuring and test equipment are found to be out of calibration, an evaluation will be made and documented to determine the validity of previous measurements and/or corrective action will be implemented. The QA officer will lead the evaluation process.

All laboratory calibration requirements must be met before sample analysis can begin. The laboratory will follow the calibration procedures found in the analytical methods listed in this QAPP or in the laboratory's SOPs. If calibration non-conformances are noted, samples will be reanalyzed under compliant calibration conditions within method-specified holding times.

3.6 Inspection/Acceptance of Supplies and Consumables

The Field Manager will be responsible for material procurement and control. The Field Manager will verify upon receipt that materials meet the required specifications and that, as applicable, material or standard certification documents are provided and maintained. The Field Manager will also verify that material storage is properly maintained and contamination of materials is not allowed.

Laboratories contracted for this project must have procedures that are documented and followed that cover the following:

- Checking purity standards, reagent grade water, and other chemicals as appropriate versus intended use
- Preparation and storage of chemicals
- Requirements for disposable glassware (grade and handling).

For this project, the Field Manager or designee will be responsible for procuring and shipping the appropriate sample containers and preservatives to the sampling site. The containers will be pre-cleaned and certified by lot. Reagents provided will be of the appropriate grade for the analysis. Records of these certifications and grades of material will be maintained on file at the laboratory.

3.7 Non-Direct Measurements

Existing chemical data from previous site characterization efforts have been reviewed to assist in identifying proposed sampling locations, discussed in the SAP. All historical data were previously reviewed for quality assurance.

3.8 Data Management

All hard copies of project field documentation, analytical results, and reports will be filed and stored at the consultant's library.

Analytical laboratories are expected to submit data in both electronic and hard copy.
The Laboratory Project Manager should contact the Project QA/QC Coordinator prior to data delivery to discuss specific format requirements. A library of routines will be used to translate typical electronic output from laboratory analytical systems and to generate data analysis reports. The use of automated routines ensures that all data are consistently converted into the desired data structures and that operator time is kept to a minimum. In addition, routines and methods for quality checks will be used to ensure such translations are correctly applied.

Written documentation will be used to clarify how field and laboratory duplicates and QA/QC samples were recorded in the data tables and to provide explanations of other issues that may arise. The data management task will include keeping accurate records of field and laboratory QA/QC samples so that project team members who use the data will have appropriate documentation.

4 Assessment and Oversight

4.1 Assessment and Response Actions

Assessment of field sample collection methods will be evaluated using the sampling equipment rinsate blank results. If there is a detectable level of the compound of interest in the equipment rinsate blank, samples will be qualified based on possible contamination.

Assessment of the field and laboratory methods will be evaluated using the field duplicate results. A significant variation between the original sample and the field duplicate may be caused by laboratory error or due to field sampling conditions. This variation will be identified during data validation with results compared to both the laboratory reports and field notes.

Nonconforming items and activities are those which do not meet the project requirements or approved work procedures. Non-conformance may be detected and identified by any of the following groups:

- Project Staff: During the performance of field activities and testing, supervision of subcontractors, performance of audits, and verification of numerical analyses
- Laboratory Staff: During the preparation for and performance of laboratory testing, calibration of equipment, and QC activities
- QA Staff: During the performance of audits.

If possible, action will be taken in the field to correct any nonconformance observed during field activities. If necessary and appropriate, corrective action may consist of re-sampling. If implementation of corrective action in the field is not possible, the nonconformance and its potential impact on data quality will be discussed in the report.

Corrective action to be taken as a result of nonconformance during field activities will be situation-dependent. The laboratory will be contacted regarding any deviations from the QAPP, will be asked to provide written justification for such deviations, and in some instances, will be asked to reanalyze the sample(s) in question. An example of a laboratory nonconformance that would require corrective action is if holding times were exceeded prior to analysis. All corrective actions must be documented. The person identifying the nonconformance will be responsible for its documentation.

Documentation will include the following information:

- Name(s) of the individual(s) identifying or originating the nonconformance
- Description of the nonconformance
- Any required approval signatures
- Method(s) for correcting the nonconformance or description of the variance granted.

Documentation will be made available to project, laboratory, and/or QA management. Appropriate personnel will be notified by the management of any significant nonconformance detected by the project, laboratory, or QA staff. Implementation of corrective actions will be the responsibility of the PM or the QA Officer. Any significant recurring nonconformance will be evaluated by project or laboratory personnel to determine its cause. Appropriate changes will then be instituted in project requirements and procedures to prevent future recurrence. When such an evaluation is performed, the results will be documented. If there are unavoidable deviations from this QAPP, the Project Manager will document the alteration and track the change in the subsequent deliverables.

4.2 Reports to Management

Deliverables from this project include:

- Laboratory hardcopy results and EDDs
- Data validation reports
- Soil boring, monitoring well logs
- Groundwater sampling field forms
- Report(s) discussing the results.

5 Data Validation and Usability

5.1 Data Review, Verification, and Validation

EPA method control limits (or WA State method control limits for NWTPH methods) for surrogate and matrix spike recoveries will be used for the determination of data quality. If surrogate or matrix spike recoveries are not within their method-specific control limits, then the analysis must be repeated. If the re-analyzed values are within required limits and holding times, they will be reported as true values. If, in the repeated analysis, the values are still outside required limits, the data will be identified and the Data Validator will verify the representativeness of the data following EPA guidelines. Laboratory analysts are responsible for reviewing calibration integrity, sample holding times, method compliance, and completeness of tests, forms, and logbooks.

Analytes detected at concentrations between the MRL and the method detection limit (MDL) will be reported with a J qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). Non-detects will be reported at the MRL. The MRL will be adjusted by the laboratory as necessary to reflect sample dilution or matrix interference.

Verification of completeness and method compliance, as well as raw data entry and calculations by analysts will be reviewed by a laboratory supervisor or the Laboratory Coordinator. The Laboratory Coordinator will be responsible for checking each group or test data package for precision, accuracy, method compliance, compliance to special client requirements, and completeness. The Laboratory Coordinator will also be responsible certifying that hardcopy and EDD data are identical prior to release from the laboratory.

Data validation will be completed by the Data Validator. Data validation will be completed within three weeks after receipt of the complete laboratory data package. A detailed report of the data validation results will be submitted to the Quality Assurance Officer and included in the final deliverable.

The analytical laboratories will generate a Level 4 CLP-like fully validatable data package (EPA, 1991).

5.2 Reconciliation with User Requirements

The QA Officer will review the field notebooks, laboratory report, and results of the data validation to determine if the data quality objectives have been met. Instances where the data quality objectives were not met will be documented. The usability of the data will depend on the magnitude of the data quality objective exceedance. Data that has been rejected will be flagged as “R” and maintained in the database but will not be used in any decision making. Data quality assurance criteria are provided in Table 2.

6 References

Lombard, S.M. and C.J. Kirchmer. 2004. Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies. Washington State Department of Ecology Environmental Assessment Program. July 2004. Publication Number 04-03-030

Shannon and Wilson, August 2019. Draft Conceptual Site Model and Data Gaps Report, Former Jenson Shipyard, Friday Harbor, Washington.

U.S. Environmental Protection Agency (EPA) 1991. EPA Region V Model Quality Assurance Project Plan. U.S. Environmental Protection Agency, Region V, Office of Superfund.

U.S. Environmental Protection Agency (EPA) 1986. Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods, 3rd Edition. EPA SW-846, 1986.

U.S Environmental Protection Agency (EPA) 2013. EPA Hazardous Waste Support Section, SOP No. HW-34 Revision 3, Trace Volatile Data Validation. EPA SOP HW-34 Revision 3 February 2013.

Tables

Table 1
Analytical Methods and Requirements
Jensen's Shipyard and Marina
Port of Friday Harbor

Chemical	Laboratory	Analytical Method	Bottle Type	Preservative	Holding Time
Soil					
Metals (arsenic, cadmium, chromium, copper, lead, zinc)	FBI	USEPA 6020B	One 4-oz WMG	None, cool to <6 °C	14 days
Mercury	FBI	USEPA 1631E	One 4-oz WMG	None, cool to <6 °C	14 days
Total petroleum hydrocarbons: gasoline- range	FBI	NWTPH-Gx	5035 Kit: Four pre-tared 40-mL VOA	None, cool to <6 °C for up to 48 hours	Freeze to <-7 °C within 48 hours, 14 days to analyze
Total petroleum hydrocarbons: diesel- and oil-range	FBI	NWTPH-Dx	One 4-oz WMG	None, cool to <6 °C	14 days to extract, then 40 days to analyze
Polycyclic aromatic hydrocarbons (PAH), Tributyltin	FBI, Eurofins	USEPA 8270D-SIM	One 4-oz WMG AMBER	None, Cool <6°C	14 days to extract, then 40 days to analyze
Polychlorinated biphenyl (PCB) Aroclors®	FBI	USEPA 8082A	One 4-oz WMG	None, Cool <6°C	14 days
Dioxins/Furans	Frontier	USEPA 8290/1613B	One 4-oz WMG AMBER	None, Cool <6°C	1 year
Organochlorine Pesticides	FBI	USEPA 8081	One 4-oz WMG	None, Cool <6°C	40 days
Groundwater					
Metals (arsenic, cadmium, chromium, copper, lead, zinc)	FBI	USEPA 6020B	One 250-mL HDPE	HNO_3 to pH<2 Cool to <4 °C For dissolved: pre-filter at 0.45-micron	6 months
Metals (arsenic, cadmium, chromium, copper, lead, zinc)	BAL	USEPA 1638	One 1-L HDPE	Cool to <4 °C Pre-filter at 0.45-micron HNO_3 to 0.2% in lab within 14 days	6 months
Mercury	FBI	USEPA 1631E	One 250-mL HDPE	HNO_3 to pH<2 Cool to <4 °C	6 months
Total petroleum hydrocarbons: gasoline- range	FBI	NWTPH-Gx	Three 40-mL VOA	Cool to <4 °C, HCl to pH<2, no headspace	14 days
Total petroleum hydrocarbons: diesel- and oil-range	FBI	NWTPH-Dx	One 500-ml amber glass	Cool to <4 °C, HCl to pH<2	14 days to extract, then 40 days to analyze
Polycyclic aromatic hydrocarbons (PAH), Tributyltin	FBI, Eurofins	USEPA 8270D-SIM	Two 1-liter AMBER	None, Cool <6°C	7 days to extract, 40 days to analyze
Polychlorinated biphenyl (PCB) Aroclors ®	FBI	USEPA 8082A	One 1-liter AMBER	None, Cool <6°C	1 year
Dioxins/Furans	Frontier	USEPA 8290/1613B	Two 1-liter AMBER	None, Cool <6°C	30 days to extract, then 45 days to analyze
Organochlorine Pesticides	FBI	USEPA 8081	One 1-liter AMBER	None, Cool <6°C	7 days to extract, then 40 days to analyze

°C - degrees Celsius
HCl - hydrochloric acid
HDPE - high density polyethylene
mL - milliliters
oz - ounces
USEPA - United States Environmental Protection Agency
WMG - wide mouth glass jar
VOA - volatile organic analysis
FBI - Friedman & Bruya, Inc. - Seattle, WA
Eurofins - Tacoma, WA
Frontier - Frontier Analytical Laboratory - El Dorado Hills, CA
BAL - Brooks Applied Labs - Bothell, WA

Table 2
Data Quality Assurance Criteria
Jensen's Shipyard and Marina
Port of Friday Harbor

Chemical	Precision [1]	Accuracy	Completeness	Reference
Soil				
Metals	±20% RPD	80–120%	95%	USEPA 6020B/1631E
Total petroleum hydrocarbons gasoline-range	±30% RPD	65–135%	95%	NWTPH-Gx
Total petroleum hydrocarbons: diesel- and oil-range	±30% RPD	65–135%	95%	NWTPH-Dx
Polychlorinated biphenyls	±30% RPD	30-160%	95%	USEPA 8082A
Polycyclic aromatic hydrocarbons, Tributyltin	±30% RPD	30-160%	95%	USEPA 8270D-SIM
Dioxins/Furans	±30% RPD	30-160%	95%	USEPA 8290/1613B
Organochlorine pesticides	±30% RPD	30-160%	95%	USEPA 8081
Groundwater				
Metals	±20% RPD	80–120%	95%	USEPA 6020B/1631E/1638
Total petroleum hydrocarbons: gasoline-range	±30% RPD	65–135%	95%	NWTPH-Gx
Total petroleum hydrocarbons: diesel- and oil-range	±30% RPD	65–135%	95%	NWTPH-Dx
Polychlorinated biphenyls	±30% RPD	30-160%	95%	8082A
Polycyclic aromatic hydrocarbons, Tributyltin	±30% RPD	30-160%	95%	USEPA 8270D-SIM
Dioxins/Furans	±30% RPD	30-160%	95%	USEPA 8290/1613B
Pesticides	±30% RPD	30-160%	95%	USEPA 8081

Note:

1 Precision criteria apply to analytical precision only. Field duplicate precision will be screened against an RPD of 50%.

RPD - relative percentage difference

USEPA - United States Environmental Protection Agency

Attachment 2

Standard Operating Procedures

1 INTRODUCTION

1.1 Purpose and Applicability

This Standard Operating Procedure (SOP) describes the methods available for collecting subsurface soil samples using commercially available Geoprobe™ Systems or split spoon sampling methods or similar soil sampling equipment. Sub surface soil samples may be obtained using this system for purposes of determining subsurface soil conditions and for obtaining soil samples for physical and/or chemical evaluation.

This SOP covers subsurface soil sampling using Geoprobe™ Systems equipment; specifically, the Macro-Core Soil Sampler, and the Large Bore Sampler. Use of this sampling equipment requires use of the Geoprobe™ hydraulically-powered percussion/probing machine. The Geoprobe™ sampling methods are applicable to unconsolidated soil/fill materials and to a maximum depth of approximately 15-30 feet. The maximum depth is dependent on the site specific soil density because the sampling equipment is hydraulically-powered. Sample recovery is also dependent on grain size as very coarse gravel, cobbles, and boulders will occasionally cause premature refusal of the sampler.

This SOP also covers subsurface soil sampling by split spoon, which is a common method for obtaining samples at deeper depths (greater than 20 feet) but can also be used to collect shallower samples. Other types of samplers such as thin-wall tube samples (e.g. Shelby tubes), piston samplers and continuous core barrel samplers but are not discussed in this SOP, details of sampling related to these types of samplers can be found in the American Society of Testing and Materials standards.

1.2 General Principles

1.2.1 Geoprobe Sampling

The percussion/probing machine is typically mounted onto the bed of a truck or ATV-mounted so that a stable working platform is established. The percussion/probing machine pushes and hammers the soil sampling equipment vertically into the ground within the targeted sampling interval. The soil sampler is then extracted from the ground to recover the sample.

The Macro-Core Sampler consists of a 45-inch long by 1.5-inch diameter open-ended steel sampling tool with liners made of clear plastic (cellulose acetate butyrate), stainless steel, or Teflon®. The tool is designed for use in a continuous sampling capacity in an open borehole up to depths of approximately 30-50 feet. The borehole walls are required to stay open in order to collect a sample from the next depth interval. Once the sampling tool is removed from the ground, the inserted liner containing the soil sample is removed from the tool. The soil sample is then cut from or extracted from the liner. This sampling tool is most often used for soil profiling and collection of larger volume soil samples (1,300 ml).

The Large Bore Sampler consists of a 22-inch long by a slightly over 1-inch diameter steel sampling tool and may be used for sampling to depths of approximately 30-50 feet. Various liner types are available for use with this sampler, and include: plastic, brass, stainless steel, and Teflon®. The metal liners are available in segmented 6-inch lengths. The sampler is designed for discrete interval sampling and is not affected significantly by borehole wall collapse. This sampler is similar to a piston sampler where a retractable drive (piston) point is withdrawn when the targeted sampling interval is achieved and the soil sample enters the sampler. Once the sampler is removed from the ground, the inserted liner containing the soil sample is extracted from the sampler and the soil sample is then cut from or extracted from the liner. The segmented liner materials and discrete interval sampling capability gives this device greater suitability for collection of smaller volume soil samples (320 ml).

1.2.2 Split Spoon Sampling

Split-spoon subsurface sampling methods require the use of a drilling rig (e.g. hollow-stem auger) to drill a borehole in which a split spoon sampling device is inserted and then driven to collect soil at the desired depth. The sampling device is driven using a weighted hammer and retrieved and opened to remove the recovered soil sample. Soil samples can be collected at continuous intervals or at pre-selected intervals. Typical split spoon samplers are used on a 2 inch diameter auger, though sampling devices come in a variety of sizes to fit difference auger diameters.

1.3 Quality Assurance Planning Considerations

Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific Quality Assurance Project Plan (QAPP). Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements outlined in the QAPP typically suggest the collection of a sufficient quantity of field duplicate, field blank, and other samples.

1.4 Health and Safety Considerations

All utilities (electric, water, sewer, etc.) or property owners who may have equipment or transmission lines buried in the vicinity of proposed investigation area should be notified. Sufficient time should be allowed after notification (typically 3 working days) for the utilities to respond and mark locations of any equipment that may be buried on site. The estimated location of utility installations, such as sewer, telephone, electric, water lines and other underground installations that may reasonably be expected to be encountered during excavation work, shall be verified by the site owner prior to opening an excavation and may require a private utility locate to verify location and or material present.

The health and safety considerations for the site, including both potential physical and chemical hazards, will be addressed in the site-specific Health and Safety Plan (HASP). All field activities will be conducted in conformance to this HASP.

2 RESPONSIBILITIES

2.1 Project Geologist/Engineer

It will be the responsibility of the project geologist/sampling engineer to conduct subsurface soil sampling in a manner which is consistent with this SOP. The project geologist/sampling engineer will observe all activities pertaining to subsurface soil sampling to ensure that the SOP is followed, and to record all pertinent data onto a boring log. It is also the project geologist/sampling engineer's responsibility to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. The project geologist/sampling engineer is also responsible for the collection of representative environmental or stratigraphic characterization samples once the sampling device has been retrieved and opened. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain-of-custody procedures are implemented.

2.2 Drilling Subcontractor

It will be the responsibility of the drilling subcontractor to provide the necessary Geoprobe™ or auger drilling equipment for obtaining subsurface soil samples. For Geoprobe™ equipment this generally includes the truck or ATV-mounted percussion/probing machine and one or more Macro-Core and Large Bore samplers in good operating condition, appropriate liners, and other necessary equipment for borehole preparation and sampling. For split spoon sampling a drill rig – such as a hollow-stem auger drill rig – and one or more split spoon sampling devices which fit with the drill rig augers, all of which should be in good operating condition.

It is the drilling subcontractor's responsibility to provide and maintain their own boring logs if desired. Equipment decontamination materials should also be provided by the subcontractor and should meet project specifications.

3 REQUIRED MATERIALS

In addition to those materials provided by the subcontractor, the project geologist/sampling engineer will require:

- Project Sampling Plan, QAPP, and HASP

- Field records/logbook (boring logs)
- Sampling spoons and sample collection bowl
- Stakes and/or fluorescent flagging for marking locations
- Sample kit (bottles, labels, custody records and tape, cooler)
- Folding rule or tape measure
- Equipment decontamination materials (as required by QAPP)
- Health and safety equipment (as required by HASP)
- Sheet plastic
- Decontamination materials and solutions

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be constructed of stainless steel, Teflon®, or glass, unless specified otherwise in the Project Sampling Plan or QAPP.

4 METHOD

4.1 General Method Description – Geoprobe

Geoprobe™ soil sampling methods generally involve collection of soil samples by driving the sampling tool directly into the ground using the percussion/probing machine and without the aid of hollow-stem augers or other casing-installed drilling methods. Both the Macro-Core and Large Bore soil samplers consist of metal tubes of seamless construction which cannot be split apart like split-spoons. Liner/sleeve inserts are required in order to extract an intact soil core/sample from the sampling device.

Both sampling devices operate by being directly pushed/hammered into the ground by the percussion/probing machine. The borehole is created as the sampling device is advanced downward. The Macro-Core Sampler collects samples continuously and requires that an open borehole be maintained for efficient sample recovery. The Large Bore Sampler contains a piston tip/drive point which allows for advancing the sampler to a designated depth for discrete interval sampling. The piston tip is retracted when the desired sampling interval is reached. When the soil sampling device is retrieved from the borehole, the drive head, cutting shoe and/or piston assembly is removed, and the liner insert with sample is removed from the sampling device. The project geologist/sampling engineer is then given access to the sample for whatever purpose is required.

4.2 General Method Description – Split Spoon Sampling

Split spoon sampling devices are typical construction of steel and most commonly available in lengths of 18 and 24 inches. Sampling device diameters are typical 1.5 to 3 inches. The sampling device includes a long tubular column with two halves that split apart lengthwise, a drive head is located on the upper end with a ball-check valve for venting and a hardened steel cutting shoe is located at the bottom. Soil enters the sampling device through the hardened steel cutting shoe as the sampler is driven into the ground to the required depth. Inside the cutting shoe is often a plastic or metal basket that prevents the soil sample from falling out of the shoe as the sample is retrieved.

Soil borings completed with a hollow-stem auger (typical for completing soil borings for the collection of soil samples) must have casing/augers of sufficient diameter to allow for the collection of the minimum soil sample volume required in the Sampling Plan. The casing/augers are advanced to the required sampling depth per the Sampling Plan. If hollow-stem augers are used, a temporary plug shall be used in the lead auger to prevent the auger from becoming filled with drill cuttings while drilling is in progress.

Use of added or recirculated water during drilling is permitted when necessary but should be minimized to avoid any possible impacts to the sample quality. Water usage shall be documented in the field notebook and should follow the QAPP or Sampling Plan.

4.3 Equipment Decontamination

Each sampling device must be decontaminated prior to its initial use and following collection of each soil sample. If sampling for soil logging only is conducted, thorough sampler decontamination between samples may not be necessary although sufficient cleansing is necessary for the sampler to operate properly. Site-specific requirements for equipment decontamination should be outlined in the Project Sampling Plan.

4.4 Sampling Procedures - Macro-Core Sampler

These procedures are excerpted from Geoprobe™ Systems literature. This SOP assumes that the subcontractor will perform sampling; therefore, detailed procedures regarding sample acquisition are not provided.

4.4.1 Sampler Preparation

- Decontaminate the sampler parts (cutting shoe, sample tube, liners) before assembly.
- Assemble the sampler by first placing the liner over the inside end of the cutting shoe, then inserting the liner/shoe assembly into the sample tube, and then finally threading the cutting shoe into the sample tube. Tighten the cutting shoe with the shoe wrench.
- Thread the sampler onto the drive head.

4.4.2 Sampling

- Using the percussion/probing machine, drive the sampler into the ground until the drive head reaches the ground surface.
- For deeper samples, the borehole walls must remain stable. The cutting shoe is designed with a tapered surface to limit sidewall scraping. Add additional probe rods until the sampler reaches the targeted sample interval, then drive the sampler through the desired sample interval.
- Use the machine hydraulics to pull the sampler from the borehole.

4.4.3 Sample Recovery

- Once the sampler has been removed from the borehole, the sampler must be unthreaded from the drive head, the cutting shoe unthreaded from the sampler, and the liner/shoe assembly removed from the sample tube.
- Disconnect the cutting shoe from the liner which contains the soil sample. The recovered soil sample may now be viewed, logged, and extracted from the liner for analysis (refer to Section 4.5 for sample containment procedures).

4.5 Sampling Procedures - Large Bore Sampler

These procedures are excerpted from Geoprobe™ Systems literature. This SOP assumes that the subcontractor will perform sampling; therefore, detailed procedures regarding sample acquisition are not provided. Additional detailed sampling procedures for this specific item of equipment is presented in Geoprobe™ Technical Bulletin No.93-660, appended to this SOP.

4.5.1 Sampler Preparation

- Decontaminate the sampler parts (cutting shoe, piston rod/tip, sample tube, liners) before assembly.
- Assemble the sampler by first placing the liner on the cutting shoe, then threading the liner/shoe assembly into the sample tube, then connecting the piston tip to the piston rod, and then finally inserting the piston tip/rod assembly into the sample tube. Tighten the cutting shoe with the shoe wrench.
- Thread the sampler onto the drive head. Thread the stop-pin onto the drive head (stop-pin holds the piston tip/rod in place while driving the sampler to the desired sample interval).

4.5.2 Sampling

- Using the percussion/probing machine, drive the sampler into the ground until the upper portion of the targeted sampling interval is achieved.

- Unthread and remove the stop-pin from the drive head using extension rods. This will activate the piston tip/rod.
- Drive the sampler through the targeted sampling interval to collect the sample. The piston tip/rod will retract as the sample enters the sample tube.
- Use the machine hydraulics to pull the sampler from the ground.

4.5.3 Sample Recovery

- Once the sampler has been removed from the ground, the sampler must be unthreaded from the drive head, then the cutting shoe unthreaded from the sample tube, and the liner/shoe assembly removed from the sample tube.
- Disconnect the cutting shoe from the liner which contains the soil sample. The recovered soil sample may now be viewed, logged, and extracted from the liner for analysis (below).

4.6 Sampling Procedures – Split Spoon Sampler

- Decontaminate the sampler parts (cutting shoe, piston rod/tip, sample tube, baskets) before assembly.
- Assemble the sampler by placing the 2 split halves together, thread the cutting shoe (with the basket inserted, if used) and then place the top ball check valve. Tighten the cutting shoe with the shoe wrench.
- Thread the sampling device to the drilling auger.

4.6.1 Sampling

- The driller will lower the split spoon into the borehole. The sampler will be driven, using Standard Penetration Test in ASTM Standards (ASTM D 1586-84) with a 140-pound hammer with a vertical free drop of 30 inches using two turns of rope on the cathead. The number of hammer blows required for every 6 inches of penetration will be recorded on the boring log.
- Once the split spoon is driven to depth, or to refusal, it will be removed, buy the driller, from the borehole.

4.6.2 Sample Recovery

- Once the sampler has been removed from the ground, the sampler must be unthreaded from the drive head, then the cutting shoe unthreaded from the sample tube, and the liner/shoe assembly removed from the sample tube.
- Disconnect the cutting shoe from the liner which contains the soil sample. The recovered soil sample may now be viewed, logged, and extracted for analysis (below).

4.7 Sample Containment

4.7.1 General

- The soil sample can be removed from the liner/split spoon device following viewing and/or logging. Non-segmented plastic or Teflon® liners should be cut with a utility knife into approximate 6-inch lengths to facilitate sample extraction or to isolate specific sample zones targeted for analysis. Segmented metal liners can be manually separated.
- Once the liner has been separated, the soil sample may be extracted from the individual liner segments with a spoon or spatula. Except for volatile organic samples (see below), the soil sample should be placed into a sample collection pan and homogenized. Place the sample directly into the required sample container.
- Once filled, the sample container should be properly capped, cleaned and labeled. Sample chain-of-custody and preservation procedures should then be initiated.
- Perform equipment decontamination following containment of the sample.

4.7.2 Volatile Organic Samples

- Using Geoprobe methods, the use of Teflon® liners is preferred when sampling for analysis of volatile organic compounds (VOC) because these liners are more inert. In order to limit the potential for loss of volatiles, the soil sample should be removed from the liner as soon as possible after sample recovery. VOC soil samples should be selected from a central point within the liner unless another specific sample zone has been targeted. The liner should be cut with a knife and the sample immediately extracted and containerized. Clean and label the container and place it into a cooler immediately. Residual sample may then be used to fill other sample or logging requirements.
- Using a split spoon sampling methods, to limit the potential loss of volatiles during sample collection, the soil sample needs to be obtained as quickly and as directly (from the sampler) as possible. This generally means the VOC sample is collected and placed in the sample container as soon as the split spoon is opened, prior to inspection of the soil or the collection of other samples. The VOC sample should be collected from a discrete portion of the entire sample interval and not composited or homogenized in the field, as this can cause VOC to volatize with the air.

5 QUALITY CONTROL

Quality control requirements are dependent on project-specific sampling objectives. The QAPP will provide requirements for equipment decontamination (frequency and materials), sample preservation and holding times, sample container types, sample packaging and shipment, as well as requirements for the collection of various quality assurance samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

6 DOCUMENTATION

Various forms are required to ensure that adequate documentation is made of sample collection activities. These forms include:

- Boring logs
- Field log books
- Sample collection records
- Chain-of-custody records
- Shipping labels

Boring logs will provide visual and descriptive information for each sample collected and are often the most critical form of documentation generated during a soil sampling program. The field log book is kept as a general log of activities and should not be used in place of the boring log. Occasionally, sample collection records are used to supplement boring logs, especially for environmental samples which have been collected for laboratory analysis. Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes. Shipping labels are required if sample coolers are to be transported to the laboratory by a third party (courier service). Original copies of these records should be maintained in the appropriate project files.

7 REFERENCES

ASTM D1586 / D1586M-18, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils, ASTM International, West Conshohocken, PA, 2018, www.astm.org

ASTM D6282 / D6282M-14, Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations, ASTM International, West Conshohocken, PA, 2014, www.astm.org

Geoprobe™ Systems, August 1993, "1993-94 Equipment and Tools Catalog".

1 INTRODUCTION

1.1 Purpose and Applicability

This SOP provides guidance for installing groundwater monitoring wells. Monitoring wells are installed to monitor the depth to groundwater, to measure aquifer properties, and to obtain samples of groundwater for chemical analysis.

This SOP is applicable to installation of single monitoring wells within a borehole. The construction and installation of nested, multilevel or other special well designs is not covered within this SOP as these type of wells are not frequently constructed. This SOP applies to both overburden and bedrock monitoring wells.

Some states and EPA Regions have promulgated comprehensive guidelines for monitoring well construction and for subsurface investigation procedures. Deviations from this SOP to accommodate other regulatory requirements should be reviewed in advance of the field program, should be explained in the project work plan, and must be documented in the field project notebook when they occur.

1.2 General Principles

Monitoring well construction and installation generally involves drilling a borehole using conventional drilling equipment, installing commercially available well construction and filter/sealing materials, and development of the well prior to sampling. This SOP covers well construction and installation methods only. Borehole drilling and well development methods are covered under SOP-7115 (Subsurface Soil Sampling) and SOP-502 (Monitoring Well Development), respectively.

1.3 Quality Assurance Planning Considerations

Field personnel should follow specific quality assurance guidelines as outlined in the site-specific QAPP. The following aspects of monitoring well design and installation procedures depend on project-specific objectives which should be addressed in the QAPP and in the project work plan:

- Borehole drilling method and diameter,
- Type of construction materials for well screen, riser, filter pack and seals,
- Diameter of well materials,
- Length of well screen,
- Location, thickness, and composition of annular seals, and
- Well completion and surface protection requirements.

1.4 Health and Safety Considerations

Monitoring well installation may involve chemical hazards associated with materials in the soil or groundwater being investigated; and always involves physical hazards associated with drilling equipment and well construction methods. When wells are to be installed in locations where the aquifer and/or overlying materials may contain chemical hazards, a Health and Safety Plan (HASP) must be prepared and approved by the Health and Safety Officer before field work commences. This plan must be distributed to all field personnel and must be adhered to as field activities are performed.

2 RESPONSIBILITIES

2.1 Drilling Subcontractor

It is the responsibility of the drilling subcontractor to provide the necessary equipment for well construction and installation. Well construction materials should be consistent with project requirements.

2.2 Surveying Contractor

It is the responsibility of the surveying subcontractor to provide one or more of the following well measurements as specified in the project work plan: ground surface elevation, horizontal well coordinates, top of well casing elevation (i.e., top-of-casing, or measuring point elevation), and/or top of protective casing elevation.

2.3 Project Geologist/Engineer

t is the responsibility of the Project Geologist/Engineer to directly oversee the construction and installation of the monitoring well by the drilling subcontractor to ensure that the well-installation specifications defined in the project work plan are adhered to, and that all pertinent data are recorded on the appropriate forms.

2.4 Project Manager

It is the responsibility of the Project Manager to ensure that each project involving monitoring well installation is properly planned and executed.

3 REQUIRED MATERIALS

3.1 Well Construction Materials

Well construction materials are usually provided by the drilling subcontractor and most often consist of commercially available flush-threaded well screen and riser pipe constructed of PVC or stainless steel with a minimum 2-inch inside diameter. The length of the screen and the size of the screen slots should be specified in the project work plan.

3.2 Well Completion Materials

Well completion materials include silica sand, bentonite, cement, protective casings and locks. Completion materials are generally provided by the drilling subcontractor.

3.3 Other required material include the following:

- Potable water supply
- Fiberglass or steel measuring tape
- Water level indicator
- Well construction diagrams (Figure 1)
- Waterproof marker or paint (to label wells)
- Health and Safety supplies
- Equipment decontamination materials
- Field project notebook/pen

4 METHOD

4.1 General Preparation

4.1.1 Borehole Preparation

Standard drilling methods should be used to achieve the desired

drilling/well installation depths specified in the project work plan. Soil sampling, if conducted, should be conducted in accordance with SOP-400 (Subsurface Soil Sampling).

The diameter of the borehole must be a minimum of 2 inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals. Bedrock wells may require reaming after coring in order to provide a large enough borehole diameter for well installation.

Rotary drilling methods requiring bentonite-based drilling fluids, if selected, should be used with caution to drill boreholes that will be used for monitoring well installation. The bentonite mud builds up on the borehole walls as a filter cake and permeates the adjacent formation, potentially reducing the permeability of the material adjacent to the well screen.

If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site. In addition, an attempt should be made to recover the quantity of fluid or water that was introduced, either by flushing the borehole prior to well installation and/or by over-pumping the well during development.

4.1.2 Well Materials Decontamination

Although new well materials (well screen and riser pipe) generally arrive at the site boxed and sealed within plastic bags, it is sometimes necessary to decontaminate the materials prior to their use. Well materials should be inspected by the project geologist/engineer upon delivery to check cleanliness. If the well materials appear dirty, or if local or regional regulatory guidance requires decontamination, then well material decontamination should be performed by the drilling subcontractor in accordance with SOP-100 (Decontamination of Field Equipment).

4.2 Well Construction Procedure

4.2.1 Depth measurement

Once the target drilling depth has been reached, the drilling subcontractor will measure the total open depth of the borehole with a weighted, calibrated tape measure. Adjustments of borehole depth can be made at this time by drilling further or installing a small amount of sand filter material to achieve the desired depth. If drilling fluids were used during the drilling process, the borehole should be flushed at this time using potable water. The water table depth may also be checked with a water level indicator if this measurement cannot be obtained with the calibrated tape.

4.2.2 Centralizers

In order to install a well which is centered within the borehole, it is recommended that centralizers be used. Centralizers are especially helpful for deep well installations where it may be difficult to position the well by hand. Centralizers may not be necessary on shallow water table well installations where the well completion depth is within 25 feet of the ground surface.

4.2.3 Well Construction

The well screen and riser pipe generally are assembled by hand as they are lowered into the borehole. Before the well screen is inserted into the borehole, the full length of the slotted portion of the well screen as well as the unslotted portion of the bottom of the screen should be measured with the measuring tape. These measurements should be recorded on the well construction diagram.

After the above measurement has been taken, the drilling subcontractor may begin assembling the well. As the assembled well is lowered, care should be taken to ensure that it is centered in the hole if centralizers are not used. The well should be temporarily capped before filter sand and other annular materials are installed.

4.2.4 Filter Sand Installation

The drilling subcontractor should fill the annular space surrounding the screened section of the monitoring well to at least 1 foot above the top of the screen with an appropriately graded, clean sand or fine gravel. In general, the filter pack should not extend more than 3 feet above the top of the screen to limit the thickness of the monitoring zone. If coarse filter materials are used, an additional 1-foot thick layer of fine sand should be placed immediately above the filter pack to prevent the infiltration of sealing components (bentonite or grout) into the filter pack. As the filter pack is placed, a weighted tape should be lowered in the annular space to verify the depth to the top of the layer. Depending upon depth, some time may be required for these materials to settle. If necessary, to eliminate possible bridging or creation of voids, placement of the sand pack may require the use of a tremie pipe. Tremie pipe sand pack installations are generally suggested for deep water table wells and for wells which are screened some distance beneath the water table.

4.2.5 Bentonite Seal Installation

A minimum 2-foot thick layer of bentonite pellets or slurry seal will be installed by the drilling subcontractor immediately above the well screen filter pack in all monitoring wells. The purpose of the seal is to provide a barrier to vertical flow of water in the annular space between the borehole and the well casing. Bentonite is used because it swells significantly upon contact with water. Pellets generally can be installed in shallow boreholes by pouring them very slowly from the surface. If they are poured too quickly, they may bridge at some shallow, undesired depth. As an option, powdered bentonite may be mixed with water into a very thick slurry and a tremie pipe used to inject the seal to the desired depth.

4.2.6 Annular Grout Seal Installation

This grout seal should consist of a bentonite/cement mix with a ratio of bentonite to cement of between 1:5 and 1:20. The grout ratio should be chosen based on site conditions with a higher percentage of bentonite generally used for formations with higher porosity. A mud balance should be used if a specific mud density is required at a particular site. Grout slurry should be pumped into the annular space using a side-discharging tremie pipe located about 2 feet above the sand pack. Side discharge will help preserve the integrity of the sand pack.

In situations where the monitoring well screen straddles the water table, the seal will be in the unsaturated zone and pure bentonites (pellets or powder) will not work effectively as seals without hydration. Dry bentonite may be used if sufficient time to hydrate the seal is allowed. Seal hydration requires the periodic addition of clean water. Optionally, seals in this situation may be a cement/bentonite mixture containing up to 10 percent bentonite by weight. This type of mixture shall be tremied to the desired depth in the borehole.

The borehole annulus will be grouted with seal materials to within 3 feet of the ground surface. Drill cuttings, even those known not to be contaminated, will not be used as backfill material.

4.2.7 Well Completion

The drilling subcontractor will cut the top of the well to the desired height and install a vented (if possible), locking cap. The upper portion of the well casing can optionally be drilled to allow venting. Well casings are usually cut to be a certain height above ground surface (typically 2.5 to 3 feet) or are cut to be flush with the ground surface.

4.2.8 Protective Casing/Concrete Pad Installation

The drilling subcontractor will install a steel guard pipe on the well as a protective casing. The borehole around the guard pipe will be dug out to an approximate 2 to 3-foot radius to a minimum depth of 1 foot at the center and 6 inches at the edges. After installing the protective casing, the excavation will be filled with a concrete/sand mix. The surface of the concrete pad will be sloped so that drainage occurs away from the well. Flush-mount protective casings may not require an extensive concrete pad and should be completed such that they are slightly mounded above the surrounding surface to prevent surface water from running over or ponding on top of the casing. It should be noted, however, that in areas subject to snowfall, flush-mount casings may have to be installed so that they are entirely flush with the ground surface as they may be damaged by snow plows.

Above-ground protective casings should also be vented or should have non-air tight caps. Road box installations should not be vented. Installation of additional guard pipes may be necessary around above-ground well completions in traffic areas. Protective casings should be lockable to prevent unauthorized access.

4.2.9 Well Numbering/Identification

The project geologist/engineer will number each well casing with an indelible marker or paint to identify the well. This is particularly important with nested or paired wells to distinguish between shallow and deep wells. The well should be labeled on both the outside of the protective casing and inside beneath the protective casing lid. A permanent identification tag may be installed the request of the well owner. For wells in the state of Washington, a Washington Department of Ecology identification tag will be installed inside the well completion of secured to the outside protective cover.

4.2.10 Measuring Point Identification

The project geologist/engineer will mark the measuring point from which water level measurements will be made at a specific location along the upper edge of the well casing. PVC wells can easily be notched with a pocket knife or saw. Stainless steel wells (or PVC wells) can be marked with a waterproof marker on the outside of the well casing with an arrow pointing to the measuring point location. The measuring point is the point which will require surveying during the well elevation survey task.

4.2.11 Well Measurements

Upon completion, the following well measurements should be taken by the project geologist/engineer and recorded on the well construction diagram (Figure 1):

- Depth to static water level if water level has stabilized,
- Total length of well measured from top-of-well casing,
- Height of well casing above ground surface,
- Height of protective casing above ground surface,
- Depth of bottom of protective casing below ground surface (may be estimated).

Well screen filter pack, bentonite seal and annular seal thicknesses and depths should also be recorded on the well construction diagram.

4.2.12 Disposal of Drilling Waste

Drill cuttings and other investigation-derived wastes such as drilling mud or well development/purge water must be properly contained and disposed of. Site-specific requirements for collection and removal of these waste materials should be outlined within the project work plan. Containment of these materials should be performed by the drilling subcontractor.

4.2.13 Well Development

At some point after installation of a well and prior to use of the well for water-level measurements or collection of water quality samples, development of the well shall be undertaken in accordance with SOP-502 (Monitoring Well Development). Well development may be performed by the drilling subcontractor if contracted to do so, or by the project geologist/engineer or other project staff.

4.2.14 Well Elevation Survey

At the completion of the well installation program, all monitoring wells are usually surveyed to provide, at a minimum, the top-of-casing measuring point elevation for water level monitoring purposes. Other surveyed points which may be required by the project work plan include: ground surface elevation, top of protective casing elevation, and well coordinate position. Well elevation surveys are usually conducted by a surveying subcontractor.

5 QUALITY CONTROL

Certain quality control measures should be taken to ensure proper well completion.

The borehole will be checked for total open depth, and extended by further drilling or shortened by backfilling, if necessary, before any well construction materials are placed.

Water level and non-aqueous phase liquid (NAPL) presence will be checked during well installation to ensure that the positions of well screen, sand pack, and seal, relative to water level, conform to project requirements.

The depth to the top of each layer of packing (i.e., sand, bentonite, grout, etc.) will be verified and adjusted if necessary to conform to project requirements before the next layer is placed.

If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids may be required for analysis of chemical constituents of interest at the site.

6 DOCUMENTATION

All well construction data will be recorded on the Monitoring Well Construction Detail form (Figure 1). All wells will be referenced onto the appropriate site map. A field notebook and/or boring log will be used as additional means of recording data. In no case will the notebook or boring log take the place of the well construction diagram.

7 TRAINING/QUALIFICATIONS

Well construction and installation requires a moderate degree of training and experience as numerous drilling situations may occur which will require field decisions to be made. It is recommended that inexperienced personnel be supervised for several well installations before working on their own. Experienced drillers are also of great assistance with problem resolution in the field. Field personnel should be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials are considered to be present. Well installations will be completed by over installed with oversight by a state licensed well driller.

8 REFERENCES

ASTM D5092 / D5092M-16, Standard Practice for Design and Installation of Groundwater Monitoring Wells, ASTM International, West Conshohocken, PA, 2016, www.astm.org

EPA, 2018. Design and Installation of Monitoring Wells, SESDGUID-101-R2. U.S. Environmental Protection Agency, Science and Ecosystem Support Division, Region 4. January 16, 2018.

MDEP, 1991. Standard References for Monitoring Wells, Massachusetts Department of Environmental Protection, WSC-310-91, 1991.

APPENDIX: DEFINITIONS

Annulus: The measured width between the borehole wall and the outside of the well screen or riser pipe.

Bentonite Seal: A granular, chip, or pellet-size bentonite material that is often used to provide an annular seal above the well screen filter pack. This seal is typically installed dry followed by in-place hydration with or without the addition of water. Hydrated bentonite is sometimes used as a grout seal.

Bottom Cap/Plug: Threaded or slip-on cap placed at the bottom of the well prior to installation. Often serves as a sump for accumulation of silt which settles within the well. The measured length from the lowermost well screen slot to the bottom of the bottom cap is known as the sump or tail pipe portion of the well.

Centralizers: Stainless steel expansion clamps which, when fitted to well screens or riser pipe, expand to contact the borehole walls positioning the well centrally within the open borehole. Centralizers assist with even positioning and distribution of filter pack and sealant materials and assist with maintaining well plumbness.

Expansion Cap/Well Cap: Cap used to cover the opening at the top of the well riser pipe. Expansion caps are equipped with a rubber gasket and threaded wing nut which, when turned, provides a watertight seal. Expansion caps may also be locked, and generally are recommended for use with flush-constructed wells where road box protective casings are also used. Other well caps may include slip-on or threaded caps made of the same material as the well casing.

Filter Pack: A well-graded, clean sand or gravel placed around the well screen to act as a filter in preventing the entry of very fine soil particles into the well.

Grout Seal: A cement/bentonite mixture used to seal a borehole that has been drilled to a depth greater than the final well installation depth or to seal the remaining borehole annulus once the well has been installed. Occasionally, pure cement or pure bentonite is used as a grout seal.

Measuring Point: A selected point at the top of the well casing (riser pipe) used for obtaining periodic water-level measurements. The measuring point should consist of either a notch or indelibly marked point on the upper surface of the casing. Typically, the highest point on the casing (if not level) is used as the measuring point. The measuring point is also the point that is surveyed when well elevation data is obtained.

Protective Casing: A locking metal casing, placed around that portion of the well riser pipe that extends above the ground surface. The protective casing is generally cemented in place when the concrete pad is constructed around the well.

APPENDIX: DEFINITIONS

Riser Pipe: The section of unperforated well casing material used to connect the well screen with the ground surface. Frequently, it is made of the same material and has the same diameter as the well screen. Riser pipe is typically available pre-cleaned and pre-threaded for immediate use.

Road Box: A protective casing that is flush-mounted with the ground around a well installation. Road boxes are used in areas where the monitoring well cannot extend above the ground surface for traffic or security reasons. Road boxes usually require a special key to open.

Tremie Pipe: A small diameter pipe which fits in the open borehole annulus and is used to inject filter sands or hydrated seal materials under pressure.

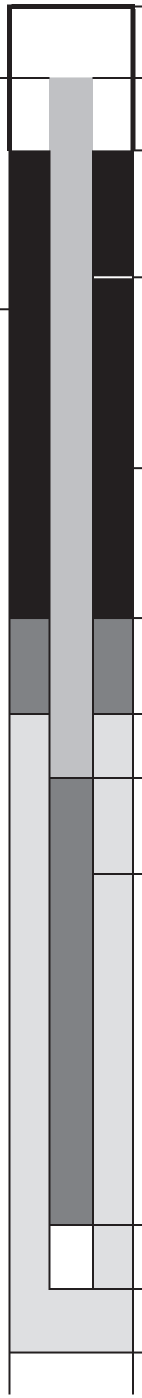
Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. Typically a well screen is purchased pre-slotted, pre-cleaned, and pre-threaded for immediate use.

Vent Hole: Small diameter hole drilled in the upper portion of the well riser pipe which provides atmospheric venting of the well. Allows for constant equilibration of the water level with changing atmospheric conditions. In flood-prone areas, or with flush-mount wells, vent holes should not be used.

Monitoring Well Construction Detail

CRETE CONSULTING, INC.	*Client:*	WELL ID:
	Project Number:	
	Site Location:	*Date installed:*
	Well Location:	*Inspector:*
	Method:	*Contractor:*

MONITORING WELL CONSTRUCTION DETAIL



	Depth from G.S. (feet)	Elevation(feet) Datum ________
Top of Steel Guard Pipe	________	________
Top of Riser Pipe	________	________
Ground Surface (G.S.)	________	________
Top of Bentonite	________	________
Top of Sand	________	________
Top of Screen	________	________
▼ Stabilized Water Level	________	________
Bottom of Screen	________	________
Bottom of Tail Pipe:	________	________
Bottom of Borehole	________	________

Measuring Point for Surveying & Water Levels

Cement, Bentonite, Bentonite Slurry Grout, or Native Materials

________ % Cement

________ % Bentonite

________ % Native Materials

Riser Pipe:
- Length ________
- Inside Diameter (ID) ________
- Type of Material ________

Bottom of Steel Guard Pipe

Bentonite Seal Thickness ________

Screen:
- Length ________
- Inside Diameter (ID) ________
- Slot Size ________
- Type of Material ________

Type/Size of sand ________

Sand Pack Thickness ________

Bottom of Tail Pipe:
- Length ________

Borehole Diameter ________

Describe Measuring Point:

____

________________ Signature

________________ Date

1 INTRODUCTION

1.1 Purpose and Applicability

This SOP describes the methods used for developing newly installed monitoring wells and/or existing wells which may require redevelopment/rehabilitation. This SOP is applicable to monitoring wells and/or small diameter recovery wells and piezometers.

Monitoring well development and/or redevelopment is necessary for several reasons:

- To improve/restore hydraulic conductivity of the surrounding formations as they have likely been disturbed during the drilling process, or may have become partially plugged with silt,
- To remove drilling fluids (water, mud), when used, from the borehole and surrounding formations, and
- To remove residual fines from well filter materials and reduce turbidity of groundwater, therefore, reducing the chance of chemical alteration of groundwater samples caused by suspended sediments.

Respective state or federal agency (regional offices) regulations may require specific types of equipment for use or variations in the indicated method of well development. Deviations from this SOP to accommodate other regulatory requirements should be reviewed in advance of the field program, should be explained in the project work plan, and must be documented in the field project notebook when they occur.

1.2 General Principles

Well development generally involves withdrawal of an un-specified volume of water from a well using a pump, surge block or other suitable method such that, when completed effectively, the well is in good or restored hydraulic connection with the surrounding water bearing unit and is suitable for obtaining representative groundwater samples or for other testing purposes.

1.3 Quality Assurance Planning Considerations

Field project personnel should follow specific quality assurance guidelines as outlined in the site-specific Quality Assurance Project Plan (QAPP) and/or Sampling Plan. The plan should indicate the preferred method of well development at a particular site based on project objectives, aquifer conditions, and agency requirements. Specific well performance criteria such as low turbidity values to be achieved following well development should also be specified as well as any requirements for collection/containerization and disposal of well development water.

1.4 Health and Safety Considerations

Monitoring well development may involve chemical hazards associated with materials in the soil or aquifer being characterized and may involve physical hazards associated with use of well development equipment. When wells are to be installed and developed on hazardous waste investigation sites, a Health and Safety Plan must be prepared and approved by the Health and Safety Officer before field work commences. This plan must be approved by the project Health and Safety Officer before work commences, must be distributed to all field project personnel, and must be adhered to as field activities are performed.

2 RESPONSIBILITIES

2.1 Project Geologist/Engineer

Development or oversight of development of new monitoring wells is the responsibility of the project geologist/engineer involved in the original installation of the well. Records of well development methods and results will be retained in the project file.

3 REQUIRED MATERIALS

Well development can be performed using a variety of methods and equipment. The specific method chosen for development of any given well is governed by the purpose of the well, well diameter and materials, depth, accessibility, geologic conditions, static water level in the well, and type of contaminants present, if any.

The following list of equipment, each with their own particular application, may be used to develop and/or purge monitoring wells.

3.1 Bailer Purging

A bailer is used to purge silt-laden water from wells after using other devices such as a surge block. In some situations, the bailer can be used to develop a well by bailing and surging, often accompanied with pumping. A bailer should be used for purging in situations where the depth to static water is greater than 25 feet and/or where insufficient hydraulic head is available for use of other development methods.

3.2 Surge Block Development

Surge blocks are commercially available for use with Waterra™-type pumping systems or may be manufactured using a rubber or Teflon™ "plunger" attached to a rod or pipe of sufficient length to reach the bottom of the well. Well drillers usually can provide surge blocks if requested.

3.3 Pump Development

A pump is often necessary to remove large quantities of silt-laden ground water from a well after using the surge block. In some situations, the pump alone can be used to develop the well and remove the fines by over pumping. Since the purpose of well development is to remove suspended solids from a well and surrounding filter pack, the pump must be capable of moving some solids without damage. The preferred pump is a submersible pump which can be used in both shallow and deep ground water situations. A centrifugal pump may be used in shallow wells but will work only where the depth to static ground water is less than approximately 25 feet. Pumping may not be successful in low-yielding aquifer materials or in wells with insufficient hydraulic head.

3.4 Other Required Materials:

- Well development records (Figure 1)
- Health and Safety equipment
- Equipment decontamination materials
- Water quality instrumentation: nephelometer, pH, temperature, specific conductance meters, as required
- Field project notebook/pen

4 METHOD

4.1 General Preparation

- Well Records Review: Well completion diagrams should be reviewed to determine well construction characteristics. Formation characteristics should also be determined from review of available boring logs.
- Site Preparation: Well development, similar to groundwater sampling, should be conducted in as clean an environment as possible. This usually requires, at a minimum, placing sheet plastic on the ground to provide a clean working area for development equipment.
- IDW Containment: Provisions should be in place for collection and management of investigation-derived wastes (IDW), specifically well development water and miscellaneous expendable materials generated during the development process. The collection of IDW in drums or tanks may be required depending on project-specific requirements. The QAPP should specify the requirements for IDW containment.

- Water Level/Well Depth Measurement: The water level and well depth should be measured with a water level indicator and written on the well development record. This information is used to calculate the volume of standing water (i.e., the well volume) within the well.
- Equipment Decontamination: All down-well equipment should be decontaminated prior to use
- Removal of Drilling Fluids: Drilling fluids such as mud or water, if used during the drilling and well installation process, should be removed during the well development procedure. It is recommended that a minimum of 1.5 times the volume of added fluid be removed from the well during development. Drilling muds should initially have been flushed from the drilling casing during the well installation procedure with water added during the flushing process. If the quantity of added fluid is not known or could not be reasonably estimated, removal of a minimum of 10 well volumes of water is recommended during the development procedure.

4.2 Development Procedures

4.2.1 Development Method Selection

The construction details of each well shall be used to define the most suitable method of well development. Some consideration should be given to the potential degree of contamination in each well as this will impact IDW containment requirements.

The criteria for selecting a well development method include well diameter, total well depth, static water depth, screen length, the likelihood and level of contamination, and characteristics of the geologic formation adjacent to the screened interval.

The limitations, if any, of a specific procedure are discussed within each of the following procedures.

4.2.2 General Water Quality Measurements

Measure and record water temperature, pH, specific conductance, and turbidity periodically during development using the available water quality instruments. These measurements will aid in determining whether well development is proceeding efficiently, will assist in identifying when well development is complete, will determine whether the development process is effective or not with any given well and, potentially, may identify well construction irregularities (i.e., grout in well, poor well screen slot-size selection). Water quality parameters should be checked a minimum of 3 to 5 times during the development process.

4.2.3 Bailer Procedure

As stated previously, bailers shall preferably not be used for well development but may be used in combination with a surge block to remove silt-laden water from the well.

- When using a bailer to purge well water; select the appropriate bailer, then tie a length of bailer cord onto the end of it.
- Lower the bailer into the screened interval of the monitoring well. Silt, if present, will generally accumulate within the lower portions of the well screen.
- The bailer may be raised and lowered repeatedly in the screened interval to further simulate the action of a surge block and pull silt through the well screen.
- Remove the bailer from the well and empty it into the appropriate storage container.
- Continue surging/bailing the well until sediment-free water is obtained. If moderate to heavy siltation is still present, the surge block procedure should be repeated and followed again with bailing.
- Check water quality parameters periodically.

4.2.4 Surge Block Procedure

- A surge block effectively develops most monitoring wells. This device first forces water within the well through the well screen and out into the formation, and then pulls water back through the screen into the well along with fine soil particles. Surge blocks may be manufactured to meet the design criteria or may be purchased as an adaptor to fit commercially available well purging systems such as the Waterra system.
- Insert the surge block into the well and lower it slowly to the level of static water. Start the surge action slowly and gently above the well screen using the water column to transmit the surge action to the screened interval. A slow initial surging, using plunger strokes of approximately 3 feet, will allow material which is blocking the screen to separate and become suspended.
- After 5 to 10 plunger strokes, remove the surge block and purge the well using a pump or bailer. The returned water should be heavily laden with suspended silt and clay particles. Discharge the purged water into the appropriate storage container.
- Repeat the process. As development continues, slowly increase the depth of surging to the bottom of the well screen. For monitoring wells with long screens (greater than 10 feet) surging should be undertaken along the entire screen length in short intervals (2 to 3 feet) at a time. Continue this cycle of surging and purging until the water yielded by the well is free of visible suspended material.
- Check water quality parameters periodically.

4.2.5 Pump Procedure

- Well development using only a pump is most effective in monitoring wells that will yield water continuously. Theoretically, pumping will increase the hydraulic gradient and velocity of groundwater near the well by drawing the water level down. The increased velocity will move residual fine soil particles into the well and clear the well screen of this material. Effective development cannot be accomplished if the pump has to be shut off to allow the well to recharge.

- When using a submersible pump or surface pump, set the intake of the pump or intake line in the center of the screened interval of the monitoring well.
- Pump a minimum of three well volumes of water from the well and raise and lower the pump line through the screened interval to remove any silt/laden water. Continue pumping water from the well until sediment-free water is obtained. This method may be combined with the manual surge block method if well yield is not rapid enough to extract silt from the surrounding formations.
- Check water quality parameters periodically.

5 QUALITY CONTROL

A well has been successfully developed when the sediment load in the well has been eliminated or greatly reduced. Regulatory requirements may be in place which state that water turbidity values ranging from 5 to 50 NTU must be achieved at the end of the development procedure. Use of a nephelometer is required during the well development procedure to measure water turbidity if meeting a specific turbidity value is required by the regulations. Attaining low turbidity values in fine-grained formations may be difficult to achieve.

In rare instances, slow groundwater recharge to the well may be hindering well purging and development. In these cases, the well may need developed in stages over multiple well visits in which sufficient recharge is allowed in order to remove any silts, sands, or turbid water.

6 DOCUMENTATION

The Monitoring Well Development Record (Page 8) will be completed by the geologist or hydrogeologist conducting the development. In addition, a field project notebook should be maintained detailing any problems or unusual conditions which may have occurred during the development process.

7 Training/Qualifications

Well development procedures vary in complexity. It is recommended that initial development attempts be supervised by more experienced personnel. Field personnel should be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials are considered to be present.

8 REFERENCES

ASTM D5521 / D5521M-18, Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers, ASTM International, West Conshohocken, PA, 2018, www.astm.org

Standard References for Monitoring Wells, Massachusetts Department of Environmental Protection, WSC-310-91, 1991.

EPA 1992. Monitoring Well Development Guidelines for Superfund Project Managers. April 1992.

EPA 2001. Standard Operating Procedures (2044) Monitoring Well Development

Monitoring Well Development Record

Date:	**Well ID:**
Project Name:	**Location:**
Project Number:	**Developer:**
Check One	**Development Method:**
Original Development **Redevelopment**	**Well Construction Date**

Well Diameter		Geology at Screen Interval:
Total Well Depth		
Depth of Top of Screen		Purge Water and Sediment Disposal Method:
Depth of Bottom of Screen		
Water Level		
Three Well Volumes		**Well Volume = 3.14*(R^2*H*(CF)** R= Radius (feet), 2 inch = 0.17 feet H = Height of the water column CF = conversion factor = 7.48 gal/ft3

Water Quality Parameters					
Date/Time					
Approximate Volume Purged					
Color of Water/Notes					
Turbidity (NTU)					
pH					
Specific Conductivity					
Temperature					

During development periodically measure the water quality parameters Depending on project objectives and available time, development should proceed until these water quality parameters stabilize, or until the water has a turbidity of less than 50 nephelometric turbidity units (NTUs).

Development should include the removal of a minimum of three well volumes.

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1 INTRODUCTION

1.1 Purpose and Applicability

This standard operating procedure (SOP) is concerned with the collection of valid and representative samples of groundwater from monitoring wells. The scope of this document is limited to field operations and protocols applicable during groundwater sample collection.

This SOP is written in a broad-based manner and considers the application of a variety of sampling equipment in the collection of representative groundwater samples. Respective state and/or federal agency regulations may require specific types of equipment to be used when applying this SOP to a particular project. The project manager should review the applicable regulatory requirements, if any, prior to the start of the field sampling program. Deviations from this SOP to accommodate regulatory requirements should be reviewed in advance of the field program and documented in the project work plan.

This SOP has been developed based on the Washington State Department of Ecology (Ecology) Standard Operating Procedure for Purging and Sampling Monitoring Wells plus Guidance on Collecting Samples for Volatiles and other Organic Compounds (Ecology 2014) and the Environmental Protection Agency Low Stress Purging and Sampling Procedures for Collection of Groundwater Samples from Monitoring Wells (EPA 2017).

1.2 Quality Assurance Planning

Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific QAPP. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements typically suggest the collection of a sufficient quantity of quality control (QC) samples such as field duplicate, equipment and/or field blanks and matrix spike/matrix spike duplicate (MS/MSD) samples. These requirements should be outlined in the QAPP. Additional information regarding quality assurance sample collection relevant to groundwater sampling is contained in Section 5.0 of this SOP.

1.3 Health and Safety Considerations

Groundwater sampling may involve chemical hazards associated with the materials being sampled. Adequate health and safety measures must be taken to protect project sampling personnel from potential chemical exposures or other hazards.

These measures must be addressed in the project Health and Safety Plan (HASP). This plan must be approved by the project Health and Safety Officer before work commences, must be distributed to all personnel performing sampling, and must be adhered to as field activities are performed.

2 RESPONSIBILITIES

2.1 Project Manager

The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOP and the project-specific work plan.

2.2 Sampling Technician

It is the responsibility of the sampling technician to be familiar with the sampling procedures outlined within this SOP and with specific sampling, quality assurance, and health and safety requirements outlined within project-specific work plans (Sampling Plan, HASP, and QAPP). The sampling technician is responsible for collection of groundwater samples and for proper documentation of sampling activities as samples are being collected.

3 REQUIRED MATERIALS

Groundwater sampling objectives may vary significantly between projects. Project objectives should be defined within the project-specific work plans. The list of required materials below identifies the types of equipment which may be used for a range of groundwater sampling applications. From this list, a project-specific equipment list should be selected based upon project objectives and other factors such as the depth to groundwater, well construction, required purge volumes, and analytical parameters, among others. The various types of sampling equipment which may be used include:

Well Purging Equipment

- Bailers
- Bladder pumps
- Submersible pumps
- Peristaltic pumps
- Centrifugal Pumps
- Waterra™ pumps

Field Instruments

- Individual or multi-parameter meter(s) to measure temperature, pH, specific conductance, dissolved oxygen (DO) oxidation reduction potential (ORP), and/or turbidity

- Water level measuring device

- Interface probe or product detection paste

Sampling Equipment

- Reusable or disposable bailers

- Peristaltic pump

- Bladder pump

Sample Preparation Equipment

- Filtration equipment

- Intermediate containers

- Sample kit (i.e., bottles, labels, preservatives, custody records, cooler)

General Equipment

- Project-specific sampling plans (SAP, QAPP, HASP)

- Sample collection records

- Field notebook/pen

- Waterproof marker pens

- Deionized water dispenser bottler

- Sample cup

- Buckets

- Coolers, or sample shuttles

- Instrument calibration solutions
- Power source (generator of 12V marine battery)
- Equipment decontamination supplies
- Health and safety supplies
- First-Aid kit
- Tool box

Expendable Materials

- Deionized water supply
- Disposable bailer string (nylon or polypropylene)
- 0.45 micron filters
- Paper towels
- Plastic sheeting
- Ice/blue ice for sample preservation
- Disposable latex powder-free glove liners
- Disposable nitrile gloves
- Plastic trash bags
- Ziplock® bags

This equipment list was developed to aid in field organization and should be used in preparation for each sampling event. Depending on the site-specific sampling plan, additional material and equipment may be necessary and should be determined before the scheduled sampling event. Similarly, not all of the items shown in this list may be necessary for any one sampling event.

4 Method

4.1 Free Product Determination

Wells that may potentially contain free product should be assessed for product with an interface probe or product detection paste. Interface probes generally operate on the same principle as a water level tape although they are designed to register water and product levels usually with different audible tones. Product paste generally is used in combination with some type of measuring tape which is lowered into the well with a coating of paste applied to it. Wells containing free product are generally not used for groundwater sampling, since the concentration of contaminants present in the free product can adversely affect the quality of the water sample, lending to a non-representative water sample.

4.2 Water Level Measurement

To obtain a water level measurement, lower the probe of a water level measuring device into the well until the audible sound of the unit is detected or the light on an electronic sounder illuminates. At this time the precise measurement should be determined (to nearest 0.01 feet) by repeatedly raising and lowering the tape to converge on the exact measurement. Obtain the reading of the TOC measuring point. The water level measurement should be entered on the Groundwater Sample Collection Record or in the field records.

The measurement device shall be decontaminated immediately after use with a non-phosphatic detergent and rinsed with distilled water. Generally, only that portion of the tape which enters the water table should be cleaned. It is important that the measuring tape is never placed directly on the ground surface or allowed to become kinked. Measuring devices, including interface probes, which come into contact with free product will likely require more thorough decontamination.

4.3 Purge Volume Calculation

Wells designated for sampling require purging to remove stagnant water in the well. A single casing volume of groundwater will be calculated after measuring the length of the water column and checking the well casing diameter.

The amount of standing water can be calculated using a variety of methods. One equation is:

Well volume: V = 0.041 x HD2 = ____ gallons, where

- V is volume of water in the well, in gallons,
- H is height of water column in well (i.e. total well depth – measured depth to water), in feet, and
- D is the inside diameter of the well casing, in inches

4.4 Well Purging Methods and Procedures

4.4.1 Objectives

Prior to sample collection, purging must be performed for all groundwater monitoring wells to remove stagnant water from within the casing and gravel pack and to ensure that a representative groundwater sample is obtained.

There are three general types of non-dedicated equipment used for well purging and include: bailers, surface pumps and down-well pumps. The purge method and equipment selected should be specified in the project-specific work plans.

NOTE: This SOP only describes the most common equipment and methods used for purging. Other purging equipment, as well as dedicated equipment, can be used provided that the method employed does not have an adverse effect on the overall quality of the groundwater.

Regardless of the purge method, purge water temperature, pH, and specific conductance will be monitored at predetermined purge volumes and recorded on the Groundwater Sample Collection Record. Additional water quality parameters may be required by the project-specific sampling plan. In general, purging will be considered complete following the withdrawal of at least 3 to 5 well volumes of groundwater and when all field parameters have stabilized.

Purging a well to dryness may occur under some low-yield conditions or tidal conditions. When the well recovers, a cascading effect may occur within the screened zone which can volatilize some organic compounds. This may be considered inappropriate by regulatory agencies when volatile organic compounds (VOC) are the target analyte of interest. Purging a well to dryness, then sampling after it has recovered may be acceptable for other target analytes, however. Under low yield conditions, low-flow sampling pumps such as bladder pumps may be required for VOC sample collection.

4.4.2 Bailing

General

Bailing is often the most convenient method for well purging especially if only a small volume of purge water is required during the purge routine. Bailers are constructed using a variety of materials including PVC, polyethylene, stainless steel, and Teflon®. Teflon® bailers are generally most "inert" and are available in reusable and disposable form. Disposable polyethylene bailers are relatively inert and inexpensive. Reusable stainless steel and PVC bailers must be decontaminated between uses. Most commercially available bailers are constructed to fit into a 2-inch diameter well, although other bailer diameters are available.

Waterra™ foot valves are essentially bailer check valves which manually thread onto the bottom of standard pump tubing (polyethylene, Teflon®). The foot valves are commercially available in a variety of diameters in stainless steel, Teflon®, and high-density plastic (Delrin). The foot valves operate by manually or mechanically raising and lowering the valve assembly within the water column which raises the water level within the discharge tube. Flow rates usually in the vicinity of 1 gallon per minute can be achieved with these devices.

Measurements of the pumping rate, temperature, pH, and specific conductance (and/or other parameters as required) should be made after each purge volume is removed and documented on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been withdrawn and the field parameters have stabilized to within 10% of their preceding measurement. Project-specific sampling objectives may require that the sample be collected with a bailer.

Bailing presents two potential problems with well purging. First, increased suspended solids may be present in samples as a result of the turbulence caused by raising and lowering the bailer through the water column. High solids concentrations may affect sample representativeness. Second, bailing may be less feasible for deep wells or wells which require a large volume of water to be removed during purging because of the time involved with continuous insertion and removal/emptying of the bailer.

Bailing Procedure

Obtain a clean bailer and a spool of clean polypropylene or nylon bailer cord. Uncover the top end of the bailer and tie a bowline knot, or equivalent, through the bailer loop. Test the knot and the bailer itself to ensure that all knots and parts are secure prior to inserting the bailer into the well.

Remove the protective wrapping from the bailer, and lower the bailer to the bottom of the monitoring well and cut the cord at a proper length. Bailer rope should never touch the ground surface at any time during the purge routine. Tie a hand loop at the end of the bailer cord.

Raise the bailer by grasping a section of cord using each hand alternatively in a "rocking" action. This method requires that the sampler's hands be kept approximately 2-3 feet apart and that the bailer rope is alternately looped onto or off each hand as the bailer is raised and lowered.

Grab the bailer with one hand as it emerges from the well. Pour the bailed groundwater from the bailer into a graduated bucket to measure the purged water volume. Repeat this procedure until one complete purge volume of water is removed from the well.

At the end of one complete well purge volume, place a small of purged water into a sample cup. Measure temperature, pH and specific conductance (and for other assigned parameters) and record the results on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been withdrawn and the specific field parameters have stabilized to within 10% of their preceding measurement.

4.4.3 Surface Pumps

General

Well purging using pumps located at the ground surface can be performed with peristaltic or centrifugal pumps if the water level in the well is within approximately 20 feet of the top of the well.

Peristaltic pumps provide a low rate of flow typically in the range of 0.02-0.2 gallons/minute (75-750 ml/min). For this reason, peristaltic pumps are not particularly effective for well purging. Peristaltic pumps are suitable for purging situations where disturbance of the water column must be kept minimal for particularly sensitive analyses.

Centrifugal pumps are designed to provide a high rate of pumping, in the range of 5 to 40 gallons/minute (gpm), depending on pump capacity. Discharge rates can also be regulated somewhat, provided the pump has an adjustable throttle. These pumps also require polyethylene or Teflon®-lined polyethylene tubing as suction line. The pump may also require priming to initiate flow.

Peristaltic Pump Procedure

Attach a new suction and discharge line to the peristaltic pump. Silicon tubing must be used through the pump head and must meet the pump head specifications. A second type of tubing may be attached to the silicon tubing for use as the suction and discharge continuous discharge. If drawdown causes the discharge to stop, the suction line will be lowered very slowly further down into the well until pumping restarts.

Measurements of temperature, pH and specific conductance (and/or other assigned parameters) should be made after each well purge volume and documented on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been removed and the specific field parameters have stabilized to within 10% of their preceding measurement. Project-specific sampling objectives may require that the sample be collected with a bailer.

Measure the length of the suction line and lower it down the monitoring well until the end is in the upper foot or more of the water column. Start the pump and direct the discharge into a graduated bucket. Adjust the pumping rate with the speed control knob so that a smooth flowing discharge is attained.

Centrifugal Pump Procedure

Attach a new suction and discharge line to the centrifugal pump. Start the pump and record the stabilized rate of discharge. As with other well purging systems, measurement of temperature, pH, and specific conductance (or other parameters as required) will be made after each well purge volume has been removed. These measurements shall be recorded on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been removed and the field parameters have stabilized to within 10% of their preceding measurement. Project-specific sampling objectives may require that the sample be collected with a bailer.

4.4.4 Down-Well Pumps

Groundwater withdrawal using non-dedicated down-well pumps may be performed with a submersible pump or a bladder pump.

Electric submersible pumps provide an effective means for well purging and in some cases sample collection. Submersible pumps are particularly useful for situations where the depth to water table is greater than 20 feet and where the depth or diameter of the well requires that a large purge volume be removed before sample collection.

Commonly available submersible pumps include the Johnson-Keck pump model SP-82, the Grundfos Ready-Flow 2 pump, and disposable marine galley pumps, all of which are suited for operation in 2-inch or larger internal diameter wells.

Recently, the use of bladder pumps (positive gas-displacement pumps) has been promoted by the EPA for use in well purging and sampling primarily because the pumps can be operated at low flow rates (less than 1 liter per minute). Bladder pumps generally reduce the potential turbidity of the sample and theoretically reduce the potential for loss of VOC constituents, ultimately providing a more representative groundwater sample. Use of bladder pumps may require additional time for purging and sampling because of the low flow rate. Please note, however, that when using bladder pumps, it may not be necessary to purge an entire well volume of water prior to each check of the water quality parameters. Well purging is accomplished at such a low rate that, theoretically, the influent flow into the pump represents groundwater flow through the well screen, thereby eliminating the requirement for purging several entire well volumes of water before sample collection.

Bladder pumps usually consist of a stainless steel pump housing with an internal Teflon® or polyethylene bladder. Discharge tubing is generally made from Teflon®, polyethylene, or Teflon®-lined polyethylene. The pump is operated by lowering it into the water column within the well screen, then pulsing air into the bladder with an air compressor and pump controller unit. Pumps and controllers are often not interchangeable between manufacturers; therefore, it is usually necessary to have both items provided by the same manufacturer. Pump bladders are generally field-serviceable and replaceable.

A check of well condition may be required prior to inserting any down-well pump if the well has not been sampled for some time or if groundwater quality conditions are not known. The well condition check should include a check of casing plumbness as a bent well casing could cause a pump to get stuck. Casing plumbness can be checked by lowering a clean cylindrical tube with the approximate pump dimensions into the well. If the well casing is not plumb then an alternative purging method should be used.

The well inspection should also include a check of air quality or headspace conditions within the well for potentially explosive gasses and a check for free product which could foul the pump. Well casing headspace conditions can be monitored with a photoionization detector (PID) and/or an explosimeter for the presence of potentially explosive gasses. If potentially hazardous conditions exist, then an alternative purging method should be used. In general, it is rare for explosive conditions to be present.

The presence of free product should be determined before inserting the submersible pump into the well because free product may contaminate the pump's internal mechanisms making it extremely difficult to decontaminate. An interface probe should be used to check for free product.

Electric Submersible Pump Procedure

Once the above well conditions have been assessed, and assuming it's safe to precede, slowly lower the submersible pump with attached discharge line into the monitoring well taking notice of any roughness or restriction within the well riser pipe. The pump should be placed in the uppermost section of the static water column of the monitoring well. The power cord should be attached to the discharge line with an inert material (i.e., zip-ties) to prevent the power cord from getting stuck between the pump, discharge line, and the well casing. Secure the discharge line and power cord to the well casing, using tape or a clamp, taking care not to crimp or cut either the discharge line or power cord.

Connect the power cord to the power source (i.e., rechargeable battery pack, auto battery, or generator) and turn the pump on. Voltage and amperage meter readings on the pump controller (if provided) should be monitored closely during purging. The operations manual for the specific pump used should be reviewed regarding changes in voltage/amperage and the potential impacts on pump integrity. Pumping should be discontinued if warning conditions occur and/or if the well is pumped to where drawdown falls below the pump's intake level.

If drawdown continues to the extent that the well is pumped dry, the pump should be shut off and the well allowed to recharge. This on/off cycle may be necessary in order to purge the well properly.

Measurements of the pumping rate, temperature, pH, and specific conductance (and/or other required parameters) should be made after each purge volume is removed and documented on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been withdrawn and the field parameters have stabilized to within 10% of their preceding measurement. Project-specific sampling objectives may require that the sample be collected with a bailer.

Bladder Pump Procedure

To operate the bladder pump system, the pump and discharge line should be lowered into the well close to the bottom of the well screen, and then secured to the well casing with a clamp. The air compressor should then be turned on to activate pumping. The pump controller is used to vary the discharge rate to the required flow.

Measurements of the pumping rate, temperature, pH, and specific conductance (and/or other required parameters) should be made at periodic intervals while water is removed and documented on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required field parameters have stabilized to within 10% of their preceding measurement. Generally, because of the low flow rate, samples are usually obtained from the bladder pump discharge line.

4.5 Sample Collection Methods and Procedures

4.5.1 Objectives

Groundwater samples can be collected using similar methods employed for purging, provided these methods do not adversely affect the quality of the groundwater. These methods include bailing, surface pumping and down-well pumping.

In most cases during sampling, groundwater will be transferred to the appropriate containers directly for the discharge source. During transfer, discharge tubing and other equipment shall not contact the inside of the sample containers. In addition, a clean pair of nitrile or latex gloves will be worn during sample collection and handling.

As a general rule of thumb, samples should be collected in order of decreasing volatilization of the target parameters. The preferred order of sample collection is as follows: volatile organic compounds, extractable organic compounds (e.g., semi-volatile organic compounds, PCBs, pesticides), metals, and general water chemistry (ions and turbidity).

4.5.2 Bailers

The methods and procedures described in this section also apply to collecting groundwater samples with a bailer. If a bailer was used to purge the well, the same bailer may be used for sampling. If other well purging equipment was used, a decontaminated or new disposable bailer should be used for sampling.

When volatile organic compounds are the target sampling parameter, a bottom discharge tip should be used during sample transfer. A discharge tip restricts the outflow of the sample from the bailer and diminishes the potential for volatilization. Reusable bailers may require a special screw-on tip fitted with a bottom discharge top. Disposable bottom discharge tips are usually supplied with disposable bailers.

Bailer cord shall be discarded after sampling is completed. Disposable bailers should only be used in one well. Reusable bailers should be appropriately decontaminated between uses.

4.5.3 Surface Pumps

The methods and procedures described in this section for peristaltic and centrifugal pumps also apply to groundwater sample collection.

Peristaltic Pumps

Peristaltic pumps equipped with the appropriate type tubing will be used to collect groundwater from wells in which the water resides at a depth less than 20 feet. Sample bottles shall be filled directly from the pump's discharge line and care shall be taken to keep the discharge tube from contacting the sample container.

Groundwater samples requiring filtration prior to placement in sample containers can be placed in intermediate containers for subsequent filtration, or may be filtered directly with in-line disposable 0.45-micron filters.

After sampling is complete, all used tubing and filters shall be disposed of appropriately.

Centrifugal Pumps

Centrifugal pumps are generally not recommended for use in sample collection, especially when volatile organic compounds are the target analyte of interest. Samples for other analytes, however, may be obtained with use of an in-line sample trap. It is suggested that if samples cannot be obtained before going through the pump, that samples be obtained by using a bailer once purging is complete and pumping has ceased. Collecting samples from the pump discharge is not recommended.

After sampling is complete, all suction line tubing should be disposed of properly.

4.5.4 Down-Well Pumps

Electric Submersible Pump

Using the pump methods described in Section 4.9.4, groundwater samples can be collected directly from the pump discharge line, provided the discharge line is composed of inert material. Sample bottles will be filled directly from the discharge line of the pump. This method is generally not recommended for collection of volatile organic samples.

Bladder Pumps

Groundwater samples, including those collected for VOC analysis may be collected directly from the pump discharge tubing under active pumping conditions. Sample bottles will be filled directly from the discharge line of the pump.

After sampling is complete, the pump, discharge line and power cord shall be decontaminated and/or disposed of as required by the project-specific work plan.

Low Volume and Poor Recovery Wells - Purging and Sampling Procedures

Even with a low pumping rate, some wells experience significant drawdown or in extreme cases may even purge dry. Slow recovering wells or wells that purge dry require extra care in order to be purged and sampled with minimal disturbance to the water column and fine materials in and around the well screen.

For low volume and poor recovery wells, review past field data sheets if available for previous purge rates, amounts of drawdown, and purge volume prior to sample collection. Measure the well's water level. If you suspect the well may be low yielding, calculate the amount of standing water in one well volume as described in step 4.3.

If the well is not equipped with a dedicated sampling system, install a decontaminated pump or pump tubing. Slowly lower the equipment through the water column to avoid stirring up particulates. The final pump intake depth should be near the bottom of the screened interval. To prevent stirring up particulates it is important not to touch the well bottom. Record the intake depth on the field data sheet.

Once the pump or pump tubing is in place, slowly lower the water level probe back into the well. It is important to frequently measure the water level throughout purging in low volume or poor recovery wells to enable the pump rate to be adjusted downward if necessary.

Start purging at a rate less than 0.5 liter per minute if the pump capacity allows. Record the pump rate on the field data sheet. At regular intervals record field parameter values, water level, time of measurement, and amount of purge water discharged. Allow at least one complete exchange of water in the flow cell between measurements. Note and provide qualifying remarks if parameter readings are anomalous, the water level is dropping or if at some point the water level stabilizes. Record observations on the pumped waters appearance (e.g. clarity, odor, etc.) during purging and sampling. Continue purging until field parameters stabilize.

Attempts should be made to avoid purging low yielding wells dry. However, if this is not possible shut the pump off and allow the well to recover at least once before collecting samples. This generally constitutes an adequate purge, and the well can be sampled as soon as it has recovered sufficiently to produce an adequate volume of water to fill the sample containers. If time permits, purge the well a second time and allow it to recover before sampling. Samples should be collected within 24 hours of the final purge/recovery cycle.

It should be noted that there can be significant alterations in groundwater chemistry when a well is purged dry and allowed to recover before sampling. Groundwater chemistry can change as formation water surrounding or entering the screened interval of the well is exposed to air which can affect volatile organics and redox sensitive analytes. Increased turbidity can also be an issue when sampling metals and some general chemistry parameters (Ecology 2014). Collect samples once field parameters stabilize and any end of purge analysis has been conducted.

If the well has been purged dry and allowed to recover, field parameters should be measured after sample collection if there is an adequate volume of water. Sample containers should be filled in the order specified in the project QAPP. However, when sampling low-yielding wells which may not have a sufficient volume of water to fill all the sample containers, the relative importance of each analyte should be evaluated. Samples for analytes of most interest should be collected first.

4.6 Sample Filtration

Groundwater samples collected for total dissolved metals analyses will be filtered prior to being placed in sample containers and properly preserved. Groundwater filtration will be performed using a peristaltic pump and a 0.45-micron in-line water filter. Disposable filters are commonly available in 0.45-micron size. Low-capacity or high-capacity cartridges are available and may be selectively used based on sample turbidity.

The filtration of groundwater samples shall be performed either directly from the pump discharge line or from laboratory-supplied intermediate containers. In either case, well purging shall be performed first. Fresh groundwater shall then be filtered directly into sample containers.

4.7 Sample Handling

All samples collected should be packaged and handled according to ensure no breakage during shipping. Preservatives should be used where analytical methods require preservation. The QAPP will indicate the type of sample preservation necessary.

5 QUALITY CONTROL

5.1 Field Blank/Equipment Blank Sample Collection

Field blank samples serve as a quality assurance check of equipment and field conditions at the time of sampling. Field blank samples are usually prepared by transferring analyte-free water into a clean set of sample containers, then analyzing it as a sample. Sometimes, the analyte-free water is transferred over or through the sampling device before it is placed into the sample containers. This type of field blank sample is known as an equipment blank. The QAPP contains specific information regarding the type and number of field blanks or equipment blanks required for collection.

5.2 Field Duplicate Sample Collection

Field duplicate samples are collected for the purpose of providing two sets of results for comparison. These samples are used to assess precision. Duplicate samples are usually prepared by splitting the sample into two sets of sample containers, then analyzing each set as a separate sample. The QAPP contains specific information regarding the type and number of duplicate samples for collection.

5.3 MS/MSD Sample Collection

MS/MSDs provide information about the effect of the sample matrix on digestion and measurement methodology. For samples submitted for MS/MSD analysis, triple sample volume is generally required (contact the analytical laboratory for information specific to the project analytical parameters). The QAPP contains specific information regarding the frequency of MS/MSD samples.

6 DOCUMENTATION

Specific information regarding sample collection should be documented in several areas: the sample chain-of-custody record, sample collection record, field notebook, and sample labels, tags. Additional information regarding each form of documentation is presented in the following paragraphs:

6.1 Sample Chain-of-Custody Record

This ENSR standard form requires input of specific information regarding each collected sample for laboratory analytical purposes. The information requested includes site name and location, project number, field notebook reference, collection date and type of analysis requested. Each sample submitted for analysis is also listed individually using its field identification number, number and type of container, and requested analyses.

6.2 Groundwater Sample Collection Record

This form (Attachment 1 or 2) requires input of specific information regarding the collection of each individual sample including sample identification, water quality parameters, collection method, and containers/preservation requirements.

6.3 Field Logbook

This logbook should be dedicated to the project and should be used by field personnel to maintain a general log of activities throughout the sampling program. This logbook should be used in support of, and in combination with, the sample collection record. Documentation within the logbook should be thorough and sufficiently detailed to present a concise, descriptive history of the sample collection process.

6.4 Sample Labels/Tags

Sample labels shall be completed at the time each sample is collected and attached to each sample container. Labels will include the information listed below.

- Client or project name/project number
- Sample number
- Sample designation
- Analysis type
- Preservative
- Sample collection date
- Sample collection time
- Sampler's name

7 TRAINING/QUALIFICATIONS

Groundwater sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling attempts be supervised by more experienced personnel. Sampling technicians should be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials are considered to be present.

8 REFERENCES

Washington State Department of Ecology (Ecology) Standard Operating Procedure for Purging and Sampling Monitoring Wells plus Guidance on Collecting Samples for Volatiles and other Organic Compounds. Version 2.0. January 27, 2014.

EPA, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, EQASOP-GW4. Revised September 19, 2017.

EPA, Handbook for Sampling and Sample Preservation of Water and Wastewater, EPA-600/4-82-029, September 1982.

EPA, RCRA Groundwater Monitoring Technical Enforcement Guidance, November 1992.

Geotrans, Inc., RCRA Permit Writer's Manual, Groundwater Protection, prepared for the U.S. EPA, Contract No. 68-01-6464, October 1983.

Code of Federal Regulations, Chapter 40 (Section 261.4(d)).

Low Flow Groundwater Sample Collection Record

Date:	**Well ID:**
Project Name:	**Location:**
Project Number:	**Collector(s):**
Start Time:	**End Time:**

Water Level Data

Total Well Depth:		Water Table Depth:	
Screen Interval:		Tubing Placement Depth:	
Well Volume		**Well Volume = 3.14*(R^2*H*(CF)** R= Radius (feet), 2 inch = 0.17 feet H = Height of the water column CF = conversion factor = 7.48 gal/ft3	
Purge Method:		Purge Rate:	

Water Quality Parameters

Time (24 hr)	Vol. Purged (L)	Temp (C)	pH	Spec. Cond (uS/cm)	DO (mg/L)	ORP (mv)	Turbidity (NTU)	Flow Rate (ml/min)	DTW	Color/ Odor

Acceptance Criteria defined:									
Temp	3%	pH	+/- 1.0 unit	Spec. Cond	3%	DO	10%		
Turbidity	<5 NTU*	ORP	+/- 10 MV	Drawdown	<0.3'*				
Sample Collection:							Duplicate Details:		

*Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. If after 2 hours of purging indicator field parameters have not stabilized, discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization.

Attachment 3

Health and Safety Plan

JENSEN'S SHIPYARD AND MARINA, HEALTH AND SAFETY PLAN

1293 Turn Point Road, Friday Harbor, Washington

June 2022

Prepared for:
Port of Friday Harbor

Prepared by:

CRETE CONSULTING, INC.

Crete Consulting Incorporated, PC
16300 Christensen Road, Suite 214
Tukwila, WA 98188
www.creteconsulting.com

JENSEN'S SHIPYARD AND MARINA, HEALTH AND SAFETY PLAN

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Acronyms and Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
APR	air purifying respirator
BEHP	bis(2-ethylhexyl)phthalate
CRETE	CRETE Consulting, Inc.
CRZ	contaminant reduction zone
EPA	United States Environmental Protection Agency
HASP	Health and Safety Plan
HEPA	high-efficiency particulate air
IDHL	immediately dangerous to health and life
IP	ionization potential
JHA	job hazard analysis
kV	kilovolt
MSDS	material safety data sheet
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PFD	personal floatation device
PID	photoionization detector
PPE	personal protective equipment
REL	reasonable exposure limit
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
STEL	short-term exposure limit
SVOC	semivolatile organic compound
TCE	trichloroethene
TPH	total petroleum hydrocarbons
TLV	threshold limit value
TWA	time weighted average
UST	underground storage tank
VOC	volatile organic compound
WAC	Washington Administrative Code

1 Introduction

The Uplands Area Sampling and Analysis Plan describes sampling to be conducted at the Jensen's Marina and Shipyard as part of the Remedial Investigation (RI) for the Port of Friday Harbor (Port). This Health and Safety Plan (HASP) describes the health and safety protocols to be used during activities at completed at Jensen's Marina and Shipyard (Site).

The Subcontractors, such as drillers, involved in this work will follow their own HASPs. CRETE Consulting, Inc. (CRETE) will oversee the well/soil drilling, and Geoprobe boring, and CRETE will collect soil and groundwater samples from the Site. This plan was written by CRETE, who will subcontract the drillers to perform concurrent work on the Site. This HASP is unique to activities to be performed by CRETE staff/field managers. General site information is summarized in Table 1-1. Background information pertaining to site history and general hazards is listed in Table 1-2.

In addition to the requirements set forth in this HASP, Crete personnel shall comply with the HASPs and related protocols of all onsite Contractors and any health and safety protocols required by the Port of Friday Harbor.

1.1 Site Safety Plan Acknowledgment and Acceptance

The Field Manager shall be responsible for informing all individuals assigned to work on the Site as part of RI activities outlined in the SAP, or who visit the site within the exclusion or contaminant reduction zones, of the contents of this HASP and for ensuring that each person signs the Site Safety Plan Acknowledgment Form (Appendix A). By signing the Site Safety Plan Acknowledgment Form, individuals recognize the site health and safety hazards, known or suspected, and will adhere to the protocols required to minimize exposure to such hazards. Subcontractors will also adhere to their own HASPs related to the work they are performing, e.g., safe drill operation.

All visitors who enter the work zone are required to sign in and sign out with the Field Manager (Appendix B).

1.2 Site Health and Safety Meetings

A pre-work meeting addressing site-specific health and safety issues shall be held on the first day of mobilization to the site and prior to the commencement of any work activities. Mandatory attendance is required for all personnel assigned to the particular tasks for which the equipment was mobilized. For example, a work meeting with the drilling operators may occur at a different time than the meetings with other Subcontractors, as these activities may be performed on different days and each have their own mobilization events. The intent of these meetings is to discuss the site-specific health and safety issues (such as known or suspected contaminants, underground utilities, etc.), not to discuss activity-specific (such as well installation) health and safety issues.

At the conclusion of the meeting, personnel are to sign the Site Safety Plan Acknowledgment Form in Appendix A, indicating their attendance and understanding of the health and safety protocols. As additional personnel are assigned to the site, it is the responsibility of the Field Manager to ensure that new personnel are briefed on site-specific health and safety information and that they also have signed the Site Safety Plan Acknowledgment Form (Appendix A).

Daily tailgate meetings will be held by the Field Manager or field staff in charge of the day's activities, and attendance will be documented in the tailgate meeting form Appendix C).

1.3 Training Requirements

All personnel assigned to work on this site beyond the support zone must have successfully completed 40 hours of Training for Hazardous Waste Site Work, in accordance with Occupational Safety Health Act (OSHA) 29 CFR 1910.120(e)(3), and must be current with their 8-hour Refresher Training, in accordance with OSHA 29 CFR 1910.120(e)(8).

Personnel managing or supervising work on site must also have successfully completed 8 hours of Manager/Supervisor Training, meeting the requirements of 29 CFR 1910.120(e)(4). Documentation of CRETE staff training is maintained in each company's respective databases. Each contractor must maintain documentation of OSHA training for personnel working on site.

Any exceptions to the training requirements will be explicitly specified either in this HASP or through a HASP amendment.

1.4 Medical Monitoring Requirements

All personnel, including subcontractors, assigned to work on this site beyond the support zone 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 within the past 24 months, be medically cleared to work on hazardous waste sites, and be capable of wearing appropriate personal protective equipment (PPE), including any respiratory protection.

Any exceptions to the medical monitoring requirements will be explicitly specified either in this HASP or through a HASP amendment.

1.5 Fit Testing Requirements

All CRETE personnel assigned to work on this site beyond the support zone must be familiar with the requirements in the OSHA respiratory standard (29 CFR 1910.134). All personnel who are required to wear respiratory protection must have successfully passed a respirator fit test within the past 12 months. Personnel who do not have a current fit test are prohibited from working in areas where any potential exists for exceeding OSHA

Permissible Exposure Limits (PEL). Documentation of a successful respirator fit test for the appropriate type of respirator needed for this work (half-face) must be maintained by each contractor performing onsite work. The Field Manager will check that the respirator being worn by personnel is the same size, make, and model as that specified on any respirator fit test records from the past 12-month period.

1.6 Project Staff Responsibilities

The Field Manager is responsible for overall project administration and for coordinating health and safety protocols and procedures for all onsite CRETE personnel at all times. All applicable United States Environmental Protection Agency (EPA), OSHA, state, and local health and safety requirements shall be followed throughout the course of the project. This HASP covers only CRETE personnel onsite. Any person who observes health and safety problems or infractions should immediately report the problem or infraction to appropriate personnel.

1.7 Access to Employee Exposure and Medical Records

OSHA provides employees and their designated representatives a right-of-access to relevant exposure and medical records (29 CFR 1910.20). The "Notification of Access to Employee Exposure and Medical Records" (Appendix D) is to be made accessible to all employees involved with these field operations.

1.8 Hazard Communication

The Field Manager will advise all CRETE personnel assigned to this site of the hazards associated with working onsite and of the methods to mitigate those hazards and prevent exposures. This information will be presented to personnel prior to initiation of any field activities. The following information regarding site contaminants or any chemicals brought to the site to conduct the work will be presented to site personnel prior to conducting any field work:

- Material Safety Data Sheets (MSDS; Appendix E),
- Chemical/physical hazards,
- Appropriate PPE for protection from exposure,
- Labeling.

Table 1-1 General Information

Client: Leon Environmental	**Port Project no. 040-001**
Site Name: Jensen's Marina and Shipyard	
Site Location: 1293 Turn Point Road, Friday Harbor, Washington	
Description of Field Activities: Site inspection, soil and groundwater sample collection, soil boring installation, monitoring well installation.	
Dates of Field Activities: 2022 through 2023	
Project Manager: Grant Hainsworth, CRETE	**Project Manager Telephone Number: 253-797-6323**
QA Officer: Jamie Stevens, CRETE	**Office: Seattle**
Field Manager: Rusty Jones, CRETE	
The following requirements have been fulfilled for each employee to work onsite: ☒**Completed OSHA 40-Hour HAZWOPER Training** ☒**Current OSHA 8-Hour HAZWOPER Refresher (within last 12 months)** ☒**Current Medical Surveillance Examination (within last 12 months)** ☒**Current Respirator Fit-test (within last 12 months)** ☒**Current First Aid and CPR Training (within last 2 years)** **Note:** CRETE employees may not enter a site beyond the support zone unless the training/qualifications listed above are current.	

Table 1-2 Site Background

<table>
<tr><td colspan="4">Overall Hazard Is:</td></tr>
<tr><td>High: ☐</td><td>Low: ☐</td><td>Moderate: ☒</td><td>Unknown: ☐</td></tr>
<tr><td colspan="4">Facility Description: Older small buildings/structures and unknown subsurface soil fill are present. The property contains buried debris, surface debris, and buildings that may be unsafe to enter. The upland portion of the site encompasses approximately 4.88 acres, and the aquatic lands (including piers and docks) encompass approximately 5 acres. The aquatic lands are located within Shipyard Cove, Friday Harbor. The upland portions of the facility are owned by Port of Friday Harbor.</td></tr>
<tr><td colspan="4">Status: Site is currently used for boat building and boat repairs.</td></tr>
<tr><td colspan="4">Unusual Features (containers, dikes, buildings, power lines, terrain, etc.): The site is located on Shipyard Cove, and a pier is present.</td></tr>
<tr><td colspan="4">Site History (worker injury, complaints, regulatory agency action): Past environmental investigations have been completed and have confirmed that contamination is present.</td></tr>
<tr><td colspan="4">Potential Waste Types: Soil and groundwater contamination.</td></tr>
<tr><td>Liquid: ☒</td><td>Solid: ☒</td><td>Sludge: ☒</td><td>Debris: ☒</td></tr>
<tr><td colspan="4">Characteristics:</td></tr>
<tr><td>Corrosive: ☒</td><td>Ignitable: ☐</td><td>Volatile: ☒</td><td>Toxic: ☒</td></tr>
<tr><td>Reactive: ☐</td><td>Unknown: ☒</td><td>Radioactive: ☐</td><td>Other (name): ☐</td></tr>
<tr><td colspan="4">Hazards posed by site activities (Job Hazard Analysis in Appendix F): Soil sample results indicated that portions of the site are contaminated with metals (primarily arsenic, cadmium, copper, lead, mercury, and zinc), petroleum compounds, and carcinogenic polycyclic aromatic hydrocarbons (cPAHs).
Sediment sample results indicated that marine sediments (particularly near the shore) are contaminated with metals (primarily copper, zinc, and mercury), PAHs, polychlorinated biphenyls (PCBs), phthalates, pesticides, and tributyltin.
Groundwater is contaminated with arsenic and copper.</td></tr>
<tr><td colspan="4">Unusual Hazards: Buried debris along shoreline areas.</td></tr>
</table>

2 Health & Safety Risk Analysis

This section identifies the specific hazards associated with the remedial investigation work and presents an analysis of documented or potential chemical hazards at the site. Every effort must be made to reduce or eliminate exposure to these hazards. Hazards that cannot be eliminated must be abated by use of engineering controls and/or PPE.

2.1 Hazard Analysis Requirements

2.1.1 Job Hazard Analysis

A Job Hazard Analysis (JHA) Form (Appendix F) is a basic tool that allows personnel to think through the steps involved in each job and discuss how to complete the job safely prior to mobilizing to the field. Each JHA accomplishes the following:

- Breaks a job down into individual steps
- Lists the safety hazards in each step
- Lists appropriate precautions to be followed for each hazard and safety resources (PPE, equipment, permits, etc.) to be obtained and coordinated.

Completion of a JHA requires thoroughness and attention to detail, as well as input of all those who participate in the job. As part of this HASP and prior to commencement of work, initial JHA forms (Appendix F) for soil sample collection and well installation have been completed and reviewed by the QA Officer. Each JHA will be modified if job scope or conditions change. If additional tasks are added to the scope of work in the field, a new JHA will be completed and approved by the QA Officer prior to the commencement of those additional tasks.

2.2 Precautions When Working Around Heavy Equipment

The following precautions will be taken to minimize heavy equipment hazards:

- All heavy equipment must have back-up alarms or spotters during back-ups.
- Personnel must make eye contact with the operator before approaching the equipment and remain safely outside the swing radius of the equipment.
- Personnel must wear orange visibility vests in addition to standard Level D PPE.
- Personnel must never stand on track-hoe tracks to communicate with the operator.
- Operators must be aware of personnel in the area and use proper hand signals before maneuvering.
- Operators must wear hard hats when operating machines and when going to and from their equipment.
- Operators must use spotters and be cautious when maneuvering equipment within 15 feet of overhead power lines and utility pole guy wires, and maintain safe distances at all times (greater than 10 feet).

- Provisions will be made to prevent the unauthorized start-up of equipment when personnel leave the site at the end of the shift, such as battery ignition locks.

2.3 General Site Hazards

2.3.1 Shoreline/Tides

Project activities including drilling and collection of samples will occur in steep, potentially unstable shoreline areas. Shipyard Cove, Friday Harbor is tidally influenced, and water levels along the shoreline can vary widely throughout the day. Although most work will occur above the mean higher high water level, care should be taken to avoid trips/slips while working in this area, and field staff should be aware of the level to which water is expected to rise during high tides. Water marks along the shoreline typically denote the average high tide level.

2.3.2 Lighting

Work areas must have adequate lighting for employees to see to work and identify hazards (5-foot candles minimum, comparable to a single 75- to 100-watt bulb). Personnel should have flashlights or headlamps available in all indoor or dimly lighted areas for use in the event of a power failure, or if working outdoors after daylight hours. Applicable OSHA standards for lighting (29 CFR 1910.120(m)) shall apply. All Remedial Investigation work is expected to occur outside during daylight hours, or dawn/dusk hours, if necessary.

2.3.3 Electrical Power

All electrical power must have a ground fault circuit interrupter as part of the circuit, including generators. All equipment must be suitable and approved for the class of hazardous atmosphere in which it is being used. Applicable OSHA standards for electric power (29 CFR 1910 Subpart S) shall apply.

2.3.4 Lockout/Tagout

Operations where the unexpected energization, or start-up of equipment, or release of stored energy could cause injury to personnel will be protected by the implementation of a lockout/tagout program meeting the requirements of 29 CFR 1910.147. Subcontractors are responsible for shutting down/locking down equipment when not attended, such as during lunch breaks or extended shutdowns.

2.3.5 Fall Protection

Work site slip, trip, and fall accidents can result in serious injuries or fatalities. Procedures to help prevent these types of incidents will be implemented. Elevated work (above 4 feet) where a fall potential exists will be performed using appropriate ladders and/or fall protection (i.e., body harness, lifeline, etc.) Applicable OSHA standards for fall protection (29 CFR 1910.21 through 29 CFR 1910.32) shall apply. No work is expected to be performed on ladders. However, debris exploration will occur on or near steep riverbank slopes.

2.3.6 Drum Handling

The movement, opening, handling, and storage of drums will be conducted in accordance with 29 CFR 1910.120(j). See Section 8 more details.

2.3.7 Cold Stress

When the temperature falls below 40°F, cold stress protocols shall be followed. Employees must be supplied with adequate clothing to maintain core temperature. Cold stress is discussed in detail in Appendix G.

2.3.8 Eye Wash Protection

All operations involving the potential for eye injury, splash, etc., must have approved eye wash units locally available as per 29 CFR 1910.151(c).

2.3.9 Hearing Protection

When the noise level of any operation exceeds the 8-hour Time Weighted Average (TWA) of 85 decibels (dB), a hearing protection program meeting the requirements of 29 CFR 1910.95 will be implemented.

2.3.10 Fire Prevention

Operations involving the potential for fire hazards shall be conducted in a manner that minimizes the risk. Non-sparking tools and fire extinguishers shall be used or available as required. Sources of ignition shall be removed. When necessary, explosion-proof instruments and/or bonding and grounding will be used to prevent explosion and/or fire.

2.3.11 Utilities

All underground utility hazards shall be identified and/or inspected prior to conducting operations involving potential contact. Some work will occur where numerous current and historical utilities exist, and special caution should be exercised in all ground disturbing work. Utility locate requests (Dig Tickets) will be submitted and verified completed prior to work being conducted. Locate request documentation will be maintained by the Field Manager and provided to all employees upon request.

2.3.12 Confined Space Entry

If any operation is conducted in an area classified as a permit-required confined space by OSHA, a "Confined Space Entry Permit" will be completed and all applicable procedures meeting the requirements of 29 CFR 1910.146 will be implemented. No confined space work is to be conducted under the scope of this HASP. Confined space entry will require an amendment to this HASP, and verification of applicable training by all personnel involved.

2.3.13 Overhead Utilities and Power Lines

Any time work is performed in the vicinity of overhead utilities, including power lines, a spotter will be assigned to help operators maneuver equipment in and around the wires. The following distances will always be maintained around high-tension wires:

- For lines rated 50 kilovolts (kV) or below, minimum clearance between the lines and any part of the crane or load shall be 10 feet.
- For lines rated over 50 kV, minimum clearance between the lines and any part of the crane or load shall be 10 feet plus 0.4 inch for each 1 kV over 50 kV, or twice the length of the line insulator, but never less than 10 feet.
- In transit with no load and boom lowered, the equipment clearance shall be a minimum of 4 feet for voltages less than 50 kV, 10 feet for voltages over 50 kV, up to and including 345 kV, and 16 feet for voltages up to and including 750 kV.

In addition, all utility pole "guy-wire" support cables will be identified, marked, and/or barricaded prior to work. Unintended equipment or vehicle contact with these guy wires may result in utility poles or power lines falling on personnel or equipment.

2.3.14 Severe Weather and Lightning

The Field Manager will monitor local media resources to identify possible severe weather situations at the project site. Site work may be delayed, postponed, or cancelled due to severe weather based on the Field Manager's discretion. In the event of a weather emergency, the site will be evacuated in accordance with Section 7 of this document.

Lightning can strike up to a distance of 10 miles, but thunder can only be heard at a distance of 8 miles. Therefore, if site personnel working outdoors hear thunder and/or see lightning, work will be stopped and personnel will move to an indoor location. If indoor facilities are not available, personnel will move inside of passenger vehicles such as cars and pickups. During a thunderstorm with thunder/lightning, avoid trees/poles, standing water, high areas, and metal structures (fences, scaffolding, etc.). Work will resume 30 minutes following the final observance of thunder and/or lightning.

2.4 Chemical Hazards

Data summarized in the previous investigation reports and the RIWP indicate that the chemicals listed in Table 2-1 exist at the site in soil and/or groundwater. Detailed hazard information for selected chemicals is available through MSDSs in Appendix E. Workers will use appropriate PPE if exposure to a known or suspected contaminated medium is likely.

2.4.1 Chemicals Potentially Used

In addition to the site contaminants, chemical products will be purchased for use at the site. These chemicals may include diesel fuel, gasoline, bentonite, Portland cement, silica sand, and decontamination materials such as isopropyl alcohol, n-hexane, and soaps (e.g., Alconox). Other materials may be purchased as needed. MSDSs required by OSHA will be obtained for chemical products used at the site. Copies of the MSDSs will be maintained at the site for worker review.

2.4.2 Sample Preservatives

Preservatives including hydrochloric acid, nitric acid, sulfuric acid, zinc acetate, and sodium hydroxide may be encountered during sampling activities. Safe and proper handling techniques are to be used when collecting samples. Individuals should work upwind from the open sample keeping the bottle away from the breathing zone (approximately one arm's length) to minimize potential exposure. Personnel should be aware of any changes in wind direction that may also affect potential for exposure to vapors. Gloves and safety glasses will always be worn when collecting samples. Sample vessel seals should be immediately replaced after sample is gathered.

Should any sample preservatives come in contact with skin, the exposed area should be thoroughly irrigated with fresh water immediately.

Table 2-1 Chemical Hazards

Contaminant	Unit	PEL[a]	TLV[b]	REL[c]	STEL[d]	IDLH[e]	Odor Threshold	IP[f] (in eV)
Benzene	ppm	1	0.1	0.1	1	500	34-119	9.24
Toluene	ppm	200	50	100	150	500	0.16-37	8.82
Ethylbenzene	ppm	100	100	100	125	800	0.092-0.06	8.76
Xylene	ppm	100	100	100	150	900	20	8.44 - 8.56
Benzo(a)pyrene	mg/m^3	0.2 (soluble aerosol, as coal tar pitches		0.1	10 (mineral mist)	Ca	None Reported	NA
Diesel (as mist)	mg/m^3	5	5	5	10	Ca	None Reported	NA
Gasoline	ppm	None	300	LOQ 15	C, 500	Ca	None Reported	9.24
Phenol	mg/m^3	19	19	19	NA	962.5	0.04	NA
Naphthalene	ppm	10	10	10	15	250	0.084	8.12
Trichloroethylene (TCE)	ppm	100	50	25	NA	1000	1.36	9.45
Tetrachloroethylene (perc; PCE)	ppm	100	100	Ca	100	150 Ca	1	9.32
Dichloroethane	ppm	50	10	1	2	50	11.2	11.05
Dichlorobenzene	ppm	75	25	75	NA	150	0.72	8.98
Vinyl Chloride	ppm	1	1	1	5	NA	0.253	9.80
PCBs	mg/m^3	0.5	0.5	0.001	NA	5	None Reported	NA
Arsenic	mg/m^3	0.01	0.01	0.002	NA	5 Ca	None Reported	NA

Contaminant	Unit	PEL[a]	TLV[b]	REL[c]	STEL[d]	IDLH[e]	Odor Threshold	IP[f] (in eV)
Cadmium	mg/m^3	0.005	0.05	NA	NA	0	None Reported	NA
Chromium	mg/m^3	1	0.5	0.5	NA	250	None Reported	NA
Lead	mg/m^3	0.05	0.05	0.05	NA	100	None Reported	NA
Mercury	mg/m^3	0.1	0.025	0.05	NA	10	None Reported	NA
Zinc	mg/m^3	5	1	5	10	500	None Reported	NA

Note:

[a] OSHA Permissible Exposure Limit (PEL) (8-hour time weighted average [TWA])

[b] American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) (8-hour TWA)

[c] National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) (8-hour TWA)

[d] Short-Term Exposure Limit (15-minute TWA that should not be exceeded at any time during the work day)

[e] Immediately Dangerous to Life & Health

[f] Ionization Potential

C = Ceiling Limit (Concentration that should not be exceeded during any part of the working exposure)

CA = Carcinogenic

mg/m^3 = milligrams per cubic meter

ppm = part per million

eV = electron volts

NA = not applicable

2.5 Hazardous Plants and Animals

This section provides an overview of some of the major plant and animal hazards in the Pacific Northwest and information on identification and prevention of injury or illness from these hazards.

2.5.1 Contact with Hazardous Plants

Common poisonous plants in the Pacific Northwest that cause allergic reactions include poison ivy, poison oak, and poison sumac. In general, poison oak grows west of the Rocky Mountains. Poison oak descriptions and photographs to aid in the identification of these plants are included in Table 2-2.

Table 2-2 Poison Oak Identification Guide

Poison Oak • Grown in the East (NJ to Texas), Pacific Coast. • 6-foot tall shrubs or long vines. • Oak-like leaves, clusters of three. • Yellow berries.	 

If you have been exposed to poison oak, act quickly because the toxin in the plants penetrates the skin within minutes. If possible, stay outdoors until you complete the first two steps:

1) Cleanse the exposed skin with generous amounts of isopropyl alcohol.

2) Wash the skin with water.

3) Take a regular shower with soap and warm water. Do not use soap until this point because it will pick up the toxin from the surface and move it around.

4) Wash clothes, tools, and anything else that may have been in contact with the toxin, with alcohol and water. Be sure to wear hand protection during that process.

Signs and symptoms of exposure include redness and swelling that appears 12 to 48 hours after exposure. Blistering and itching will follow. If you have had a severe reaction in the past, you should see a physician right away. Otherwise, there are quite a few effective over-the-counter products to help with symptoms, including Cortaid, Lanacort, baking soda, colloidal oatmeal bath, and calamine lotion. If necessary, a pharmacist, can help you make an educated choice.

2.5.2 Insect Stings

During environmental investigations, most encounters with stinging insects occur when nests built in well casings or excavation areas are disturbed. Before opening a well casing, take a few moments to observe whether or not insects are entering or exiting. If they are flying to and from the casing, avoid it if possible. If you must be in an area where disturbing a nest is likely, be sure to wear long pants and a long-sleeved shirt. Stinging insects fly around the top of their target, so if you get into trouble, pull a portion of your shirt over your head and run away.

If you get stung, look for a stinger, and, if present, remove it within 15 seconds of the sting. Several over-the-counter products or a simple cold compress can be used to alleviate the pain of the sting. If the sting is followed by severe symptoms, or if it occurs in the neck or the mouth, seek medical attention immediately because swelling could cause suffocation.

If you need to destroy a nest, consult with the Field Manager. Commercially available stinging insect control aerosols are very effective, but could potentially contaminate the well. Once the nest is destroyed, fine mesh may be applied over the exit and entry points of a well casing to prevent re-infestation.

2.5.3 Tick Bites

Ticks in North America can be carriers of several diseases, including Lyme Disease, Rocky Mountain Fever, and ehrlichiosis. Washington has relatively few tick-borne disease cases reported each year.

Limiting exposure to ticks reduces the likelihood of infection when you're exposed to tick-infested habitats. The following measures can prevent tick exposure:

- Remove leaf litter and brush in areas where you will be working prior to tick season.
- Wear light colored clothing so that ticks are visible.
- Tuck your pant legs into your socks, securing with duct tape.
- Apply repellents to discourage tick attachment.
- Promptly inspect your body and remove crawling or attached ticks when you leave a tick-infested area.

If a tick bites you, use the following procedure to remove it:

- Use fine-tipped tweezers or shield your fingers with tissue, paper towel, or rubber gloves.
- Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause mouthparts to break off and remain in the skin.
- Do not squeeze, crush, or puncture the body of the tick because its fluids may contain infectious organisms.

- Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin.
- After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.
- You may wish to save the tick for identification in case you become ill within 2-3 weeks. Place the tick in a zip lock bag in the freezer, and mark the bag with the date of the bite.

2.5.4 Spider Bites

The most dangerous spiders to humans in North America are black widows and brown spiders (also known as brown recluse or fiddleback spiders). Brown spiders are not found in Washington State, though information on this spider is included in Table 2-3 to assist with identification.

Table 2-3 Hazardous Spider Identification Guide

Black Widow Spider

- Abdomen usually shows hourglass marking.
- The female is 3-4 centimeters in diameter.
- Have been found in well casings and flush-mount covers.
- Not aggressive, but more likely to bite if guarding eggs.
- Light, local swelling and reddening of the bite are early signs of a bite, followed by intense muscular pain, rigidity of the abdomen and legs, difficulty breathing, and nausea.
- If bitten, see physician as soon as possible.

Yellow Sac Spider

- Primarily eastern Washington, but even Seattle.
- 5 to 10-mm long body and pale in color, yellow to beige.
- No webs, they build silk sacs in which they hide in during the day. Gardens, woodpiles.
- Bite is painful, and sore is ulcerative. May take few days or weeks to heal.
- Not lethal unless severe allergy.

Hobo Spider

- Common across all of Washington.
- 7 to 14 mm long body and brownish in color.
- Reluctant biters, they usually try to escape.
- Bite is mildly painful, with some swelling.
- Not lethal unless rare instance of severe allergy.

Brown Spiders (Recluse)

- Central and South U.S., although in some other areas as well.
- ¼-to-½-inch-long body and size of silver dollar.
- Hide in baseboards, ceiling cracks, and undisturbed piles of material.
- Bite either may go unnoticed or may be followed by a severe localized reaction, including scabbing, necrosis of affected tissue, and very slow healing.
- If bitten, see physician as soon as possible.

2.5.5 Inhalation of Bird Droppings

Large populations of roosting birds may present a disease risk. The most serious health risks arise from disease organisms that grow in the accumulations of bird droppings, feathers, and debris under a roost—especially if roosts have been active for years. Among the fungal diseases associated with bird droppings, the two most common are Histoplasmosis and Cryptococcosis.

If you are working in an area where large quantities of droppings are present, follow certain precautions to minimize the risk from disease organisms in the droppings:

- Wear a respirator that can filter particles as small as 0.3 microns, such as a high efficiency particulate air (HEPA) filter.
- Wear disposable protective gloves, hat, coveralls, and boots if you will be in close contact.
- Wash or shower at the work site after cleanup, if possible.
- Modify the structure or use methods to prevent birds from reestablishing the roost.

2.5.6 Snake Bites

Venomous snakes native to the U.S. include rattlesnakes, copperheads, and cottonmouths (water moccasins). Of these, only the rattlesnake (the western rattlesnake) is found in eastern Washington (east of the Cascade Mountains). If any employee is exposed to snake bite, of any kind, he should seek medical attention immediately.

2.5.7 Contact with Rodent-Borne Diseases

Rodent infestation in the workplace has the potential to cause serious communicable diseases including hantavirus pulmonary syndrome and bubonic plague. The most common rodent-borne disease is hantavirus which may infect workers who inhale tiny droplets containing the virus when fresh rodent urine, droppings, or nesting materials are stirred up.

Working conditions that my put workers at risk of hantavirus include:

- Contact with rodent feces or dried urine which may mobilize particles of these wastes into the air where they may be inhaled
- Entry into rooms or warehouses that have been closed up and infested for extended periods
- Activities that stir up dust which may mobilize hantavirus.

If working in areas of obvious rodent infestation, take the following precautions:

- Do not enter rooms or warehouses that have been closed up unless absolutely necessary.
- If work in closed up areas or areas with rodent infestation is necessary, contact professional exterminators to eliminate the infestation and clean up the location.
- If an exterminator is not available/possible, employees should clean up the infested area using the following steps
- When going into outbuildings or rooms that have been closed for an extended period, open them up and air out before cleaning.
- Don an air purifying respirator equipped with HEPA P-100 cartridges and nitrile gloves before cleaning.
- Don't stir up dust by sweeping up or vacuuming up droppings, urine, or nesting materials.
- Thoroughly wet contaminated areas with detergent or liquid to deactivate the virus. Most general-purpose disinfectants and household detergents are effective. However, a sodium hypochlorite solution prepared by mixing 1 and 1/2 cups of household bleach in 1 gallon of water may be used in place of commercial disinfectant.
- Once everything is wet, take up contaminated materials with a damp towel, then mop or sponge the area with disinfectant.

- Spray dead rodents with disinfectant and flea repellent (to avoid bubonic plague), then double-bag and dispose in appropriate waste disposal system. Contact the local or state health department other disposal methods.
- Finally, remove respirator and disinfect gloves before taking them off with disinfectant or soap and water. After taking off the clean gloves, thoroughly wash hands with soap and warm water.

If you experience hantavirus symptoms (fatigue, fever, and muscle aches) within 1 to 5 weeks of exposure to potentially affected rodents and their droppings, seek medical attention.

3 Personal Protective Equipment

PPE is required for all field work. The level of PPE required varies by the type and duration of potential exposures. The EPA terminology for protective equipment (Levels A, B, C, and D) provides guidance on typical work levels and required PPE. Additional training is required for Levels A and B; CRETE personnel are not permitted to use Level A or Level B at the Site. A guide to the type of chemical protective clothing and respirator cartridges to be used for chemicals commonly encountered during remedial investigations is provided in Table 3-1, and requirements for Level C or Level D PPE are described below.

Respiratory protective equipment shall be NIOSH-approved and use shall conform to OSHA 29 CFR 1910.134.

Table 3-1 PPE Selection Guide

Chemical Hazard	Glove Material	Coverall Material	Boot Material	Respirator Cartridge
Acids • Hydrochloric • Sulfuric	Butyl rubber	Saranex or Butyl rubber apron	Butyl rubber	Acid vapor
Coal Tar • Polyisocyanate • Naphtha	Nitrile rubber	Polycoated Tyvek	Nitrile rubber	Organic vapor
Creosote	Butyl rubber	Polycoated Tyvek	Butyl rubber	Organic vapor
Dry Particulates • Metals • Asbestos	Nitrile rubber	Tyvek	Tyvek	HEPA
Fuel Hydrocarbons • Gasoline • Diesel	Nitrile rubber	Polycoated Tyvek	Nitrile rubber	Organic vapor
Halogens, Aliphatic • Carbon tetrachloride • Ethylene dichloride	Teflon	Polycoated Tyvek	Nitrile rubber	Organic vapor
Halogens, Vinylic • Vinyl chloride	Nitrile rubber	Polycoated Tyvek	Nitrile rubber	Organic vapor

Forsberg, K. and Mansdorf, S.Z., 1997. Quick Selection Guide to Chemical Protective Clothing, Third Edition. John Wiley & Sons, Inc.

3.1 Level C

Level C protection shall be used when:

- Substance(s) require the same level of skin protection as Level B, but a lesser level of respiratory protection.
- The types of air contaminants have been identified, concentrations have been measured, and respirator decision logic indicates that air purifying respirators (APRs) are sufficient to remove the contaminants.
- The substance has adequate warning properties (odor threshold is below occupational exposure limits) and all criteria for the selection of APR have been met.

Table 3-2 Level C PPE to be Utilized

(Check Appropriate PPE)

☒	Half-face APR (OSHA/NIOSH-approved)
☐	Full-face APR (OSHA/NIOSH-approved)
☒	Type of Cartridges to be Used: AG/OV/P100
☐	Chemical-resistant clothing <u>check appropriate garments</u> (one-piece coverall; hooded one- or two-piece; chemical splash suit; chemical-resistant hood and apron; disposable chemical coveralls [i.e., Tyvek]) ☐ One-piece coverall ☐ Hooded one- or-two piece chemical splash suit ☐ Chemical-resistant hood and apron ☐ Disposable chemical-resistant coveralls **Fabric Type:**
☒	Disposable inner gloves (surgical)
☐	Disposable chemical-resistant outer gloves **Material Type:**
☐	Chemical-resistant boots with safety toe and steel shank or disposable boot covers for safety toe/work boots **Material Type:**
☒	Work boots with steel toe
☐	Sleeves to be duct-taped over gloves and pants to be duct-taped over boots
☒	Safety goggles (as needed)
☒	Safety glasses
☒	Hard hat
☐	Hard hat with face shield
☒	Hearing protectors (**REQUIRED** if site noise levels are greater than 85 dB based on an 8-hour TWA). **Type:** foam or rubber ear plugs
☐	**Modifications:**

3.2 Level D

Level D protection will be used when:

- The atmosphere contains no known hazard.
- Work functions preclude splashes, immersions, or the potential for unexpected inhalation of, or contact with, hazardous concentrations of chemicals.

- Atmospheric concentrations of contaminants are less than the Threshold Limit Value (TLV).

Table 3-3 Level D PPE (Minimum Work Uniform Permitted)

(Check Appropriate PPE)

☒	Standard work uniform/coveralls
☒	Work boots with safety toe
☒	Work gloves
☐	Safety goggles
☒	Safety glasses
☒	Hearing protectors (**REQUIRED** if site noise levels are greater than 85 dB based on an 8-hour TWA)
☒	Hard hat
☐	Hard hat with face shield
☐	**Modifications:** If work is over water (including on piers, walkways or on a boat) a personal flotation device (PFD) is required. **NOTE: Additional health and safety precautions required for work on a boat and a HASP amendment will be required.**

Table 3-4 Activity vs. Level of Protection

Activity	**Level of PPE**	**Special Requirements**
Groundwater and Soil Sampling	Level D	Wear proper protection from contaminants.
Site Inspections and Debris Survey	Level D	Wear proper protection from contaminants. Wear a PFD is work includes overwater components.
Soil Boring Installation, Well Installation and Well Development	Level D	Hearing protection around heavy equipment

4 Air Monitoring and Action Levels

According to 29 CFR 1910.120(h) and Washington Administrative Code (WAC), air monitoring shall be used to identify and quantify airborne levels of hazardous substances and health hazards in order to determine the appropriate level of employee protection required for personnel working on site.

4.1 Real Time Air Monitoring Requirements

Real time air monitoring is required for sites where the chemical hazards listed in Table 4-1 may be present. However, drilling and sample collection is not expected to create a hazardous atmosphere. All work will be performed outside, and personnel will be in close proximity to small volumes of soil and groundwater during sample collection. Although some of the chemical listed in Table 4-1 are present at the Site, monitoring with a photoionization detector (Table 4-2) will be the only air monitoring conducted at the Site. No excavations or excavations entries are allowed under the scope of this HASP.

Table 4-1 Chemicals Requiring Initial Determination Air Monitoring

Chemical	OSHA and WA DOSH Standard for Respiratory Protection
Acrylonitrile	1910.1045 WAC 296-62-07340
Arsenic, inorganic	1910.1018
Benzene	1910.1028 WAC 296-62-07523
1,3-Butadiene	1910.1051 WAC 296-62-07460
Cadmium	1910.1027 1926.1127 WAC 296-62-074
Coal Tar Pitch Volatiles • Acenaphthene • Benzo(a)pyrene • Chrysene • Phenanthrene • Pyrene	1910.1029
1,2-dibromo-3-chloropropane	1910.1044 WAC 296-62-07342
Formaldehyde	1910.1048 WAC 296-62-07540
Hexavalent Chromium	WAC 296-62-08003
Lead	1910.1025 – General Industry 1926.62 – Construction

	WAC 296-62-07521
Methylene chloride	1910.1052
Methylenedianiline	1910.1050 – General Industry 1926.60 – Construction WAC 296-62-076
Vinyl chloride	1910.1017 WAC 296-62-07316

Air monitoring is conducted at the following times or as specified by the Field Manager:

- Upon initial entry to rule out oxygen deficient, flammable, and/or IDLH conditions. At this site there is no "entry", as no work in to be completed in excavations, trenches, or small spaces.
- When the possibility of an oxygen deficient, flammable, and/or IDLH condition or flammable atmosphere has developed.
- As an on-going check of the levels of contaminants in the breathing zone
- When work is initiated on a different portion of the site.
- When contaminants other than those previously identified are encountered.
- When a different operation is initiated.
- When work involves the handling of leaking drums, containers, or when working in areas with obvious liquid contamination.
- During confined space entry. At this site there is no "entry", as no work in to be completed in excavations, trenches, or small spaces.
- At the perimeter of the site as required.
- Outside the site perimeter as required (e.g., adjacent buildings).

If deemed necessary, per the conditions noted above, real time air monitoring with direct reading instruments will conform to, at a minimum, the criteria listed in Table 4-2. All air monitoring data will be recorded in the daily field logs. All air monitoring equipment calibration data is to be recorded in the daily field logs. Air monitoring instruments will be calibrated and maintained in accordance with the manufacturer's specifications.

Table 4-2 Air Monitoring/Instrumentation

X	**Photoionization Detector** Please Check Bulb Size:		
	9.5eV: ☐	**10.2eV:** ☒	**11.7eV:** ☐
Use:	Detection of Organic Gases and Vapors		

Action Level:	PID reading >15 ppm at point of operations for more than 1 minute → **Establish 25-ft diameter exclusion zone around work area**, monitor worker's breathing zone. PID reading >15 ppm in worker's breathing zone for more than 1 minute→ **Evacuate area or upgrade to Level C-half face respirator with organic vapor/HEPA cartridge**, establish contamination reduction zone with waste containers and decontamination fluids provided for personal decontamination. Re-evaluate JSAs. PID reading >75 ppm in worker's breathing zone for more than 1 minute→ **Evacuate area and move upwind** to allow vapors to dissipate, may resume work after vapors dissipate to <15-pmm. PID reading >100 ppm in worker's breathing zone for more than 1 minute OR >300 ppm instantaneous →**Evacuate area and move upwind.** If elevated levels persist, cover boring and cuttings and notify Field Manager. Re-evaluate JSAs and HASP as needed.
Frequency:	Sample the breathing space and work area periodically throughout field activities.

4.2 Respirator Cartridge Change Out

In the event of the use of respiratory protection, cartridges will be replaced daily during field work. For organic cartridges, these conditions may dictate that the cartridges be replaced more frequently:

- If the organic chemical's boiling point is <70°F and the concentration is greater than 200 ppm, contact the Field Manager to discuss cartridge replacement and options for respiratory protection.
- If physical work rate exceeds a moderate level, replace cartridges every 4 hours of work.
- If relative humidity exceeds 85%, replace cartridges every 4 hours of work.

5 Site Control

5.1 Work Zones

Work zones will be delineated by CRETE personnel. The primary purpose for site controls is to establish the hazardous area perimeter, to reduce migration of contaminants into clean areas, and to prevent access or exposure to hazardous materials by personnel or visitors. At the end of each workday, the work should be completed such that there are no open boreholes or excavations remaining. A new activity will not be started toward the end of the workday, such that an unfinished condition is left overnight. All equipment will be removed from the site or locked out such that it cannot be accessed at the end of each workday. During active working conditions, site work zones will include:

- Clean Zone/Support Zone. This uncontaminated zone will be the area outside the Exclusion Zone and Contamination Reduction Zone (CRZ) and within the geographic perimeters of the Site, but not within actively used portions of the Site, such as tenant parking areas. This area is used for staging of materials, parking of investigation personnel vehicles, and receipt of deliveries. Personnel entering this zone may include delivery personnel, visitors, security guards, etc., who will not necessarily be permitted in the exclusion zone.
  All personnel arriving in the support zone will report to the Field Manager and sign the Visitor Sign-In Log.
- The CRZ will provide a location for removal and final decontamination of contaminated PPE. A separate decontamination area will be established for heavy equipment. All personnel and equipment must exit the Exclusion Zone via the CRZ.
- Exclusion Zone/Hot Zone. The exclusion zone will be the “hot zone” or contaminated area inside the site perimeter. Entry to and exit from this zone will be made through a designated point within the CRZ. Appropriate warning signs to identify the exclusion zone should be posted (*e.g.,* **DANGER**, **AUTHORIZED PERSONNEL ONLY**, **PROTECTIVE EQUIPMENT BEYOND THIS POINT**). Personnel and equipment decontamination must occur upon exiting from the exclusion zone.

In most cases, these work zones will not be formally demarcated. Sample collection will occur at each of the locations on Figure 5 of the RIWP, and work zones will move to accommodate these locations. The area around any heavy equipment, such as a drill rig, and the area where samples are processed/logged will become informal exclusion zones. Where investigation locations may overlap frequently used areas of the property, arrangements between the Port and the tenants will be made beforehand to ensure the area is accessible for RI activities and that tenants do not wander into the area.

5.2 General Site Control Safety Procedures

- Whenever possible, avoid contact with contaminated (or potentially contaminated) surfaces. Walk around (not through) puddles and discolored surfaces. Do not kneel or set equipment on the ground as much as possible. Stay away from waste drums unless it is necessary to sample or handle the drums. Protect equipment from contamination by bagging.
- Eating, drinking, and/or smoking are only permitted in designated areas in the support zone.
- Hands and face must be thoroughly washed upon leaving the CRZ.
- Beards and/or other facial hair that interferes with respirator fit will preclude admission to the exclusion zone.
- All equipment must be decontaminated or properly discarded upon exit from the exclusion zone as determined by the Field Manager.
- All personnel exiting the exclusion zone must go through the decontamination procedures as described in this HASP.
- PPE as described in this HASP will be required for all field personnel working on site.
- Contact lenses may be worn on the site provided safety glasses or goggles are also worn. Any exceptions to wearing of contact lenses will be specified in this HASP or through a HASP amendment.

6 Decontamination

In general, everything that enters the exclusion zone must either be decontaminated or properly discarded upon exit from the exclusion zone. All personnel, including any visitors, must enter and exit the exclusion zone through the CRZ.

Contaminated equipment will be decontaminated and inspected by the equipment operator (a subcontractor). Material that is generated by decontamination procedures will be drummed and properly disposed of.

6.1 Personnel Decontamination

Personnel may become contaminated in a number of ways including, not limited to:

- Contacting vapors, gases, mists, or particulates in the air
- Being splashed by materials during sampling
- Walking through puddles or on contaminated soil
- Using contaminated instruments or equipment.

Even with safeguards, personnel contamination may occur. Harmful materials can be transferred into the clean area, exposing unprotected personnel. In removing contaminated clothing, personnel may contact contaminants on clothing or inhale them. To prevent such occurrences, decontamination procedures must be developed and established before anyone enters the site and must continue throughout site operations.

Personnel decontamination procedures will be based on the contaminants of concern and the level of protection being worn by site personnel.

6.2 Sampling Equipment

Sampling devices, when used onsite, require special cleaning procedures (Table 6-1). Use disposable, or one-time use, sampling equipment as feasible.

6.3 Equipment Decontamination

Heavy equipment will be decontaminated by the operator/subcontractor. Decontamination water and solids will be containerized and drummed.

6.4 Disposal of Contaminated Materials

All materials and equipment used for decontamination must be disposed of properly (Table 6-1).

6.5 Emergency Decontamination

Personnel with medical problems or injuries may also require decontamination. There is the possibility that the decontamination may aggravate or cause more serious health effects. If prompt lifesaving, first aid, and medical treatment are required, decontamination procedures will be omitted. In either case, a member of the site management team will accompany contaminated personnel to the medical facility to advise on matters involving decontamination.

6.6 Sanitizing of Personal Protective Equipment

Respirators, reusable protective clothing, and other personal articles not only must be decontaminated before being reused, but also sanitized. The insides of masks and clothing become soiled due to exhalation, body oils, and perspiration. Manufacturer's instructions should be used to sanitize the respirator masks. If practical, reusable protective clothing should be machine-washed after a thorough decontamination; otherwise, it must be cleaned by hand.

Table 6-1 Decontamination Procedures

☐	**Level C:** Segregated equipment drop, boot cover and glove wash, boot cover and glove rinse, boot cover removal, outer glove removal, suit/safety boot wash, suit/safety boot rinse, (canister or mask change), safety boot removal, splash suit removal, inner glove wash, face piece removal, inner glove removal, inner clothing removal, field wash, re-dress. **Modifications**:
☒	**Level D:** Segregated equipment drop, boot and glove wash, boot and glove rinse, or dispose of gloves. **Modifications:**
☐	**Sampling Equipment:** Use disposable, one-time use sampling equipment when feasible (tubing, bailers, nitrile gloves, scoops or trowels).
☐	**Heavy Equipment Decontamination:** Pressure wash, focusing on areas of contact with site soils and cuttings and visually impacted areas.
☐	**Decontamination Disposal Procedures:** Drum soil debris, drum wash and rinse water separate from solids/soils. Label drums, assess drum contents for waste characterizations.
☐	**Emergency Decontamination Equipment Procedures:**

7 Emergency Response/Contingency Plan

It is essential that site personnel be prepared in the event of an emergency. Emergencies can take many forms: illnesses, injuries, chemical exposure, fires, explosions, spills, leaks, releases of harmful contaminants, or sudden changes in weather. Table 7-1 outlines the contact information for emergencies. The first two numbers should be called in the order listed for all emergencies requiring immediate assistance. The other numbers are specific to emergency type (e.g., spill, poisoning). The Project Manager and the client contact are to be notified of the incident after the emergency situation is addressed.

Table 7-1 Emergency Contacts/Telephone Numbers

1. Fire, Police, Ambulance	911 or
Capable of Transporting Contaminated Personnel?	**Yes:** ☒ **No:** ☐
2. Port of Friday Harbor Security	(360) 378-2688
Hospital:	PeaceHealth Peace Island Medical Center 1117 Spring St, Friday Harbor, WA 98250 (360) 378-2141
Chemical Trauma Capabilities?	**Yes:** ☒ **No:** ☐
Decontamination Capabilities?	**Yes:** ☒ **No:** ☐
Directions from Site to Hospital:	1. Head west on Turn Point Rd. 2. Continue onto Warbass Way 3. Turn right onto First St. S. 4. Continue onto First St S to Spring St. 5. Turn left onto Spring St. 6. Destination will be on the left after 3-miles.
Note: See map for route to hospital at the end of this section. ***The route to the hospital was verified by:*** Rusty Jones Distance from the Site to the hospital is: 2.2 miles. The approximate driving time is: 8 minutes.	
Poison Control Center:	(800) 222-1222
National Response Center (for spill reporting)	(800) 424-8802
Washington Emergency Management Division (for spill reporting)	(800) 258-5990 or (800) OILS-911
Center for Disease Control	(800) 232-4636
ATF (explosion information)	(888) 283-2662
Washington Department of Ecology Northwest Regional Office	(206) 594-0000
CRETE Consulting Office and Project Manager	Mr. Grant Hainsworth (253) 797-6323

CRETE Consulting Personnel Medical Consultant	Valley Medical Center Occupation Health and Safety
Client Contact	Peter Leon, Leon Environmental (206) 948-5366

Table 7-2 Emergency Equipment Available On Site

Communication Equipment:	
☐	Public Telephones
☐	Private Telephones
☒	Cellular Telephones
☐	Two-Way Radio (walkie-talkie)
☐	Emergency Alarms/Horns
Medical Equipment:	
☒	First Aid Kits
☐	Stretcher
☒	Eye Wash Station and/or Bottle
☐	Safety Shower
☐	Blankets
☐	Other (please specify):
Fire Fighting Equipment:	
☒	Fire Extinguisher
☐	Other:
Spill/Leak Equipment	
☒	Absorbent Boom Pads
☒	Dry Absorbent
Additional Safety Equipment:	

7.1 Incident Reporting and Management

In the event of any type of health or safety incident, including but not limited to, near misses, injury/illness, environmental release or impact, property damage, or a potential exposure the onsite Field Manager is responsible for providing a verbal notification to Port of Friday Harbor security as well as to Grant Hainsworth, the Crete Project Manager, as soon as possible following the incident. Written follow-up and an evaluation of procedures leading up to the incident may be conducted depending on the severity of the incident.

The following steps should be followed if an injury or illness case occurs:

1) Check the scene of the injury or illness and; either provide first aid, if trained and the conditions are safe to do so, or call 911 to obtain emergency care for the victim.

2) Ensure that appropriate decontamination treatment for exposed or injured personnel is obtained.

3) Once the victim is stabilized, place the following calls in the following order :

Port Security	**(360) 378-2688**
Grant Hainsworth (Crete)	**(253) 797-6323 (Cell)**

4) Grant Hainsworth will then call the following individuals:

Peter Leon, Leon Environmental	**(206) 948-5366**

5) Notify the victim to inquire with the medical care provider about whether there is an "over-the-counter" medication that would work as well as a prescription medication, or if non-prescription strengths of a medication may have the same therapeutic benefit. This is to avoid unnecessary prescriptions that would result in the incident being considered OSHA recordable.

6) If the incident results in one or more fatalities or hospitalization of three or more personnel, notify the Washington State Department of Labor and Industries within 8 hours.

7) The Project Manager or his designee will follow up with the victim after receiving medical attention to find out about the nature of the injury or illness, medical care given, and whether there are any work restrictions or modifications.

Any person transporting an injured/exposed person to a hospital for treatment should take directions to the hospital (Figure 7-1) and information on the chemicals involved with him. Any vehicle used to transport contaminated personnel will be cleaned or decontaminated as necessary.

In order to be prepared for an emergency, field staff should add key phone numbers to their cell phone contact lists, such as Port Security. If using a smart phone onsite, staff should also save hospital directions into the Google Maps or similar application.

7.2 Environmental or Property Damage Incident Response

The Field Manager or designee has primary responsibility for responding to environmental and property damage incidents. The Field Manager will:

1) Take appropriate measures to protect the public and the environment including isolating and securing the site, preventing run-off to surface waters, and ending and/or controlling the emergency to the extent possible.

2) Ensure that the appropriate federal, state, and local agencies are informed, and emergency response plans are coordinated. In the event of an air release of toxic materials, 911 and Port Security should be informed in order to assess the need for evacuation.

3) Notify the Project Manager.

4) The Project Manager or his/her designee will follow up with the victim after receiving medical attention to find out about the nature of the injury or illness, medical care given, and whether there are any work restrictions or modifications.

7.3 Fire or Explosion

Although unlikely for the work outline in the RIWP, in the event of a fire or explosion, the local fire department must be summoned immediately. Upon their arrival, the Field Manager and any additional personnel with firsthand knowledge of the nature of the fire will advise the fire commander of the location and nature of the fire and identification of all hazardous materials on site.

If it is safe to do so and personnel have been properly trained, site personnel may use fire-fighting equipment available on site, or remove or isolate flammable or other hazardous materials, which may contribute to the fire (i.e., incipient stage fire-fighting only).

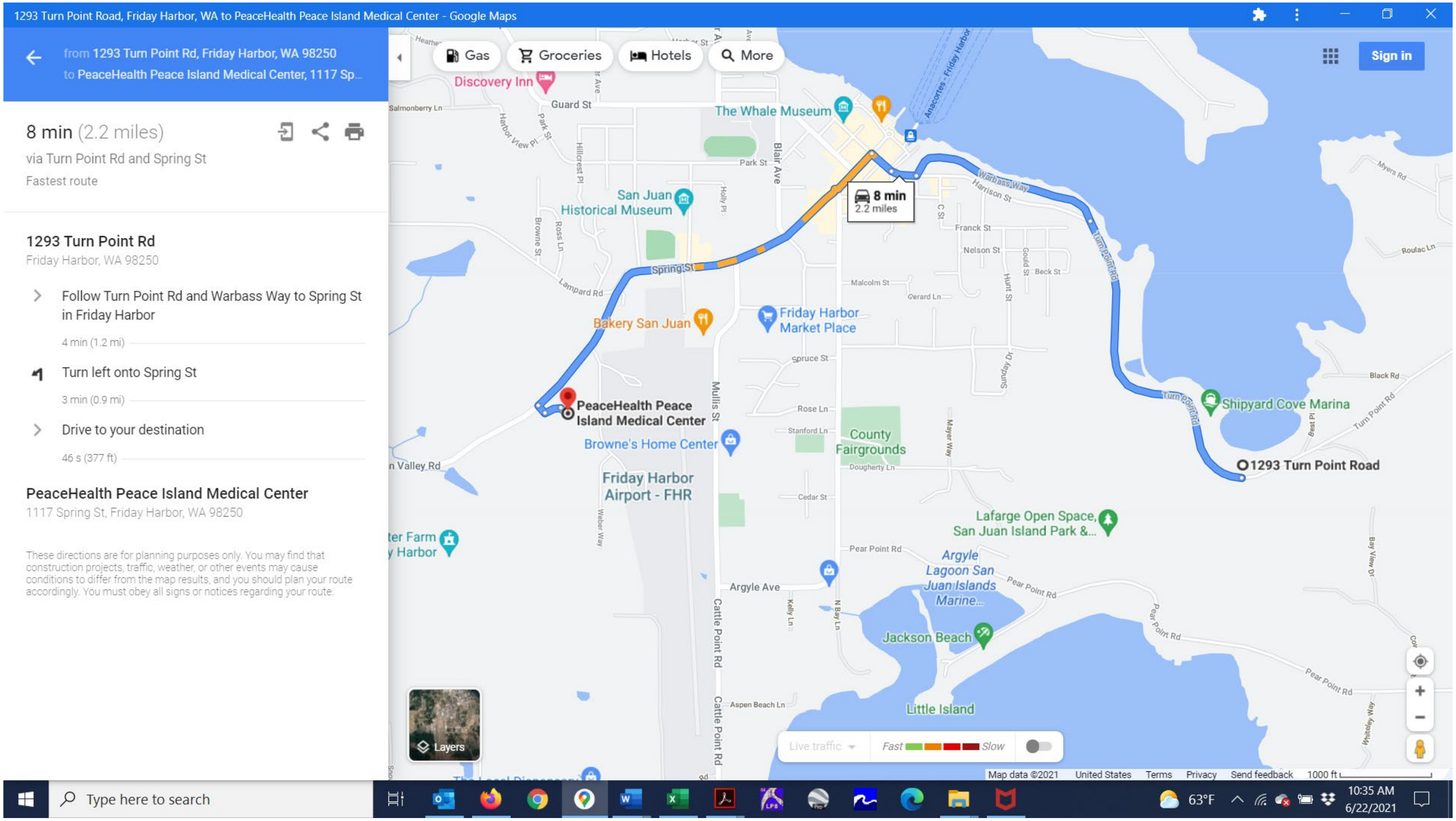
7.4 Evacuation Routes and Resources

As the Site is at the end of peninsula on the east end of San Juan Island, the evacuation route is to the west towards the town of Friday Harbor. Evacuation should be conducted immediately, without regard for equipment, under conditions of extreme emergency.

In the event a site evacuation is necessary, all personnel are to:

- Escape the emergency situation
- Decontaminate to the maximum extent practical
- Meet at command post, or some other pre-arranged location
- Notification may be verbal or by a continuous blast on an air horn or vehicle horn.
- Keep upwind of smoke, vapors, or spill location
- Exit through the decontamination corridor, if possible.

Figure 7-1 Route to Hospital



1293 Turn Point Road, Friday Harbor, WA to PeaceHealth Peace Island Medical Center - Google Maps

from 1293 Turn Point Rd, Friday Harbor, WA 98250
to PeaceHealth Peace Island Medical Center, 1117 Sp...

8 min (2.2 miles)
via Turn Point Rd and Spring St
Fastest route

1293 Turn Point Rd
Friday Harbor, WA 98250

Follow Turn Point Rd and Warbass Way to Spring St in Friday Harbor
4 min (1.2 mi)

Turn left onto Spring St
3 min (0.9 mi)

Drive to your destination
46 s (377 ft)

PeaceHealth Peace Island Medical Center
1117 Spring St, Friday Harbor, WA 98250

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Peace Health Peace, Island Medical Center - 1117 Spring St, Friday Harbor, WA 98250 - (360) 378-2141

8 Drum Handling

Will this project require the handling of drummed materials?

No: ☐	**Yes:** ☒

Soil cuttings, well purge/development water, and decontamination water will be drummed.

Accidents may occur during handling of drums and other investigation derived waste containers. Hazards include vapor generation and/or physical injury resulting from moving heavy containers by hand and working around drums and heavy equipment. OSHA regulations (29 CFR Parts 1910 and 1926) include general requirements and standards for storing, containing, and handling chemicals and containers, and for maintaining equipment used for handling materials. U.S. EPA regulations 40 CFR Part 265 stipulate requirements for types of containers, maintenance of containers and containment structures, and design and maintenance of storage areas. Department of Transportation (DOT) regulations (49 CFR Parts 171 through 178) also stipulate requirements for containers and procedures for shipment of hazardous waste.

- Have a dry chemical fire extinguisher on hand to control small fires.
- Check for labels, markings, etc., and note conditions of containers. Are the drums bulging, deteriorated, or leaking?
- Before moving any drum or container, determine the most appropriate sequence in which the various containers should be moved.
- Exercise extreme caution in handling drums that are not intact or tightly sealed.
- Use the following types of equipment to move drums and/or containers: 1) drum grappler attached to a hydraulic excavator, 2) small front-end loader with a bucket sling, 3) rough terrain fork lift, or 4) drum cart or drum dolly.
- Train personnel in proper lifting and moving techniques to prevent back injuries.
- Have over packs ready before any attempt is made to move drums.
- Pressurized drums are extremely hazardous. If possible, do not move drums that may be under internal pressure as evidenced by bulging or swelling. This is not expected because the only drums to be handled during the Remedial Investigation are those storing investigation derived waste (soil cuttings, purged groundwater, decontamination fluid).
- If a drum containing liquid cannot be moved without rupture, immediately transfer its contents to a sound drum using a pump designed for transferring the liquid.
- DO NOT use picks, chisels, or firearms to open drums.

- If pressure must be released manually, place a barrier such as explosion-resistant plastic sheeting between the worker and bung to deflect any gas, liquid, or solid that may be expelled as the bung is loosened.
- Reseal open bungs and drill holes with new bungs or plugs to avoid explosions and/or vapor generation. If an open drum cannot be resealed, place the drum into an over pack. Plug any opening in pressurizing drums with pressure venting caps set for 5 psi.
- Cover drum tops with plastic sheeting or other suitable non-chlorinated material to avoid excessive contact with drum tops.
- Never stand on drum tops or stack drums.

9 Drilling Safety

Will this project require the use of a drill or direct push equipment rig (Geoprobe) for well installation and/or subsurface sampling?

No: ☐	**Yes:** ☒

Accidents may occur during drilling activities. Hazards include subsurface and overhead utilities, heavy machinery, heavy falling objects, slip/trip/fall, and potential flying debris. Prior to mobilization, the Project Manager should receive confirmation from the contractors that all personnel meet the following requirements:

- Personnel are 40-Hour OSHA trained.
- Personnel are current with 8-Hour Annual Refresher Training.
- Personnel are enrolled in a medical monitoring program.
- Personnel have been successfully fit-tested within the last 12 months.
- Personnel are trained in drill rig safe operating practices.
- Personnel are trained in First Aid/CPR.

Every drill crew should have a designated safety supervisor who has authority to enforce safety on the drilling site.

The drilling operator is responsible for making sure the drilling activities are conducted in a safe manner and that the operators are wearing appropriate PPE, are familiar with the Site and with emergency procedures, and are cognizant of safe operating methods for their equipment.

Appendix A-1

COVID-19 Infection Control Procedures

APPENDIX A-1

Protecting Workers: Guidance on Mitigating and Preventing the Spread of COVID-19 in the Workplace

About COVID-19

SARS-CoV-2, the virus that causes **COVID-19**, is highly infectious and spreads from person to person, including through aerosol transmission of particles produced when an infected person exhales, talks, vocalizes, sneezes, or coughs. COVID-19 is less commonly transmitted when people touch a contaminated object and then touch their eyes, nose, or mouth. The virus that causes COVID-19 is highly transmissible and can be spread by people who have no symptoms and who do not know they are infected. Particles containing the virus can travel more than 6 feet, especially indoors and in dry conditions with relative humidity below 40%. The Centers for Disease Control and Prevention (CDC) estimates that over fifty percent of the spread of the virus is from individuals with no symptoms at the time of spread.

More information on COVID-19 is available from the Centers for Disease Control and Prevention.

What Workers Need To Know about COVID-19 Protections in the Workplace

SARS-CoV-2, the virus that causes COVID-19, spreads mainly among unvaccinated people who are in close contact with one another - particularly indoors and especially in poorly ventilated spaces.

Vaccination is the key element in a multi-layered approach to protect workers. Learn about and take advantage of opportunities that your employer may provide to take time off to get vaccinated. Vaccines authorized by the U.S. Food and Drug Administration are highly effective at protecting vaccinated people against symptomatic and severe COVID-19 illness and death. According to the CDC, a growing body of evidence suggests that fully vaccinated people are less likely to have symptomatic infection or transmit the virus to others. See CDC's Guidance for Fully Vaccinated People; and Science Brief.

You should follow recommended precautions and policies at your workplace. Multi-layered controls tailored to your workplace are especially important for those workers who are unvaccinated or otherwise at-risk. Many employers have established COVID-19 prevention programs that include a number of important steps to keep unvaccinated and otherwise at-risk workers safe. These COVID-19 prevention programs include measures such as telework and flexible schedules, engineering controls (especially ventilation), administrative policies (e.g., vaccination policies), PPE, face coverings, physical distancing, and enhanced cleaning programs with a focus on high-touch surfaces.

In addition, the CDC recommends that fully vaccinated people wear a mask in public indoor settings if they are in an area of substantial or high transmission. Fully vaccinated people might choose to mask regardless of the level of transmission, particularly if they or someone in their household is immunocompromised or at increased risk for severe disease, or if someone in their household is unvaccinated. Ask your employer about plans in your workplace. In addition, employees with disabilities who are at-risk may request reasonable accommodation under the ADA.

Even if your employer does not have a COVID-19 prevention program, if you are unvaccinated or otherwise at risk, you can help protect yourself by following the steps listed below:

- You should get a COVID-19 vaccine as soon as you can. Ask your employer about opportunities for paid leave, if necessary, to get vaccinated and recover from any side effects.
- Properly wear a face covering over your nose and mouth. Face coverings are simple barriers worn over the face, nose and chin. They work to help prevent your respiratory droplets or large particles from reaching others. Individuals are encouraged to choose higher quality masks so that they are providing a greater measure of protection to themselves as well as those around them. CDC provides general guidance on masks, including face coverings.
- If you are working outdoors, you may opt not to wear face coverings in many circumstances; however, your employer should support you in safely continuing to wear a face covering if you choose, especially if you work closely with other people.
- Unless you are fully vaccinated and not otherwise at-risk, stay far enough away from other people so that you are not breathing in particles produced by them – generally at least 6 feet (about 2 arm lengths), although this approach by itself is not a guarantee that you will avoid infection, especially in enclosed or poorly ventilated spaces. Ask your employer about possible telework and flexible schedule options at your workplace, and take advantage of such policies if possible. Perform work tasks, hold meetings, and take breaks outdoors when possible.
- Participate in any training offered by your employer/building manager to learn how rooms are ventilated effectively, encourage your employer to provide such training if it does not already exist, and notify the building manager if you see vents that are clogged, dirty, or blocked by furniture or equipment.
- Practice good personal hygiene and wash your hands often. Always cover your mouth and nose with a tissue, or the inside of your elbow, when you cough or sneeze, and do not spit. Monitor your health daily and be alert for COVID-19 symptoms (e.g., fever, cough, or shortness of breath). See CDC’s Daily Activities and Going Out and CDC’s Interim Public Health Recommendations for Fully Vaccinated People.
- Get tested regularly, especially in areas of substantial or high community transmission.

COVID-19 vaccines are highly effective at keeping you from getting COVID-19. If you are not yet fully vaccinated or are otherwise at risk, optimum protection is provided by using multiple layers of interventions that prevent exposure and infection.

The Roles of Employers and Workers in Responding to COVID-19

Under the OSH Act, employers are responsible for providing a safe and healthy workplace free from recognized hazards likely to cause death or serious physical harm.

CDC's Interim Public Health Recommendations for Fully Vaccinated People explains that under some circumstances, fully vaccinated people need not take all the precautions that unvaccinated people should take, except where required by federal, state, local, tribal, or territorial laws, rules and regulations, including local business and workplace guidance. However, in light of evidence related to the Delta variant of the SARS-CoV-2 virus, the CDC updated its guidance to recommend that even people who are fully vaccinated wear a mask in public indoor settings in areas of substantial or high transmission, or if they have had a known exposure to someone with COVID-19 and have not had a subsequent negative test 3-5 days after the last date of that exposure. Schools should continue to follow applicable CDC guidance, which recommends universal indoor masking for all teachers, staff, students, and visitors to K-12 schools, regardless of vaccination status.

Employers should engage with workers and their representatives to determine how to implement multi-layered interventions to protect unvaccinated and otherwise at-risk workers and mitigate the spread of COVID-19, including:

1. ***Facilitate employees getting vaccinated***. Employers should grant paid time off for employees to get vaccinated and recover from any side effects. The Department of Labor and OSHA, as well as other federal agencies, are working diligently to ensure access to COVID-19 vaccinations. CDC provides information on the benefits and safety of vaccinations. Businesses with fewer than 500 employees may be eligible for tax credits under the American Rescue Plan Act if they provide paid time off from April 1, 2021, through September 30, 2021, for employees who decide to receive the vaccine or to accompany a family or household member to receive the vaccine and to recover from any potential side effects from the vaccine. Employers should also consider working with local public health authorities to provide vaccinations in the workplace for unvaccinated workers. Finally, OSHA suggests that employers consider adopting policies that require workers to get vaccinated or to undergo regular COVID-19 testing – in addition to mask wearing and physical distancing – if they remain unvaccinated.
2. ***Instruct any workers who are infected, unvaccinated workers who have had close contact with someone who tested positive for SARS-CoV-2, and all workers with COVID-19 symptoms to stay home from work*** to prevent or reduce the risk of transmission of the virus that causes COVID-19. As recommended by the CDC, fully vaccinated people who have a known exposure to someone with suspected or confirmed COVID-19 should get tested 3-5 days after exposure and should wear a mask in public indoor settings for 14 days or until they receive a negative test result. People who are not fully vaccinated should be tested immediately after being identified, and, if negative, tested again in 5–7 days after last exposure or immediately if symptoms develop during quarantine. Ensure that absence policies are non-punitive. Eliminate or revise policies that encourage workers to come to work sick or when unvaccinated workers have been exposed to COVID-19. Businesses with fewer than 500 employees may be eligible for refundable tax credits under the American Rescue Plan (ARP) Act if they provide paid time off for sick and family leave to their employees due to COVID-19-related reasons. The ARP tax credits are available to eligible employers that pay sick and family leave for qualified leave from April 1, 2021, through September 30, 2021. More information is available from the IRS.
3. ***Implement physical distancing in all communal work areas for unvaccinated and otherwise at-risk workers.*** A key way to protect such workers is to physically distance them from other such people (workers or customers) – generally at least 6 feet of

distance is recommended, although this is not a guarantee of safety, especially in enclosed or poorly ventilated spaces. In a workplace, workers often are required to work in close proximity to each other and/or customers or clients for extended periods of time. Maintaining physical distancing at the workplace for such workers is an important control to limit the spread of COVID-19.

Employers could also limit the number of unvaccinated or otherwise at-risk workers in one place at any given time, for example by implementing flexible worksites (e.g., telework); implementing flexible work hours (e.g., rotate or stagger shifts to limit the number of such workers in the workplace at the same time); delivering services remotely (e.g., phone, video, or web); or implementing flexible meeting and travel options, for such workers.

At fixed workstations where unvaccinated or otherwise at-risk workers are not able to remain at least 6 feet away from other people, transparent shields or other solid barriers can separate these workers from other people. Barriers should block face-to-face pathways between individuals in order to prevent direct transmission of respiratory droplets, and any openings should be placed at the bottom and made as small as possible. The height and posture (sitting or standing) of affected workers, directional airflow, and fire safety should be considered when designing and installing barriers, as should the need for enhanced ventilation.

4. ***Provide workers with face coverings or surgical masks,[4] as appropriate, unless their work task requires a respirator or other PPE.*** In addition to unvaccinated and otherwise at-risk workers, CDC recommends that even fully vaccinated people wear masks in public indoor settings in areas of substantial or high transmission and notes that fully vaccinated people may appropriately choose to wear masks in public indoor settings regardless of community level of transmission, particularly if they are at risk or have someone in their household who is at risk or not fully vaccinated.

   Workers should wear a face covering that covers the nose and mouth to contain the wearer's respiratory droplets and to help protect others and potentially themselves. Face coverings should be made of at least two layers of a tightly woven breathable fabric, such as cotton, and should not have exhalation valves or vents. They should fit snugly over the nose, mouth, and chin with no large gaps on the outside of the face. Employers should provide face coverings to workers who request them at no cost (and make replacements available to workers when they request them). Under federal anti-discrimination laws, employers may need to provide reasonable accommodations for any workers who are unable to wear or have difficulty wearing certain types of face coverings due to a disability or who need a religious accommodation under Title VII of the Civil Rights Act of 1964. In workplaces with employees who are deaf or hard of hearing, employers should consider acquiring masks with clear coverings over the mouth to facilitate lip-reading.

   Unless otherwise provided by federal, state, or local requirements, workers who are outdoors may opt not to wear face coverings unless they are at risk, for example, if they are immunocompromised. Regardless, all workers should be supported in continuing to wear a face covering if they choose, especially in order to safely work closely with other people.

When an employer determines that PPE is necessary to protect unvaccinated and otherwise at-risk workers from exposure to COVID-19, the employer must provide PPE in accordance with **relevant mandatory OSHA standards** and should consider providing PPE in accordance with other industry-specific guidance. Respirators, if necessary, must be provided and used in compliance with 29 CFR 1910.134 (e.g., medical determination, fit testing, training on its correct use), including certain provisions for voluntary use when workers supply their own respirators, and other PPE must be provided and used in accordance with the applicable standards in 29 CFR part 1910, Subpart I (e.g., 1910.132 and 133). There are times when PPE is not called for by OSHA standards or other industry-specific guidance, but some workers may have a legal right to PPE as a reasonable accommodation under the ADA. Employers are encouraged to proactively inform employees who have a legal right to PPE as a reasonable accommodation for their disability about how to make such a request. Other workers may want to use PPE if they are still concerned about their personal safety (e.g., if a family member is at higher risk for severe illness, they may want to wear a face shield in addition to a face covering as an added layer of protection). Encourage and support voluntary use of PPE in these circumstances and ensure the equipment is adequate to protect the worker.

For operations where the face covering can become wet and soiled, provide workers with replacements daily or more frequently, as needed. Face shields may be provided for use with face coverings to protect them from getting wet and soiled, but they do not provide adequate protection by themselves. See CDC's Guide to Masks.

Employers with workers in a setting where face coverings may increase the risk of heat-related illness indoors or outdoors or cause safety concerns due to introduction of a hazard (for instance, straps getting caught in machinery) may wish to consult with an occupational safety and health professional to help determine the appropriate face covering/respirator use for their setting.

5. ***Educate and train workers on your COVID-19 policies and procedures using accessible formats and in languages they understand.*** Train managers on how to implement COVID-19 policies. Communicate supportive workplace policies clearly, frequently, and via multiple methods to promote a safe and healthy workplace. Communications should be in plain language that unvaccinated and otherwise at-risk workers understand (including non-English languages, and American Sign Language or other accessible communication methods, if applicable) and in a manner accessible to individuals with disabilities. Training should be directed at employees, contractors, and any other individuals on site, as appropriate, and should include:
    A. Basic facts about COVID-19, including how it is spread and the importance of physical distancing (including remote work), ventilation, vaccination, use of face coverings, and hand hygiene.
    B. Workplace policies and procedures implemented to protect workers from COVID-19 hazards.

    For basic facts, see About COVID-19 and What Workers Need to Know About COVID-19 above and see more on vaccinations, improving ventilation, physical distancing (including remote work), PPE, and face coverings, respectively, elsewhere in this

document. Some means of tracking which workers have received this information, and when, could be utilized by the employer as appropriate.
In addition, ensure that workers understand their rights to a safe and healthful work environment, whom to contact with questions or concerns about workplace safety and health, and their right to raise workplace safety and health concerns free from retaliation. (See Implementing Protections from Retaliation, below.) This information should also be provided in a language that workers understand. Ensure supervisors are familiar with workplace flexibilities and other human resources policies and procedures.

6. ***Suggest or require that unvaccinated customers, visitors, or guests wear face coverings in public-facing workplaces such as retail establishments, and that all customers, visitors, or guests wear face coverings in public, indoor settings in areas of substantial or high transmission***. This could include posting a notice or otherwise suggesting or requiring that people wear face coverings, even if no longer required by your jurisdiction. Individuals who are under the age of 2 or are actively consuming food or beverages on site need not wear face coverings.
7. ***Maintain Ventilation Systems.*** The virus that causes COVID-19 spreads between people more readily indoors than outdoors. Improving ventilation is a key engineering control that can be used as part of a layered strategy to reduce the concentration of viral particles in indoor air and the risk of virus transmission to unvaccinated and otherwise at-risk workers in particular. A well-maintained ventilation system is particularly important in any indoor workplace setting and when working properly, ventilation is an important control measure to limit the spread of COVID-19. Some measures to improve ventilation are discussed in CDC's Ventilation in Buildings and in the OSHA Alert: COVID-19 Guidance on Ventilation in the Workplace. These recommendations are based on American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guidance for Building Operations and Industrial Settings during the COVID-19 Pandemic. Adequate ventilation will protect all people in a closed space. Key measures include ensuring heating, ventilation, and air conditioning (HVAC) systems are operating in accordance with the manufacturer's instructions and design specifications, conducting all regularly scheduled inspections and maintenance procedures, maximizing the amount of outside air supplied, installing air filters with a Minimum Efficiency Reporting Value (MERV) 13 or higher where feasible, maximizing natural ventilation in buildings without HVAC systems by opening windows or doors, when conditions allow (if that does not pose a safety risk), and considering the use of portable air cleaners with High Efficiency Particulate Air (HEPA) filters in spaces with high occupancy or limited ventilation.
8. ***Perform routine cleaning and disinfection***. If someone who has been in the facility within 24 hours is suspected of having or confirmed to have COVID-19, follow the CDC cleaning and disinfection recommendations. Follow requirements in **mandatory OSHA standards** 29 CFR 1910.1200 and 1910.132, 133, and 138 for hazard communication and PPE appropriate for exposure to cleaning chemicals.
9. ***Record and report COVID-19 infections and deaths:*** Under **mandatory OSHA rules in 29 CFR part 1904**, employers are required to record work-related cases of COVID-19 illness on OSHA's Form 300 logs if the following requirements are met: (1) the case is a

confirmed case of COVID-19; (2) the case is work-related (as defined by 29 CFR 1904.5); and (3) the case involves one or more relevant recording criteria (set forth in 29 CFR 1904.7) (e.g., medical treatment, days away from work). Employers must follow the requirements in 29 CFR part 1904 when reporting COVID-19 fatalities and hospitalizations to OSHA. More information is available on OSHA's website. Employers should also report outbreaks to local health departments as required and support their contact tracing efforts.

In addition, employers should be aware that Section 11(c) of the Act prohibits reprisal or discrimination against an employee for speaking out about unsafe working conditions or reporting an infection or exposure to COVID-19 to an employer. In addition, **mandatory OSHA standard** 29 CFR 1904.35(b) also prohibits discrimination against an employee for reporting a work-related illness.

Note on recording adverse reactions to vaccines: OSHA, like many other federal agencies, is working diligently to encourage COVID-19 vaccinations. OSHA does not want to give any suggestion of discouraging workers from receiving COVID-19 vaccination or to disincentivize employers' vaccination efforts. As a result, OSHA will not enforce 29 CFR part 1904's recording requirements to require any employers to record worker side effects from COVID-19 vaccination at least through May 2022. OSHA will reevaluate the agency's position at that time to determine the best course of action moving forward. Individuals may choose to submit adverse reactions to the federal Vaccine Adverse Event Reporting System.

10. ***Implement protections from retaliation and set up an anonymous process for workers to voice concerns about COVID-19-related hazards:*** Section 11(c) of the OSH Act prohibits discharging or in any other way discriminating against an employee for engaging in various occupational safety and health activities. Examples of violations of Section 11(c) could include discriminating against employees for raising a reasonable concern about infection control related to COVID-19 to the employer, the employer's agent, other employees, a government agency, or to the public, such as through print, online, social, or any other media; or against an employee for voluntarily providing and safely wearing their own PPE, such as a respirator, face shield, gloves, or surgical mask. In addition to notifying workers of their rights to a safe and healthful work environment, ensure that workers know whom to contact with questions or concerns about workplace safety and health, and that there are prohibitions against retaliation for raising workplace safety and health concerns or engaging in other protected occupational safety and health activities (see educating and training workers about COVID-19 policies and procedures, above); also consider using a hotline or other method for workers to voice concerns anonymously.
11. ***Follow other applicable mandatory OSHA standards:*** All of OSHA's standards that apply to protecting workers from infection remain in place. These **mandatory OSHA standards** include: requirements for PPE (29 CFR part 1910, Subpart I (e.g., 1910.132 and 133)), respiratory protection (29 CFR 1910.134), sanitation (29 CFR 1910.141), protection from bloodborne pathogens: (29 CFR 1910.1030), and OSHA's requirements for employee access to medical and exposure records (29 CFR 1910.1020). Many healthcare workplaces will be covered by the **mandatory OSHA COVID-19 Emergency Temporary**

Standard. More information on that standard is available on OSHA's website. Employers are also required by the General Duty Clause, Section 5(a)(1) of the OSH Act, to provide a safe and healthful workplace free from recognized hazards that are causing or likely to cause death or serious physical harm.

Appendix: Measures Appropriate for Higher-Risk Workplaces with Mixed-Vaccination Status Workers

Employers should take additional steps to mitigate the spread of COVID-19 among unvaccinated or otherwise at-risk workers due to the following types of workplace environmental factors, especially in locations of substantial or high transmission:

- **Close contact**– where unvaccinated and otherwise at-risk workers are working close to one another, for example, on production or assembly lines or in busy retail settings. Such workers may also be near one another at other times, such as when clocking in or out, during breaks, or in locker/changing rooms.
- **Duration of contact** – where unvaccinated and otherwise at-risk workers often have prolonged closeness to coworkers (e.g., for 6–12 hours per shift). Continued contact with potentially infectious individuals increases the risk of SARS-CoV-2 transmission.
- **Type of contact** – where unvaccinated and otherwise at-risk workers may be exposed to the infectious virus through respiratory particles in the air—for example, when infected workers in a manufacturing or factory setting cough or sneeze, especially in poorly ventilated spaces. Confined spaces without adequate ventilation increase the risk of viral exposure and transmission. It is also possible, although less likely, that exposure could occur from contact with contaminated surfaces or objects, such as tools, workstations, or break room tables. Shared closed spaces such as break rooms, locker rooms, and interior hallways in the facility may contribute to risk.
- **Other distinctive factors that may increase risk among unvaccinated or otherwise at-risk workers include:**
    - A common practice at some workplaces of sharing employer-provided transportation such as ride-share vans or shuttle vehicles;
    - Frequent contact with other individuals in community settings, especially in areas where there is substantial or high community transmission; and
    - Communal housing or living quarters onboard vessels with other unvaccinated or otherwise at-risk individuals.

In these types of higher-risk workplaces – which include manufacturing; meat, seafood, and poultry processing; high-volume retail and grocery; and agricultural processing settings – this Appendix provides best practices to protect unvaccinated and otherwise at-risk workers. Please note that these recommendations are *in addition to* those in the general precautions described above, including isolation of infected or possibly infected workers, and other precautions.

In all workplaces with heightened risk due to workplace environmental factors where there are unvaccinated or otherwise at-risk workers in the workplace:

- Stagger break times in these generally high-population workplaces, or provide temporary break areas and restrooms to avoid groups of unvaccinated or otherwise at-risk workers congregating during breaks. Such workers should maintain at least 6 feet of distance from others at all times, including on breaks.

- Stagger workers' arrival and departure times to avoid congregations of unvaccinated or otherwise at-risk workers in parking areas, locker rooms, and near time clocks.
- Provide visual cues (e.g., floor markings, signs) as a reminder to maintain physical distancing.
- Require unvaccinated or otherwise at-risk workers, and also fully vaccinated workers in areas of substantial or high community transmission, to wear masks whenever possible, encourage and consider requiring customers and other visitors to do the same.
- Implement strategies (tailored to your workplace) to improve ventilation that protects workers as outlined in CDC's Ventilation in Buildings and in the OSHA Alert: COVID-19 Guidance on Ventilation in the Workplace, and ASHRAE Guidance for Building Operations and Industrial Settings During the COVID-19 Pandemic.

Unvaccinated or otherwise at-risk workers are also at risk when traveling to and from work in employer-provided buses and vans.

- Notify unvaccinated and otherwise at-risk workers of this risk and, to the extent feasible, help them limit the number of such workers in one vehicle.
- Make sure all unvaccinated and otherwise at-risk workers sharing a vehicle are wearing appropriate face coverings. Make sure all workers wear appropriate face coverings in areas of substantial or high community transmission.
- Where not prohibited by weather conditions, open vehicle windows.

---

[1] CDC provides information about face coverings as one type of mask among other types of masks. OSHA differentiates face coverings from the term "mask" and from respirators that meet OSHA's Respiratory Protection Standard.
CDC's definition of masks includes those that are made of cloth, those that are disposable, and those that meet a standard. Cloth face coverings may be commercially produced or improvised (i.e., homemade) and are not considered personal protective equipment (PPE). Surgical masks are typically cleared by the U.S. Food and Drug Administration as medical devices and are used to protect workers against splashes and sprays (i.e., droplets) containing potentially infectious materials; in this capacity, surgical masks are considered PPE.

[2] People who are not fully vaccinated should be tested immediately after being identified (with known exposure to someone with suspect or confirmed COVID-19), and, if negative, tested again in 5–7 days after last exposure or immediately if symptoms develop during quarantine.

[3] The CDC and the Department of Education have addressed situations where a student cannot wear a mask because of disability. See Guidance for COVID-19 Prevention in K-12 Schools and COVID-19 Manual - Volume 1 (updated).

[4] See footnote 1 for more on masking.

SOURCE:
https://www.osha.gov/coronavirus/safework

Types of Masks and Respirators (Updated Jan. 28, 2022)

Key Messages:

- Masking is a critical public health tool for preventing spread of COVID-19, and it is important to remember that any mask is better than no mask.
- To protect yourself and others from COVID-19, CDC continues to recommend that you wear the most protective mask you can that fits well and that you will wear consistently.
- Masks and respirators are effective at reducing transmission of SARS-CoV-2, the virus that causes COVID-19, when worn consistently and correctly.
- Some masks and respirators offer higher levels of protection than others, and some may be harder to tolerate or wear consistently than others. It is most important to wear a well-fitting mask or respirator correctly that is comfortable for you and that provides good protection.
- While all masks and respirators provide some level of protection, properly fitting respirators provide the highest level of protection. Wearing a highly protective mask or respirator may be most important for certain higher risk situations, or by some people at increased risk for severe disease.
- CDC's mask recommendations provide information that people can use to improve how well their masks protect them.

For information about how to use your N95 correctly, see How to Use Your N95 Respirator. This page describes different types of masks and respirators that you can use to protect yourself and others from getting and spreading COVID-19. Masks and respirators can provide varying degrees of protection, with well-fitting National Institute for Occupational Safety and Health (NIOSH)-approved respirators offering the most protection. Masking is a critical public health tool for preventing spread of COVID-19, and it is important to remember that any mask is better than no mask. This page presents options in order of least to most protective. To protect yourself and others from COVID-19, CDC continues to recommend that you wear the most protective mask you can that fits well and that you will wear consistently.

Types of Masks and Respirators

Masks are made to contain droplets and particles you breathe, cough, or sneeze out. If they fit closely to the face, they can also provide you some protection from particles spread by others, including the virus that causes COVID-19.

Respirators are made to protect you by filtering the air and fitting closely on the face to filter out particles, including the virus that causes COVID-19. They can also contain droplets and particles you breathe, cough, or sneeze out so you do not spread them to others.

Choosing a Mask or Respirator for Different Situations

Masks and respirators (i.e., specialized filtering masks such as "N95s") can provide different levels of protection depending on the type of mask and how they are used. Loosely woven cloth products provide the least protection, layered finely woven products offer more protection, well-fitting disposable surgical masks and KN95s offer even more protection, and well-fitting NIOSH-approved respirators (including N95s) offer the highest level of protection.

Whatever product you choose, it should provide a good fit (i.e., fitting closely on the face without any gaps along the edges or around the nose) and be comfortable enough when worn properly (covering your nose and mouth) so that you can keep it on when you need to. Learn how to improve how well your mask protects you by visiting CDC's Improve How Your Mask Protects You page.

A respirator has better filtration, and if worn properly the whole time it is in use, can provide a higher level of protection than a cloth or procedural mask. A mask or respirator will be less effective if it fits poorly or if you wear it improperly or take it off frequently. Individuals may consider the situation and other factors when choosing a mask or respirator that offers greater protection.

- When caring for someone who is sick with COVID-19.
- If you are at increased risk for severe illness, for example, people who are immunocompromised, older adults, and people with certain underlying medical conditions.
- When working at a job where you interact with large numbers of the public, especially when not everyone is consistently wearing a mask. For example, bus drivers and grocery store workers.
- When riding on planes, buses, trains, or other forms of public transportation*, especially if it is for a long period of time on crowded conveyances.
- When physical distancing is not possible or when you are in crowded indoor or outdoor public settings.
- If you are not up to date on COVID-19 vaccinations.

*Note: The options listed on this page may be used to fulfill the requirements of CDC's Mask Order for public transportation. Learn more about attributes of masks needed to fulfill the requirements of the Order at this website.

Masks

When choosing a mask, look at how well it fits. Gaps can let air with respiratory droplets leak in and out around the edges of the mask. Gaps can be caused by choosing the wrong size or type of mask and when a mask is worn with facial hair.

It is important to check that it fits snugly over your nose, mouth, and chin.

- Check for gaps by cupping your hands around the outside edges of the mask.
- Make sure no air is flowing from the area near your eyes or from the sides of the mask.
- If the mask has a good fit, you will feel warm air come through the front of the mask and may be able to see the mask material move in and out with each breath.

Cloth Masks can be made from a variety of fabrics and many types of cloth masks are available. Wear cloth masks with:

- A proper fit over your nose, mouth, and chin to prevent leaks
- Multiple layers of tightly woven, breathable fabric
- Nose wire
- Fabric that blocks light when held up to bright light source

Do NOT wear cloth masks with:

- Gaps around the sides of the face or nose
- Exhalation valves, vents, or other openings

- Single-layer fabric or those made of thin fabric that don't block light
- Wet or dirty material

Procedure Masks: Disposable **procedure** masks are widely available. They are sometimes referred to as surgical masks or medical procedure masks.

Wear procedure masks with:
- A proper fit over your nose, mouth, and chin to prevent leaks
- Multiple layers of non-woven material
- A nose wire

Do NOT wear procedure masks with:
- Gaps around the sides of the face or nose
- Wet or dirty material

Ways to have better fit and extra protection with cloth and disposable masks:
- Wear two masks (disposable mask underneath **AND** cloth mask on top)
- Combine either a cloth mask or disposable mask with a fitter or brace
- Knot and tuck ear loops of a 3-ply mask where they join the edge of the mask
    - For disposable procedure masks, fold and tuck the unneeded material under the edges. (For instructions, see the following https://youtu.be/GzTAZDsNBe0external icon)
- Use masks that attach behind the neck and head with either elastic bands or ties (instead of ear loops)

Masks that Meet a Standard: Some masks are designed and tested to ensure they perform at a consistent level. These masks are labeled to tell you what standard they meet. These masks are labeled:
- MEETS ASTM F3502external icon
- MEETS WORKPLACE PERFORMANCE
- MEETS WORKPLACE PERFORMANCE PLUS

These are new standards. Lists of masks that meet these standards and more information on their availability can be found on the NIOSH Personal Protective Equipment Information (PPE-Info) webpage. These masks have markings printed on the product to indicate they are authentic.

Follow manufacturer's instructions on how to wear, store, and clean or properly dispose of the mask. These should be worn according to the manufacturer's instructions without modifications.

Wear masks that meet a standard with:
- A proper fit over your nose and mouth to prevent leaks
- Multiple layers of non-woven material
- A nose wire

Do NOT wear masks that meet a standard:
- If it is hard to breathe while wearing them
- If they are wet or dirty
- With other masks or respirators
- As a replacement for NIOSH-approved respiratory protection when required by your job

Respirators: When choosing a respirator, look at how well it fits and read the manufacturer instructions. These instructions should include information on how to wear, store, and clean or properly dispose of the respirator. Respirators have markings printed on the product to indicate they are authentic, see appropriate N95 markings image icon and KN95 markings.

It is important to wear your respirator properly, so it forms a seal to your face. Gaps can let air with respiratory droplets leak in and out around the edges of the respirator. Gaps can be caused by choosing the wrong size or type of respirator or when a respirator is worn with facial hair. **For information about how to use your N95 correctly, see How to Use Your N95 Respirator.** The information on this page is about N95 respirators but also applies to international respirators, like KN95 respirators.

Most publicly available respirators are disposable and should be discarded when they are dirty, damaged, or difficult to breathe through.

More information on these two types of respirators is provided below.

Respirators that Meet International Standards: Some respirators are designed and tested to meet international standards. The most widely available respirators that meet an international standard are **KN95 respirators**. Other examples include 1st, DL2, DL3, DS2, DS3, FFP2, FFP3, KN100, KP95, KP100, P2, P3, PFF2, PFF3, R95, and Special.

Poor quality KN95 respirators:

- **About 60% of KN95 respirators NIOSH evaluated during the COVID-19 pandemic in 2020 and 2021 did not meet the requirements that they intended to meet.**
    - Using a poor-quality product may not provide the level of protection indicated.
- Learn about factors to consider when purchasing an international respirator. This webpage and a webinar provide reliable information to guide you.

What to know about international respirators:

- They are designed to standards that do not often have a quality requirement.
- They filter varying levels of particles in the air depending on the standard they are designed to meet.
- They seal tightly to your face when fitted properly.
- It is important to pick a respirator that fits your face and seals well since not all fit the same.

Do NOT wear international respirators:

- If they have exhalation valves, vents, or other openings
- If it is hard to breathe while wearing them
- If they are wet or dirty
- With other masks or respirators
- As a replacement for NIOSH-approved respiratory protection when required by your job

NIOSH-Approved Respirators: NIOSH approves many types of filtering facepiece respirators. The most widely available are **N95 respirators**, but other types (N99, N100, P95, P99, P100, R95, R99, and R100) offer the same or better protection as an N95 respirator. Lists of respirators that are NIOSH-approved can be found on the NIOSH-Approved Particulate Filtering Facepiece Respirators webpage.

CDC recommends that specially labeled “surgical” N95 respirators — a special subtype of N95 respirators that provide additional protection against hazards present during medical procedures, such as blood splatter — should be reserved for use by healthcare personnel.

Employers who want to distribute N95 respirators to employees shall follow an Occupational Safety and Health (OSHA) respiratory protection program external icon.

What to know about NIOSH-approved respirators:

- When worn consistently and properly, they provide the highest level of protection from particles, including the virus that causes COVID-19. Additionally, they contain your respiratory droplets and particles so you do not expose others.
- They seal tightly to your face when fitted properly.
- It is important to pick a respirator that fits your face and seals well since not all fit the same.
- Respirators approved by NIOSH are evaluated against a specific US standard that includes a quality requirement.
- They filter at least 95% of particles in the air when approved by NIOSH and when you have a proper fit.
- If you have COVID-19, an N95 or other filtering facepiece respirator with a valve may not protect others as well as one without a valve. To make a filtering facepiece respirator with a valve as protective as one without a valve, follow the manufacturer's instructions for covering the valve.

Do NOT wear NIOSH-approved respirators:

- If it is hard to breathe while wearing them
- If they are wet or dirty
- With other masks or respirators

SOURCE:
https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/types-of-masks.html

Stay Up to Date with Your Vaccines (Updated Jan. 16, 2022)

Get Vaccinated and Stay Up to Date: Up to date means a person has received all recommended COVID-19 vaccines, including any booster dose(s) when eligible.
Fully vaccinated means a person has received their primary series of COVID-19 vaccines.
COVID-19 Vaccines: COVID-19 vaccines available in the United States are effective at protecting people from getting seriously ill, getting hospitalized, and even dying. As with vaccines for other diseases, people who are up to date are optimally protected. CDC recommends that everyone 5 years and older get their primary series of COVID-19 vaccines, and receive a booster dose when eligible.
When Are You Up to Date? You are up to date with your COVID-19 vaccines when you have followed the current recommendations listed below. The recommendations will be different depending on your age, your health status, and when you first got vaccinated.
Many people who are immunocompromised may need an additional dose as part of their primary vaccine series.
Note that booster shots are not recommended for everyone at this time.

Pfizer-BioNTech[1]

Ages Recommended
5+ years old
Primary Series
2 doses[3,4]
Given 3 weeks (21 days) apart [5]
Fully Vaccinated
2 weeks after final dose in primary series
Booster Dose
Everyone ages 12+ should get a booster dose at least 5 months after the last dose in their primary series.

- Teens 12–17 should only get a Pfizer-BioNTech COVID-19 Vaccine booster
- Everyone 18+ should get a booster dose of either Pfizer-BioNTech or Moderna (mRNA COVID-19 vaccines)

When Boosted
A person is considered "boosted" and **up to date** right after getting their booster dose.

Moderna[1]

Ages Recommended
18+ years old
Primary Series
2 doses [3]
Given 4 weeks (28 days) apart [5]
Fully Vaccinated
2 weeks after final dose in primary series

Moderna[1](continued)

Booster Dose

Everyone ages 18+ should get a booster dose of either Pfizer-BioNTech or Moderna (mRNA COVID-19 vaccines) at least 5 months after the last dose in their primary series.

When Boosted

A person is considered "boosted" and **up to date** right after getting their booster dose.

Johnson & Johnson's Janssen[1,2]

Johnson & Johnson's Janssen[1,2]

Ages Recommended

18+ years old

Primary Series

1 dose

Fully Vaccinated

2 weeks after 1st dose

Booster Dose

Everyone ages 18+ should get a booster dose of either Pfizer-BioNTech or Moderna (mRNA COVID-19 vaccines) at least 2 months after the first dose of J&J/Janssen COVID-19 Vaccine. You may get J&J/Janssen in some situations.

When Boosted

A person is considered "boosted" and **up to date** right after getting their booster dose.

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[1] If you had a severe allergic reaction after a previous dose or if you have a known (diagnosed) allergy to a COVID-19 vaccine ingredient, you should not get that vaccine. If you have been instructed not to get one type of COVID-19 vaccine, you may still be able to get another type.

[2] CDC has updated its recommendations for COVID-19 vaccines with a preference for mRNA (Pfizer-BioNTech or Moderna) vaccines. Learn more about the updated guidance on the use of Janssen (Johnson & Johnson) COVID-19 vaccine.

[3] The primary series of these vaccinations includes a third dose for people ages 18 years and older with moderate to severe immunocompromise. This third dose occurs 28 days after the second dose in the primary series.

[4] The primary series of this vaccination includes a third dose for people ages 5–17 years with moderate to severe immunocompromise. The third dose occurs 28 days after the second dose in the primary series.

[5] You should get your second shot as close to the recommended 3-week or 4-week interval as possible. You should not get the second dose early.

SOURCE:
https://www.cdc.gov/coronavirus/2019-ncov/vaccines/stay-up-to-date.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fvaccines%2Ffully-vaccinated-guidance.html

CRETE
CONSULTING, INC.

Employee Name/Company	Email	Phone

	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
	Time:		Time:		Time:		Time:		Time:		Time:		Time:	
Temperature		Deg F		Deg F		Deg F		Deg F		Deg F		Deg F		Deg F
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Do you have a fever or chills?														
Do you have a cough or shortness of breath?														
Do you have fatigue or muscle aches?														
Do you have new loss of taste or smell?														
Have you knowingly had close contact with anyone who has tested positive for COVID-19?														
Have you ever had a positive lab test for COVID-19?														
Recommended for Worksite Access?	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Notes:														
Project:														

Revised 5/1/2020

Appendix A-2

Site Safety Plan Acknowledgment Form

Site Safety Plan
Acknowledgment Form

I have been informed, understand, and will abide by all the procedures and protocols set forth in this Site Health and Safety Plan for the Jensen's Shipyard and Marina site.

Name (Print)	**Signature**	**Affiliation**	**Date**

Appendix B

Visitor Sign-In Log

Visitor Sign-In Log

Client:_______________________________________

Project Name:_________________________________

Location:_____________________________________

Field Activity:_________________________________

Project Mgr.:__________________________________

Field Manager:_________________________________

Date	**Name**	**Affiliation**	**Purpose of Visit**	**Site EHS Training**		**Do you have Level D PPE?**		**Time In**	**Time Out**
				Yes	**No**	**Yes**	**No**		

Appendix C

Site Safety/Tailgate Meeting Form

Our behavior-based safety process is the key to our success!

Site Safety/Tailgate Meeting Form

Project Name:_____________________ **Location**:__________________________
Date:______________________________ **Time**:______________________________
Project Number:____________________ **Instructor**:_________________________

Safety Topics Presented

JHA:____
____
____
____

Lessons Learned:____
____
____

General Safety Topics:____
____
____

Attendee Name	**Attendee's Signature**

Appendix D

Notification of Access to Employee Exposure and Medical Records

Notice

To All Employees: This Notice Is to Provide Information for Compliance with 29 CFR Part 1910 Subpart C - General Safety and Health Provisions - Paragraph 1910.1020, Access to Employee Exposure and Medical Records.

(i) The existence, location, and availability of any records covered by this section is as follows:

CRETE Consulting, Inc.

16300 Christensen Rd, Suite 214,
Tukwilla, WA 98188
PH: (253) 797-6323

Attn: Grant Hainsworth

Grant.hainsworth@creteconsulting.com

(ii) The person responsible for maintaining and providing access to these records is CRETE's Environmental Health and Safety Manager.

(iii) Each employee has the right to access these records.

Appendix E

Material Safety Data Sheets

MATERIAL SAFETY DATA SHEET

LIQUINOX®

Prepared to U.S. OSHA, CMA, ANSI, Canadian WHMIS, Australian WorkSafe, Japanese Industrial Standard JIS Z 7250:2000, and European Union REACH Regulations

SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME:	**LIQUINOX®**	
CHEMICAL FAMILY NAME:	Detergent.	
PRODUCT USE:	Critical-cleaning detergent for laboratory, healthcare and industrial applications	
U.N. NUMBER:	Not Applicable	
U.N. DANGEROUS GOODS CLASS:	Non-Regulated Material	
SUPPLIER/MANUFACTURER'S NAME:	Alconox, Inc.	
ADDRESS:	30 Glenn St., Suite 309, White Plains, NY 10603. USA	
EMERGENCY PHONE:	**TOLL-FREE in USA/Canada**	800-255-3924
	International calls	813-248-0585
BUSINESS PHONE:	914-948-4040	
DATE OF PREPARATION:	May 2011	
DATE OF LAST REVISION:	February 2008	

SECTION 2 - HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: This product is a pale yellow liquid no odor. Exposure can be irritating to eyes, respiratory system and skin. It is a non-flammable liquid. The Environmental effects of this product have not been investigated.

US DOT SYMBOLS	CANADA (WHMIS) SYMBOLS	EUROPEAN and (GHS) Hazard Symbols
Non-Regulated	Not Controlled	None
		Signal Word: **Caution!**

EU LABELING AND CLASSIFICATION:

Classification of the substance or mixture according to Regulation (EC) No1272/2008 Annex 1
EC# 231-791-2 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 268-356-1 This substance is not classified in the Annex I of Directive 67/548/EEC
CAS# 84133-50-6 Not Listed in EU Chemical Inventory
EC# 232-483-0 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 215-090-9 This substance is not classified in the Annex I of Directive 67/548/EEC
EC# 241-543-5 This substance is not classified in the Annex I of Directive 67/548/EEC

GHS Hazard Classification(s):
None

Hazard Statement(s):
None

Precautionary Statement(s):
P264: Wash hands thoroughly after handling
P271: Use only in well ventilated area.

Hazard Symbol(s):
Not Classified

Risk Phrases:	**Safety Phrases:**
None	S24/25: Avoid contact with skin and eyes

HEALTH HAZARDS OR RISKS FROM EXPOSURE:

ACUTE: Exposure to this product may cause irritation of the eyes, respiratory system and skin. Ingestion may cause gastrointestinal irritation including pain, vomiting or diarrhea.

CHRONIC: This product contains an ingredient which may be corrosive.

TARGET ORGANS: ACUTE: Eye, respiratory System, Skin CHRONIC: None Known

SECTION 3 - COMPOSITION and INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENTS:	CAS #	EINECS #	ICSC #	WT %	HAZARD CLASSIFICATION; RISK PHRASES
Water	7732-18-5	231-791-2	Not Listed	40 – 60%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium (C10 – C16) Alkylbenzene Sulfonate	68081-81-2	268-356-1	Not Listed	10 – 20%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Alcohol Ethoxylate	84133-50-6	Not Listed	Not Listed	1 – 5%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Coconut Diethanolamide	8051-30-7	232-483-0	Not Listed	1 – 5%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Sodium Xylene Sulfonate	1300-72-7	215-090-9	1514	2 – 7%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Tripotassium EDTA	17572-97-3	241-543-5	Not Listed	1 - 5%	HAZARD CLASSIFICATION: None RISK PHRASES: None
Balance of other ingredients are non-hazardous or less than 1% in concentration (or 0.1% for carcinogens, reproductive toxins, or respiratory sensitizers).					

NOTE: ALL WHMIS required information is included in appropriate sections based on the ANSI Z400.1-2004 format. This product has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR, EU Directives and the Japanese Industrial Standard *JIS Z 7250: 2000*.

SECTION 4 - FIRST-AID MEASURES

Contaminated individuals of chemical exposure must be taken for medical attention if any adverse effect occurs. Rescuers should be taken for medical attention, if necessary. Take copy of label and MSDS to health professional with contaminated individual.

EYE CONTACT: If product enters the eyes, open eyes while under gentle running water for at least 15 minutes. Seek medical attention if irritation persists.

SKIN CONTACT: Wash skin thoroughly after handling. Seek medical attention if irritation develops and persists. Remove contaminated clothing. Launder before re-use.

INHALATION: If breathing becomes difficult, remove victim to fresh air. If necessary, use artificial respiration to support vital functions. Seek medical attention if breathing dificulty continues.

INGESTION: If product is swallowed, call physician or poison control center for most current information. If professional advice is not available, do not induce vomiting. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or who cannot swallow. Seek medical advice. Take a copy of the label and/or MSDS with the victim to the health professional.

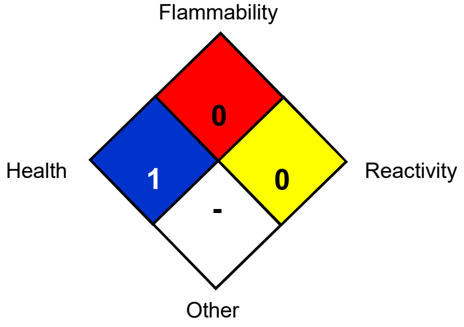
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing skin, or eye problems may be aggravated by prolonged contact.

RECOMMENDATIONS TO PHYSICIANS: Treat symptoms and reduce over-exposure.

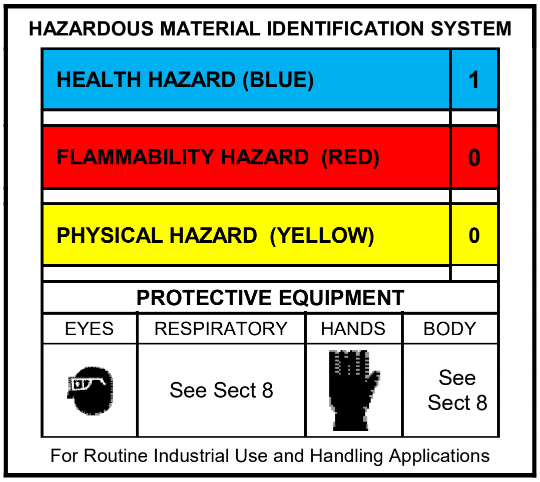
SECTION 5 - FIRE-FIGHTING MEASURES

FLASH POINT:	Not Flammable
AUTOIGNITION TEMPERATURE:	Not Applicable
FLAMMABLE LIMITS (in air by volume, %):	Lower (LEL): NA Upper (UEL): NA
FIRE EXTINGUISHING MATERIALS:	As appropriate for surrounding fire. Carbon dioxide, foam, dry chemical, halon, or water spray.
UNUSUAL FIRE AND EXPLOSION HAZARDS:	This product is non-flammable, however containers may rupture if exposed to heat or fire.
Explosion Sensitivity to Mechanical Impact:	Not Sensitive.
Explosion Sensitivity to Static Discharge:	Not Sensitive
SPECIAL FIRE-FIGHTING PROCEDURES:	Incipient fire responders should wear eye protection. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Isolate materials not yet involved in the fire and protect personnel. Move containers from fire area if this can be done without risk; otherwise, cool with carefully applied water spray. If possible, prevent runoff water from entering storm drains, bodies of water, or other environmentally sensitive areas.

NFPA RATING SYSTEM



HMIS RATING SYSTEM



HAZARDOUS MATERIAL IDENTIFICATION SYSTEM

HEALTH HAZARD (BLUE)			1
FLAMMABILITY HAZARD (RED)			0
PHYSICAL HAZARD (YELLOW)			0
PROTECTIVE EQUIPMENT			
EYES	RESPIRATORY	HANDS	BODY
	See Sect 8		See Sect 8

For Routine Industrial Use and Handling Applications

Hazard Scale: 0 = Minimal **1** = Slight **2** = Moderate **3** = Serious **4** = Severe ***** = Chronic hazard

SECTION 6 - ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK RESPONSE: Personnel should be trained for spill response operations.

SPILLS: Contain spill if safe to do so. Prevent entry into drains, sewers, and other waterways. Soak up with an absorbent material and place in an appropriate container for disposal. Dispose of in accordance with applicable Federal, State, and local procedures (see Section 13, Disposal Considerations).

SECTION 7 - HANDLING and STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: As with all chemicals, avoid getting this product ON YOU or IN YOU. Wash thoroughly after handling this product. Do not eat, drink, smoke, or apply cosmetics while handling this product. Avoid breathing dusts generated by this product. Use in a well-ventilated location. Remove contaminated clothing immediately.

STORAGE AND HANDLING PRACTICES: Containers of this product must be properly labeled. Store containers in a cool, dry location. Keep container tightly closed when not in use. Store away from strong acids or oxidizers.

SECTION 8 - EXPOSURE CONTROLS - PERSONAL PROTECTION

EXPOSURE LIMITS/GUIDELINES:

Chemical Name	CAS#	ACGIH TWA	OSHA TWA	SWA
Water	7732-18-5	Not Listed	Not Listed	Not Listed
Sodium (C10 – C16) Alkylbenzene Sulfonate	68081-81-2	Not Listed	Not Listed	Not Listed
Alcohol Ethoxylate	84133-50-6	Not Listed	Not Listed	Not Listed
Coconut Diethanolamide	8051-30-7	Not Listed	Not Listed	Not Listed
Sodium Xylene Sulfonate	1300-72-7	Not Listed	Not Listed	Not Listed
Tripotassium EDTA	17572-97-3	Not Listed	Not Listed	Not Listed

Currently, International exposure limits are not established for the components of this product. Please check with competent authority in each country for the most recent limits in place.

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation to ensure exposure levels are maintained below the limits provided below. Use local exhaust ventilation to control airborne dust. Ensure eyewash/safety shower stations are available near areas where this product is used.

The following information on appropriate Personal Protective Equipment is provided to assist employers in complying with OSHA regulations found in 29 CFR Subpart I (beginning at 1910.132) or equivalent standard of Canada, or standards of EU member states (including EN 149 for respiratory PPE, and EN 166 for face/eye protection), and those of Japan. Please reference applicable regulations and standards for relevant details.

RESPIRATORY PROTECTION: Maintain airborne contaminant concentrations below guidelines listed above, if applicable. If necessary, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), equivalent U.S. State standards, Canadian CSA Standard Z94.4-93, the European Standard EN149, or EU member states.

EYE PROTECTION: Safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133 or appropriate Canadian Standards.

HAND PROTECTION: Use chemical resistant gloves to prevent skin contact.. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada.

BODY PROTECTION: Use body protection appropriate to prevent contact (e.g. lab coat, overalls). If necessary, refer to appropriate Standards of Canada, or appropriate Standards of the EU, Australian Standards, or relevant Japanese Standards.

SECTION 9 - PHYSICAL and CHEMICAL PROPERTIES

PHYSICAL STATE:	Liquid
APPEARANCE & ODOR:	Pale yellow liquid with no odor.
ODOR THRESHOLD (PPM):	Not Available
VAPOR PRESSURE (mmHg):	17 @ 20°C (68°F)
VAPOR DENSITY (AIR=1):	>1
BY WEIGHT:	Not Available
EVAPORATION RATE (nBuAc = 1):	<1
BOILING POINT (C°):	100°C (212°F)
FREEZING POINT (C°):	Not Available
pH:	8.5
SPECIFIC GRAVITY 20°C: (WATER =1)	1.083
SOLUBILITY IN WATER (%)	Complete
COEFFICIENT OF WATER/OIL DIST.:	Not Available
VOC:	None
CHEMICAL FAMILY:	Detergent

SECTION 10 - STABILITY and REACTIVITY

STABILITY: Product is stable

DECOMPOSITION PRODUCTS: When heated to decomposition this product produces Oxides of carbon (COx), and Hydrocarbons

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Strong acids and strong oxidizing agents.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Contact with incompatible materials.

SECTION 11 - TOXICOLOGICAL INFORMATION

TOXICITY DATA: Toxicity data is not available for mixture:

SUSPECTED CANCER AGENT: None of the ingredients are found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, IARC and therefore is not considered to be, nor suspected to be a cancer-causing agent by these agencies.
IRRITANCY OF PRODUCT: Contact with this product can be irritating to exposed skin, eyes and respiratory system.
SENSITIZATION OF PRODUCT: This product is not considered a sensitizer.
REPRODUCTIVE TOXICITY INFORMATION: No information concerning the effects of this product and its components on the human reproductive system.

SECTION 12 - ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.
ENVIRONMENTAL STABILITY: No Data available at this time.
EFFECT OF MATERIAL ON PLANTS or ANIMALS: No evidence is currently available on this product's effects on plants or animals.

EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on this product's effects on aquatic life.

SECTION 13 - DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations, those of Canada, Australia, EU Member States and Japan.

SECTION 14 - TRANSPORTATION INFORMATION

US DOT; IATA; IMO; ADR:
THIS PRODUCT IS NOT HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.
PROPER SHIPPING NAME: Non-Regulated Material
HAZARD CLASS NUMBER and DESCRIPTION: Not Applicable
UN IDENTIFICATION NUMBER: Not Applicable
PACKING GROUP: Not Applicable.
DOT LABEL(S) REQUIRED: Not Applicable
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2004): Not Applicable
MARINE POLLUTANT: None of the ingredients are classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B)

U.S. DEPARTMENT OF TRANSPORTATION (DOT) SHIPPING REGULATIONS:
This product is not classified as dangerous goods, per U.S. DOT regulations, under 49 CFR 172.101.
TRANSPORT CANADA, TRANSPORTATION OF DANGEROUS GOODS REGULATIONS:
This product is not classified as Dangerous Goods, per regulations of Transport Canada.
INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA):
This product is not classified as Dangerous Goods, by rules of IATA:
INTERNATIONAL MARITIME ORGANIZATION (IMO) DESIGNATION:
This product is not classified as Dangerous Goods by the International Maritime Organization.
EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR):
This product is not classified by the United Nations Economic Commission for Europe to be dangerous goods.

SECTION 15 - REGULATORY INFORMATION

UNITED STATES REGULATIONS
SARA REPORTING REQUIREMENTS: This product is not subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act., as follows: None
TSCA: All components in this product are listed on the US Toxic Substances Control Act (TSCA) inventory of chemicals.
SARA 311/312:

Acute Health:	Yes	Chronic Health:	No	Fire:	No	Reactivity:	No

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for this product. The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lb (4,540 kg) may apply, per 40 CFR 370.20.

U.S. CERCLA REPORTABLE QUANTITY (RQ): None
CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): None of the ingredients are on the California Proposition 65 lists.

CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: All of the components of this product are on the DSL Inventory

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: No component of this product is on the CEPA First Priorities Substance Lists.

CANADIAN WHMIS CLASSIFICATION and SYMBOLS: This product is categorized as a Not Controlled Product, as per the Controlled Product Regulations

EUROPEAN ECONOMIC COMMUNITY INFORMATION:

EU LABELING AND CLASSIFICATION:

Classification of the mixture according to Regulation (EC) No1272/2008. See section 2 for details.

AUSTRALIAN INFORMATION FOR PRODUCT:

AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES (AICS) STATUS: All components of this product are listed on the AICS.

STANDARD FOR THE UNIFORM SCHEDULING OF DRUGS AND POISONS: Not applicable.

JAPANESE INFORMATION FOR PRODUCT:

JAPANESE MINISTER OF INTERNATIONAL TRADE AND INDUSTRY (MITI) STATUS: The components of this product are not listed as Class I Specified Chemical Substances, Class II Specified Chemical Substances, or Designated Chemical Substances by the Japanese MITI.

INTERNATIONAL CHEMICAL INVENTORIES:

Listing of the components on individual country Chemical Inventories is as follows:

Asia-Pac:	Listed
Australian Inventory of Chemical Substances (AICS):	Listed
Korean Existing Chemicals List (ECL):	Listed
Japanese Existing National Inventory of Chemical Substances (ENCS):	Listed
Philippines Inventory if Chemicals and Chemical Substances (PICCS):	Listed
Swiss Giftliste List of Toxic Substances:	Listed
U.S. TSCA:	Listed

SECTION 16 - OTHER INFORMATION

PREPARED BY: Paul Eigbrett Global Safety Management, 10006 Cross Creek Blvd. Suite 440, Tampa, FL 33647

Disclaimer: To the best of Alconox, Inc. knowledge, the information contained herein is reliable and accurate as of this date; however, accuracy, suitability or completeness is not guaranteed and no warranties of any type either express or implied are provided. The information contained herein relates only to this specific product.

ANNEX:

IDENTIFIED USES OF LIQUINOX® AND DIRECTIONS FOR USE

Used to clean: Healthcare instruments, laboratory ware, vacuum equipment, tissue culture ware, personal protective equipment, sampling apparatus, catheters, tubing, disk drives, clean rooms, medical devices, optical parts, electronic components, pharmaceutical apparatus, cosmetics manufacturing equipment, metal castings, forgings and stampings, industrial parts, pipes, tanks and reactors. Authorized by USDA for use in federally inspected meat and poultry plants. Passes inhibitory residue test for water analysis. Used for phosphate sensitive analysis ware. FDAcertified. Used to remove: Soil, grit, grime, slime, grease, oils, blood, tissue, particulates, deposits, chemical and solvents.

Surfaces cleaned: Corrosion inhibited formulation recommended for glass, metal, stainless steel, porcelain, ceramic, plastic, cement and fiberglass. Can be used on soft metals such as copper, aluminum, zinc and magnesium if rinsed promptly. Used for art restoration. Corrosion testing may be advisable.

Cleaning method: Soak, brush, sponge, cloth, ultrasonic, flow through clean-inplace. Will foam—not for spray or machine use.

Directions: Make a fresh 1% solution (2 1/2 Tbsp. per gal., 1 1/4 oz. per gal. or 10 ml per liter) in cold, warm or hot water. If available, use warm water. Use cold water for blood stains. For difficult soils, raise water temperature and use more detergent. Clean by soak, circulate, wipe or ultrasonic method. Not for spray machines, will foam. RINSE THOROUGHLY—preferably with running water. For critical cleaning, do final or all rinsing in distilled, deionized or purified water. For food contact surfaces, rinse with potable water. Used on a wide range of glass, ceramic, plastic and metal surfaces. Corrosion testing may be advisable.

Material Safety Data Sheet: **Simple Green® All-Purpose Cleaner and Simple Green® Scrubbing Pad**

Version No. 13005-12B Date of Issue: February 2012 *ANSI-Z400.1-2003 Format*

Section 1: PRODUCT & COMPANY IDENTIFICATION

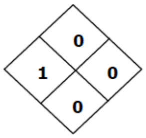
Product Name: Simple Green® All-Purpose Cleaner
Additional Names: Simple Green® Concentrated Cleaner Degreaser Deodorizer
Simple Green® Scrubbing Pad (Fluid in pad only)

Manufacturer's Part Number: **Please refer to page 4*

Company: Sunshine Makers, Inc.
15922 Pacific Coast Highway
Huntington Beach, CA 92649 USA
Telephone: 800-228-0709 ● 562-795-6000 Fax: 562-592-3830
Emergency Phone: Chem-Tel 24-Hour Emergency Service: 800-255-3924

Section 2: HAZARDS IDENTIFICATION

Emergency Overview: **CAUTION. Irritant. This is a Green colored liquid with a sassafras added odor. Scrubbing pad is a green fibrous rectangle infused with Simple Green Cleaner.**



NFPA/HMIS Rating:
Health = 1 = slight
Fire, Reactivity, and Special = 0 = minimal

Potential Health Effects

Eye Contact: Mildly irritating.
Skin Contact: No adverse effects expected under typical use conditions. Prolonged exposure may cause dryness. Chemically sensitive individuals may experience mild irritation.
Ingestion: May cause stomach or intestinal irritation if swallowed.
Inhalation: No adverse effects expected under typical use conditions. Adequate ventilation should be present for prolonged usage in small enclosed areas.

Section 3: COMPOSITION/INFORMATION ON INGREDIENTS

Ingredient	CAS Number	Percent Range
Water	7732-18-5	≥ 78%
2-butoxyethanol	111-76-2	≤ 5%
Ethoxylated Alcohol	68439-46-3	≤ 5%
Tetrapotassium Pyrophosphate	7320-34-5	≤ 5%
Sodium Citrate	68-04-2	≤ 5%
Fragrance	Proprietary Mixture	≤ 1%
Colorant	Proprietary Mixture	≤ 1%

Section 4: FIRST AID MEASURES

If Inhaled: If adverse effect occurs, move to fresh air.
If on skin: If adverse effect occurs, rinse skin with water.
If in eyes: Flush with plenty of water. After 5 minutes of flushing, remove contact lenses, if present. Continue flushing for at least 10 more minutes. If irritation persists seek medical attention.
If ingested: Drink plenty of water to dilute.

Section 5: FIRE FIGHTING MEASURES

This formula is stable, non-flammable, and will not burn. No special procedures necessary

Flammability:	Non-flammable
Flash Point:	Non-flammable
Suitable Extinguishing Media:	Use Dry chemical, CO2, water spray or “alcohol” foam.
Extinguishing Media to Avoid	High volume jet water.
Special Exposure Hazards:	In event of fire created carbon oxides, oxides of phosphorus may be formed.
Special Protective Equipment:	Wear positive pressure self-contained breathing apparatus; Wear full protective clothing.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions: See section 8 – personal protection.

Environmental Precautions: Do not allow into open waterways and ground water systems.

Method for Clean Up: Dilute with water and rinse into sanitary sewer system or soak up with inert absorbent material.

Section 7: HANDLING AND STORAGE

Handling: Keep container tightly closed. Ensure adequate ventilation. Keep out of reach of children.

Storage: Keep in cool dry area.

Section 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Limit Values:	OSHA PEL	ACGIH TLV
2-butoxyethanol	TWA 50 ppm (240 mg/m^3)	20 ppm (97 mg/m^3)
Tetrapotassium Pyrophosphate		5 mg/m^3

Exposure Controls:

Eye Contact:	Use protective glasses if splashing or spray-back is likely.
Respiratory:	Use in well ventilated areas.
Skin Contact:	Prolonged exposure or dermal sensitive individuals should use protective gloves.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Green Liquid	**Vapor Pressure:**	18 mmHg @20°C; 23.5 mmHg @26°C	
Odor:	Added Sassafras odor	**Density:**	8.5 lb/gal;	
Specific Gravity:	1.010 ± 0.010	**Water Solubility:**	100%	
pH:	9.5 ± 0.5	**VOC composite Partial Pressure:**	TBD	
Boiling Point:	~210°F (98 °C)	**VOC:**	CARB Method 310	3.8%
Freezing Point:	~ 32°F (0 °C)		SCAQMD Method 313	2.8%
Nutrient Content:	Phosphorous: 0.28% Chloride: ~110 ppm	Sulfur: ~180 ppm Fluorine: ~90 ppm		

Section 10: STABILITY AND REACTIVITY

Stability:	Stable
Materials to Avoid:	None known
Hazardous Decomposition Products:	Normal products of combustion - CO, CO2; Oxides of Phosphorous may occur.

Section 11: TOXICOLOGICAL INFORMATION

Acute Toxicity:	Oral LD_{50} (rat)	> 5 g/kg body weight
	Dermal LD_{50} (rabbit)	> 5 g/kg body weight

Toxicity calculated from ingredients using OECD SERIES ON TESTING AND ASSESSMENT Number 33

Carcinogens: No ingredients are listed by OSHA, IARC, or NTP as known or suspected carcinogens.

Section 12: ECOLOGICAL INFORMATION

Hazard to wild mammals:	Low, based on toxicology profile
Hazard to avian species:	Low, based on toxicology profile
Hazard to aquatic organisms:	Low, based on toxicology profile
Chemical Fate Information:	Readily Biodegradable per OECD 301D, Closed Bottle Test

Section 13: DISPOSAL CONSIDERATIONS

Appropriate Method for Disposal:

Unused Product:	*Dilute with water to use concentration and dispose by sanitary sewer.
Used Product:	*This product can enter into clarifiers and oil/water separators. Used product may be hazardous depending on the cleaning application and resulting contaminants.
Empty Containers:	*Triple-rinse with water and offer for recycling if available in your area. Otherwise, dispose as non-hazardous waste.

*Dispose of used or unused product, and empty containers in accordance with the local, State, Provincial, and Federal regulations for your location. Never dispose of used degreasing rinsates into lakes, streams, and open bodies of water or storm drains.

Section 14: TRANSPORT INFORMATION

U.S. Department of Transportation (DOT) / Canadian TDG: Not Regulated

IMO / IDMG:	Not classified as Dangerous
ICAO/ IATA:	Not classified as Dangerous
ADR/RID:	Not classified as Dangerous

U.N. Number	Not Required	Proper Shipping Name:	Detergent Solution
Hazard Class:	Non-Hazardous	Marine Pollutant:	No

Section 15: REGULATORY INFORMATION

All components are listed on: EINECS, TSCA, DSL and AICS Inventory.
No components listed under: Clean Air Act Section 112; Clean Water Act 307 & 311

SARA Title III 2-butoxyethanol is subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 as Category N230 – Certain Glycol Ethers.

RCRA Status: Not a hazardous waste CERCLA Status : No components listed

State Right To Know Lists

2-butoxyethanol Illinois, Massachusetts, New Jersey, Pennsylvania, Rhode Island

WHMIS Classification – Category D, subcategory 2B, eye irritant

Name	Toxic Substances List – Schedule 1 – CEPA (Canadian Environmental Protection Act)	NPRI Inventory
2-butoxyethanol	Yes	No

This product has been classified according to the hazard criteria of the CPR and the MSDS contains all the information required by Canada's Controlled Products Regulation.

Section 16: OTHER INFORMATION

Questions about the information found on this MSDS should be directed to:
SUNSHINE MAKERS, INC. – TECHNICAL DEPARTMENT
15922 Pacific Coast Hwy. Huntington Beach, CA 92649
Phone: 800/228-0709 [8am-5pm Pacific time, Mon-Fri] *Fax:* 562/592-3830 *Email:* infoweb@simplegreen.com

CAGE CODE 1Z575
GSA/FSS - CONTRACT NO. GS-07F-0065J
Scrubbing Pad GSA/BPA - CONTRACT NO. GS-07F-BSIMP
National Stock Numbers & Industrial Part Numbers:

Simple Green	Part Number	NSN	Size
	13012	7930-01-342-5315	24 oz spray (12/case)
	13005	7930-01-306-8369	1 Gallon (6/case)
	13006	7930-01-342-5316	5 Gallon
	13016	7930-01-342-5317	15 Gallon
	13008	7930-01-342-4145	55 Gallon
	13103	N/A	2oz samples
	13225	N/A	2.5 Gallon
	13275	N/A	275 Gallon tote
	48049	N/A	1 Gallon Conc. w/ 32oz dilution
Scrubbing Pad	10224	7930-01-346-9148	Each (24/case)

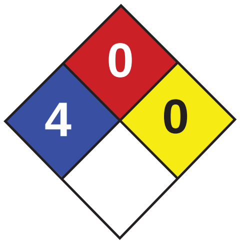
Retail Numbers:

Part Number	Size
13002	16 oz Trigger (12/case)
13005	1 Gallon (6/case)
13013	24 oz Trigger (12/case)
13014	67 oz / 2 L (6/case)
13033	32 oz Trigger (12/case)
80007	Tier display holding 13005 (36/Tier)

part number is for both industrial and retail

****International Part Numbers May Differ.**

DISCLAIMER: The information provided with this MSDS is furnished in good faith and without warranty of any kind. Personnel handling this material must make independent determinations of the suitability and completeness of information from all sources to assure proper use and disposal of this material and the safety and health of employees and customers. Sunshine Makers, Inc. assumes no additional liability or responsibility resulting from the use of, or reliance on this information.



Health	3
Fire	0
Reactivity	0
Personal Protection	

Material Safety Data Sheet
Nitric acid, 65% MSDS

Section 1: Chemical Product and Company Identification

Product Name: Nitric acid, 65%

Catalog Codes: SLN2161

CAS#: Mixture.

RTECS: Not applicable.

TSCA: TSCA 8(b) inventory: Water; Nitric acid, fuming

CI#: Not applicable.

Synonym: Nitric Acid, 65%

Chemical Name: Not applicable.

Chemical Formula: Not applicable.

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Water	7732-18-5	35
Nitric acid, fuming	7697-37-2	65

Toxicological Data on Ingredients: Nitric acid, fuming: VAPOR (LC50): Acute: 244 ppm 0.5 hours [Rat]. 344 ppm 0.5 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, . Slightly hazardous in case of inhalation (lung sensitizer). Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Prolonged exposure may result in skin burns and ulcerations. Over-exposure by inhalation may cause respiratory irritation. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to lungs, mucous membranes, upper respiratory

tract, skin, eyes, teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion: Not available.

Fire Hazards in Presence of Various Substances: of combustible materials

Explosion Hazards in Presence of Various Substances:
Explosive in presence of reducing materials, of organic materials, of metals, of alkalis. Non-explosive in presence of open flames and sparks, of shocks.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Flammable in presence of cellulose or other combustible materials. Phosphine, hydrogen sulfide, selenide all ignite when fuming nitric acid is dripped into gas. (Nitric Acid, fuming)

Special Remarks on Explosion Hazards:
Reacts exlposively with metallic powders, carbides, cyanides, sulfides, alkalies and turpentine. Can react explosively with many reducing agents. Arsine, phosphine, tetraborane all oxidized explosively in presence of nitric acid. Cesium and rubidium

acetylides explode in contact with nitric acid. Explosive reaction with Nitric Acid + Nitrobenzene + water. Detonation with Nitric Acid + 4-Methylcyclohexane. (Nitric acid, fuming)

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:
Corrosive liquid. Oxidizing material. Poisonous liquid. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Avoid contact with a combustible material (wood, paper, oil, clothing...). Keep substance damp using water spray. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep container dry. Keep away from heat. Keep away from sources of ignition. Keep away from combustible material.. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture. May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage:
Keep container tightly closed. Keep container in a cool, well-ventilated area. Separate from acids, alkalies, reducing agents and combustibles. See NFPA 43A, Code for the Storage of Liquid and Solid Oxidizers. Do not store above 23°C (73.4°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 2 STEL: 4 (ppm) from ACGIH (TLV) [United States] TWA: 2 STEL: 4 from OSHA (PEL) [United States] Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Acrid. Disagreeable and choking. (Strong.)

Taste: Not available.

Molecular Weight: Not applicable.

Color: Colorless to light yellow.

pH (1% soln/water): Acidic.

Boiling Point: 121°C (249.8°F)

Melting Point: -41.6°C (-42.9°F)

Critical Temperature: Not available.

Specific Gravity: 1.408 (Water = 1)

Vapor Pressure: 6 kPa (@ 20°C)

Vapor Density: 2.5 (Air = 1)

Volatility: Not available.

Odor Threshold: 0.29 ppm

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether.

Solubility:
Easily soluble in cold water, hot water. Soluble in diethyl ether.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials

Incompatibility with various substances:
Highly reactive with alkalis. Reactive with reducing agents, combustible materials, organic materials, metals, acids.

Corrosivity:
Extremely corrosive in presence of aluminum, of copper. Non-corrosive in presence of glass, of stainless steel(304), of stainless steel(316), of brass.

Special Remarks on Reactivity:
A strong oxidizer. Reacts violently with alcohol, organic material, turpene, charcoal. Violent reaction with Nitric acid + Acetone and Sulfuric acid. Nitric Acid will react with water or steam to produce heat and toxic, corrosive and flammable vapors. (Nitric acid, fuming)

Special Remarks on Corrosivity:
In presence of traces of oxides, it attacks all base metals except aluminum and special chromium steels. It will attack some forms of plastics, rubber, and coatings. No corrosive effect on bronze. No corrosivity data for zinc, and steel

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
LD50: Not available. LC50: Not available.

Chronic Effects on Humans:

Contains material which may cause damage to the following organs: lungs, mucous membranes, upper respiratory tract, skin, eyes, teeth.

Other Toxic Effects on Humans:
Extremely hazardous in case of inhalation (lung corrosive). Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (corrosive), of ingestion, .

Special Remarks on Toxicity to Animals: LDL - Lowest Published Lethal Dose [Human] - Route: Oral; Dose: 430 mg/kg (Nitric acid, fuming)

Special Remarks on Chronic Effects on Humans:
May cause adverse reproductive effects (effects on newborn and fetotoxicity) based on animal data. (Nitric acid, fuming)

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects: Skin: Severely irritates skin. Causes skin burns and may cause deep and penetrating ulcers of the skin with a characteristic yellow to brownish discoloration. May be fatal if absorbed through skin. Eyes: Severely irritates eyes. Causes eye burns. May cause irreversible eye injury. Ingestion: May be fatal if swallowed. Causes serious gastrointestinal tract irritation or burns with nausea, vomiting, severe abdominal pain, and possible "coffee grounds" appearance of the vomitus . May cause perforation of the digestive tract. Inhalation: May be fatal if inhaled. Vapor is extremely hazardous. Vapor may cause nitrous gas poisoning. Effects may be delayed. May cause irritation of the mucous membranes and respiratory tract with burning pain in the nose and throat, coughing, sneezing, wheezing, shortness of breath and pulmonary edema. Other symptoms may include nausea, and vomiting. Chronic Potential Health Effects: Repeated inhalation may produce changes in pulmonary function and/or chronic bronchitis. It may also affect behavior (headache, dizziness, drowsiness, muscle contaction or spasticity, weakness, loss of coordinaton, mental confusion), and urinary system (kidney faillure, decreased urinary output after several hours of

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Nitric acid UNNA: 2031 PG: II

Special Provisions for Transport: Marine Pollutant

Section 15: Other Regulatory Information

Federal and State Regulations:
New York release reporting list: Nitric acid, fuming Rhode Island RTK hazardous substances: Nitric acid, fuming Pennsylvania RTK: Nitric acid, fuming Florida: Nitric acid, fuming Minnesota: Nitric acid, fuming Massachusetts RTK: Nitric acid, fuming

New Jersey: Nitric acid, fuming TSCA 8(b) inventory: Water; Nitric acid, fuming SARA 302/304/311/312 extremely hazardous substances: Nitric acid, fuming SARA 313 toxic chemical notification and release reporting: Nitric acid, fuming 65% CERCLA: Hazardous substances.: Nitric acid, fuming: 1000 lbs. (453.6 kg);

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada):
CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC). CLASS D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.

DSCL (EEC):
R8- Contact with combustible material may cause fire. R35- Causes severe burns. S23- Do not breathe gas/fumes/vapour/ spray [***] S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S36- Wear suitable protective clothing. S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 0

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 4

Flammability: 0

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Face shield.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 10:59 AM

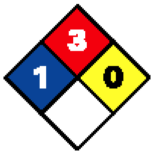
Last Updated: 11/01/2010 12:00 PM

AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades **MSDS No. 9950**

EMERGENCY OVERVIEW
DANGER!
EXTREMELY FLAMMABLE - EYE AND MUCOUS MEMBRANE IRRITANT - EFFECTS CENTRAL NERVOUS SYSTEM - HARMFUL OR FATAL IF SWALLOWED - ASPIRATION HAZARD



NFPA 704 (Section 16)

High fire hazard. Keep away from heat, spark, open flame, and other ignition sources.

If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs). Contact may cause eye, skin and mucous membrane irritation. Harmful if absorbed through the skin. Avoid prolonged breathing of vapors or mists. Inhalation may cause irritation, anesthetic effects (dizziness, nausea, headache, intoxication), and respiratory system effects.

Long-term exposure may cause effects to specific organs, such as to the liver, kidneys, blood, nervous system, and skin. Contains benzene, which can cause blood disease, including anemia and leukemia.

1. CHEMICAL PRODUCT and COMPANY INFORMATION (rev. Jan-04)

Amerada Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

EMERGENCY TELEPHONE NUMBER (24 hrs):	**CHEMTREC (800)424-9300**
COMPANY CONTACT (business hours):	Corporate Safety (732)750-6000
MSDS Internet Website	www.hess.com/about/environ.html

SYNONYMS: Hess Conventional (Oxygenated and Non-oxygenated) Gasoline; Reformulated Gasoline (RFG); Reformulated Gasoline Blendstock for Oxygenate Blending (RBOB); Unleaded Motor or Automotive Gasoline

See Section 16 for abbreviations and acronyms.

2. COMPOSITION and INFORMATION ON INGREDIENTS * (rev. Jan-04)

INGREDIENT NAME (CAS No.)	CONCENTRATION PERCENT BY WEIGHT
Gasoline (86290-81-5)	100
Benzene (71-43-2)	0.1 - 4.9 (0.1 - 1.3 reformulated gasoline)
n-Butane (106-97-8)	< 10
Ethyl Alcohol (Ethanol) (64-17-5)	0 - 10
Ethyl benzene (100-41-4)	< 3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Tertiary-amyl methyl ether (TAME) (994-05-8)	0 to 17.2
Toluene (108-88-3)	1 - 25
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 - 15

A complex blend of petroleum-derived normal and branched-chain alkane, cycloalkane, alkene, and aromatic hydrocarbons. May contain antioxidant and multifunctional additives. Non-oxygenated Conventional Gasoline and RBOB do not have oxygenates (Ethanol or MTBE and/or TAME). Oxygenated Conventional and Reformulated Gasoline will have oxygenates for octane enhancement or as legally required.

3. HAZARDS IDENTIFICATION (rev. Dec-97)

EYES
Moderate irritant. Contact with liquid or vapor may cause irritation.

SKIN
Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

INGESTION
The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

INHALATION
Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS and CARCINOGENICITY
Contains benzene, a regulated human carcinogen. Benzene has the potential to cause anemia and other blood diseases, including leukemia, after repeated and prolonged exposure. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with systemic toxicity. See also Section 11 - Toxicological Information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE
Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash). Chronic respiratory disease, liver or kidney dysfunction, or pre-existing central nervous system disorders may be aggravated by exposure.

4. FIRST AID MEASURES (rev. Dec-97)

EYES
In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN
Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops.

INGESTION
DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION
Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

5. FIRE FIGHTING MEASURES (rev. Dec-97)

FLAMMABLE PROPERTIES:

FLASH POINT:	-45 °F (-43°C)
AUTOIGNITION TEMPERATURE:	highly variable; > 530 °F (>280 °C)
OSHA/NFPA FLAMMABILITY CLASS:	1A (flammable liquid)
LOWER EXPLOSIVE LIMIT (%):	1.4%
UPPER EXPLOSIVE LIMIT (%):	7.6%

FIRE AND EXPLOSION HAZARDS

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

During certain times of the year and/or in certain geographical locations, gasoline may contain MTBE and/or TAME. Firefighting foam suitable for polar solvents is recommended for fuel with greater than 10% oxygenate concentration - refer to NFPA 11 "Low Expansion Foam - 1994 Edition."

FIRE FIGHTING INSTRUCTIONS

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 16 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES (rev. Dec-97)

ACTIVATE FACILITY SPILL CONTINGENCY or EMERGENCY PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

7. HANDLING and STORAGE (rev. Dec-97)

HANDLING PRECAUTIONS

******USE ONLY AS A MOTOR FUEL******
******DO NOT SIPHON BY MOUTH******

Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents.

STORAGE PRECAUTIONS

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

WORK/HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS and PERSONAL PROTECTION (rev. Jan-04)

EXPOSURE LIMITS

Component (CAS No.)		Exposure Limits		
	Source	**TWA (ppm)**	**STEL (ppm)**	**Note**
Gasoline (86290-81-5)	ACGIH	300	500	A3
Benzene (71-43-2)	OSHA	1	5	Carcinogen
	ACGIH	0.5	2.5	A1, skin
	USCG	1	5	
n-Butane (106-97-8)	ACGIH	800	--	2003 NOIC: 1000 ppm (TWA) Aliphatic Hydrocarbon Gases Alkane (C1-C4)
Ethyl Alcohol (ethanol) (64-17-5)	OSHA	1000	--	
	ACGIH	1000	--	A4
Ethyl benzene (100-41-4)	OSHA	100	--	
	ACGIH	100	125	A3

Component (CAS No.)	Exposure Limits			
	Source	TWA (ppm)	STEL (ppm)	Note
n-Hexane (110-54-3)	OSHA	500	--	
	ACGIH	50	--	skin
Methyl-tertiary butyl ether [MTBE] (1634-04-4)	ACGIH	50		A3
Tertiary-amyl methyl ether [TAME] (994-05-8)				None established
Toluene (108-88-3)	OSHA	200		Ceiling: 300 ppm; Peak: 500 ppm (10 min.)
	ACGIH	50	--	A4 (skin)
1,2,4- Trimethylbenzene (95-63-6)	ACGIH	25	--	
Xylene, mixed isomers (1330-20-7)	OSHA	100	--	
	ACGIH	100	150	A4

ENGINEERING CONTROLS

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

EYE/FACE PROTECTION

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

SKIN PROTECTION

Gloves constructed of nitrile or neoprene are recommended. Chemical protective clothing such as that made of of E.I. DuPont Tychem ®, products or equivalent is recommended based on degree of exposure.

Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

RESPIRATORY PROTECTION

A NIOSH-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection and limitations.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

9. PHYSICAL and CHEMICAL PROPERTIES (rev. Jan-04)

APPEARANCE

A translucent, straw-colored or light yellow liquid

ODOR

A strong, characteristic aromatic hydrocarbon odor. Oxygenated gasoline with MTBE and/or TAME may have a sweet, ether-like odor and is detectable at a lower concentration than non-oxygenated gasoline.

ODOR THRESHOLD

	Odor Detection	Odor Recognition
Non-oxygenated gasoline:	0.5 - 0.6 ppm	0.8 - 1.1 ppm
Gasoline with 15% MTBE:	0.2 - 0.3 ppm	0.4 - 0.7 ppm
Gasoline with 15% TAME:	0.1 ppm	0.2 ppm

BASIC PHYSICAL PROPERTIES

BOILING RANGE:	85 to 437 ^{o}F (39 to 200 ^{o}C)
VAPOR PRESSURE:	6.4 - 15 RVP @ 100 ^{o}F (38 ^{o}C) (275-475 mm Hg @ 68 ^{o}F (20 ^{o}C)
VAPOR DENSITY (air = 1):	AP 3 to 4
SPECIFIC GRAVITY (H_2O = 1):	0.70 – 0.78
EVAPORATION RATE:	10-11 (n-butyl acetate = 1)
PERCENT VOLATILES:	100 %

SOLUBILITY (H_2O):	Non-oxygenated gasoline - negligible (< 0.1% @ 77 ^oF). Gasoline with 15% MTBE - slight (0.1 - 3% @ 77 ^oF); ethanol is readily soluble in water

10. STABILITY and REACTIVITY (rev. Dec-94)

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources

INCOMPATIBLE MATERIALS

Keep away from strong oxidizers.

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

11. TOXICOLOGICAL PROPERTIES (rev. Dec-97)

ACUTE TOXICITY

Acute Dermal LD50 (rabbits): > 5 ml/kg	Acute Oral LD50 (rat): 18.75 ml/kg
Primary dermal irritation (rabbits): slightly irritating	Draize eye irritation (rabbits): non-irritating
Guinea pig sensitization: negative	

CHRONIC EFFECTS AND CARCINOGENICITY

Carcinogenicity: OSHA: NO IARC: YES - 2B NTP: NO ACGIH: YES (A3)

IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain.

This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

This product may contain methyl tertiary butyl ether (MTBE): animal and human health effects studies indicate that MTBE may cause eye, skin, and respiratory tract irritation, central nervous system depression and neurotoxicity. MTBE is classified as an animal carcinogen (A3) by the ACGIH.

12. ECOLOGICAL INFORMATION (rev. Jan-04)

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations. If released, oxygenates such as ethers and alcohols will be expected to exhibit fairly high mobility in soil, and therefore may leach into groundwater. The API (www.api.org) provides a number of useful references addressing petroleum and oxygenate contamination of groundwater.

13. DISPOSAL CONSIDERATIONS (rev. Dec-97)

Consult federal, state and local waste regulations to determine appropriate disposal options.

14. TRANSPORTATION INFORMATION (rev. Jan-04)

PLACARD:

DOT PROPER SHIPPING NAME:	Gasoline
DOT HAZARD CLASS and PACKING GROUP:	3, PG II
DOT IDENTIFICATION NUMBER:	UN 1203
DOT SHIPPING LABEL:	FLAMMABLE LIQUID

15. REGULATORY INFORMATION (rev. Jan-04)

U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION

This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other federal, state, or local regulations; consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow-up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

The CERCLA definition of hazardous substances contains a “petroleum exclusion” clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

SARA SECTION 311/312 - HAZARD CLASSES

ACUTE HEALTH	CHRONIC HEALTH	FIRE	SUDDEN RELEASE OF PRESSURE	REACTIVE
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION WT. PERCENT
Benzene (71-43-2)	0.1 to 4.9 (0.1 to 1.3 for reformulated gasoline)
Ethyl benzene (100-41-4)	< 3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Toluene (108-88-3)	1 to 15
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 to 15

US EPA guidance documents (www.epa.gov/tri) for reporting Persistent Bioaccumulating Toxics (PBTs) indicate this product may contain the following deminimis levels of toxic chemicals subject to Section 313 reporting:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION - Parts per million (ppm) by weight
Polycyclic aromatic compounds (PACs)	17
Benzo (g,h,i) perylene (191-24-2)	2.55
Lead (7439-92-1)	0.079

CANADIAN REGULATORY INFORMATION (WHMIS)

Class B, Division 2 (Flammable Liquid)
Class D, Division 2A (Very toxic by other means) and Class D, Division 2B (Toxic by other means)

16. OTHER INFORMATION (rev. Jan-04)

NFPA® HAZARD RATING	HEALTH:	1	Slight
	FIRE:	3	Serious
	REACTIVITY:	0	Minimal
HMIS® HAZARD RATING	HEALTH:	1 *	Slight
	FIRE:	3	Serious
	REACTIVITY:	0	Minimal
	* CHRONIC		

SUPERSEDES MSDS DATED: 12/30/97

ABBREVIATIONS:

AP = Approximately
< = Less than
> = Greater than
N/A = Not Applicable
N/D = Not Determined
ppm = parts per million

ACRONYMS:

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute (212)642-4900
API	American Petroleum Institute (202)682-8000
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act
DOT	U.S. Department of Transportation [General Info: (800)467-4922]
EPA	U.S. Environmental Protection Agency
HMIS	Hazardous Materials Information System
IARC	International Agency For Research On Cancer
MSHA	Mine Safety and Health Administration
NFPA	National Fire Protection Association (617)770-3000
NIOSH	National Institute of Occupational Safety and Health
NOIC	Notice of Intended Change (proposed change to ACGIH TLV)
NTP	National Toxicology Program
OPA	Oil Pollution Act of 1990
OSHA	U.S. Occupational Safety & Health Administration
PEL	Permissible Exposure Limit (OSHA)
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit (NIOSH)
SARA	Superfund Amendments and Reauthorization Act of 1986 Title III
SCBA	Self-Contained Breathing Apparatus
SPCC	Spill Prevention, Control, and Countermeasures
STEL	Short-Term Exposure Limit (generally 15 minutes)
TLV	Threshold Limit Value (ACGIH)
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average (8 hr.)
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Workplace Hazardous Materials Information System (Canada)

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

MATERIAL SAFETY DATA SHEET

Diesel Fuel (All Types)

MSDS No. 9909

EMERGENCY OVERVIEW
CAUTION!
OSHA/NFPA COMBUSTIBLE LIQUID - SLIGHT TO MODERATE IRRITANT
EFFECTS CENTRAL NERVOUS SYSTEM
HARMFUL OR FATAL IF SWALLOWED

Moderate fire hazard. Avoid breathing vapors or mists. May cause dizziness and drowsiness. May cause moderate eye irritation and skin irritation (rash). Long-term, repeated exposure may cause skin cancer.
If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs).

NFPA 704 (Section 16)

1. CHEMICAL PRODUCT AND COMPANY INFORMATION

Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

EMERGENCY TELEPHONE NUMBER (24 hrs): **CHEMTREC (800) 424-9300**
COMPANY CONTACT (business hours): Corporate Safety (732) 750-6000
MSDS INTERNET WEBSITE: www.hess.com (See Environment, Health, Safety & Social Responsibility)

SYNONYMS: Ultra Low Sulfur Diesel (ULSD); Low Sulfur Diesel; Motor Vehicle Diesel Fuel; Diesel Fuel #2; Dyed Diesel Fuel; Non-Road, Locomotive and Marine Diesel Fuel; Tax-exempt Diesel Fuel

See Section 16 for abbreviations and acronyms.

2. COMPOSITION and CHEMICAL INFORMATION ON INGREDIENTS

INGREDIENT NAME (CAS No.)	CONCENTRATION PERCENT BY WEIGHT
Diesel Fuel (68476-34-6)	100
Naphthalene (91-20-3)	Typically < 0.01

A complex mixture of hydrocarbons with carbon numbers in the range C9 and higher. Diesel fuel may be dyed (red) for tax purposes. May contain a multifunctional additive.

3. HAZARDS IDENTIFICATION

EYES

Contact with liquid or vapor may cause mild irritation.

SKIN

May cause skin irritation with prolonged or repeated contact. Practically non-toxic if absorbed following acute (single) exposure. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

INGESTION

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

INHALATION
Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS and CARCINOGENICITY
Similar products produced skin cancer and systemic toxicity in laboratory animals following repeated applications. The significance of these results to human exposures has not been determined - see Section 11 Toxicological Information.

IARC classifies whole diesel fuel exhaust particulates as probably carcinogenic to humans (Group 2A). NIOSH regards whole diesel fuel exhaust particulates as a potential cause of occupational lung cancer based on animal studies and limited evidence in humans.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE
Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash).

4. FIRST AID MEASURES

EYES
In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN
Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops.

INGESTION
DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION
Remove person to fresh air. If person is not breathing provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES:

FLASH POINT:	> 125 ^{o}F (> 52 ^{o}C) minimum PMCC
AUTOIGNITION POINT:	494 ^{o}F (257 ^{o}C)
OSHA/NFPA FLAMMABILITY CLASS:	2 (COMBUSTIBLE)
LOWER EXPLOSIVE LIMIT (%):	0.6
UPPER EXPLOSIVE LIMIT (%):	7.5

FIRE AND EXPLOSION HAZARDS
Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA
SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

FIRE FIGHTING INSTRUCTIONS

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 16 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES

ACTIVATE FACILITY'S SPILL CONTINGENCY OR EMERGENCY RESPONSE PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

7. HANDLING and STORAGE

HANDLING PRECAUTIONS

Handle as a combustible liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Diesel fuel, and in particular low and ultra low sulfur diesel fuel, has the capability of accumulating a static electrical charge of sufficient energy to cause a fire/explosion in the presence of lower flashpoint products such as gasoline. The accumulation of such a static charge occurs as the diesel flows through pipelines, filters, nozzles and various work tasks such as tank/container filling, splash loading, tank cleaning; product sampling; tank gauging; cleaning, mixing, vacuum truck operations, switch loading, and product agitation. There is a greater potential for static charge accumulation in cold temperature, low humidity conditions.

Documents such as 29 CFR OSHA 1910.106 "Flammable and Combustible Liquids, NFPA 77 Recommended Practice on Static Electricity, API 2003 "Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents and ASTM D4865 "Standard Guide for Generation and Dissipation of Static

Electricity in Petroleum Fuel Systems" address special precautions and design requirements involving loading rates, grounding, bonding, filter installation, conductivity additives and especially the hazards associated with "switch loading." ["Switch Loading" is when a higher flash point product (such as diesel) is loaded into tanks previously containing a low flash point product (such as gasoline) and the electrical charge generated during loading of the diesel results in a static ignition of the vapor from the previous cargo (gasoline).]

Note: When conductivity additives are used or are necessary the product should achieve 25 picosiemens/meter or greater at the handling temperature.

STORAGE PRECAUTIONS

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

WORK/HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS and PERSONAL PROTECTION

EXPOSURE LIMITS

Components (CAS No.)	Source	Exposure Limits TWA/STEL	Note
Diesel Fuel: (68476-34-6)	OSHA	5 mg/m, as mineral oil mist	
	ACGIH	100 mg/m^3 (as totally hydrocarbon vapor) TWA	A3, skin
Naphthalene (91-20-3)	OSHA	10 ppm TWA	
	ACGIH	10 ppm TWA / 15 ppm STEL	A4, Skin

ENGINEERING CONTROLS

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

EYE/FACE PROTECTION

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

SKIN PROTECTION

Gloves constructed of nitrile, neoprene, or PVC are recommended. Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

RESPIRATORY PROTECTION

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

9. PHYSICAL and CHEMICAL PROPERTIES

APPEARANCE

Clear, straw-yellow liquid. Dyed fuel oil will be red or reddish-colored.

ODOR

Mild, petroleum distillate odor

BASIC PHYSICAL PROPERTIES

BOILING RANGE:	320 to 690 oF (160 to 366 ^{o}C)
VAPOR PRESSURE:	0.009 psia @ 70 ^{o}F (21 ^{o}C)
VAPOR DENSITY (air = 1):	> 1.0
SPECIFIC GRAVITY (H_2O = 1):	0.83 to 0.88 @ 60 ^{o}F (16 ^{o}C)
PERCENT VOLATILES:	100 %
EVAPORATION RATE:	Slow; varies with conditions
SOLUBILITY (H_2O):	Negligible

10. STABILITY and REACTIVITY

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID and INCOMPATIBLE MATERIALS

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources. Keep away from strong oxidizers; Viton ®; Fluorel ®

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

11. TOXICOLOGICAL PROPERTIES

ACUTE TOXICITY

Acute dermal LD50 (rabbits): > 5 ml/kg
Primary dermal irritation: extremely irritating (rabbits)
Guinea pig sensitization: negative
Acute oral LD50 (rats): 9 ml/kg
Draize eye irritation: non-irritating (rabbits)

CHRONIC EFFECTS AND CARCINOGENICITY

Carcinogenic: OSHA: NO IARC: NO NTP: NO ACGIH: A3

Studies have shown that similar products produce skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation.

MUTAGENICITY (genetic effects)

This material has been positive in a mutagenicity study.

12. ECOLOGICAL INFORMATION

Keep out of sewers, drainage areas, and waterways. Report spills and releases, as applicable, under Federal and State regulations.

13. DISPOSAL CONSIDERATIONS

Consult federal, state and local waste regulations to determine appropriate disposal options.

14. TRANSPORTATION INFORMATION

PROPER SHIPPING NAME:	Diesel Fuel
HAZARD CLASS and PACKING GROUP:	3, PG III
DOT IDENTIFICATION NUMBER:	NA 1993 (Domestic) UN 1202 (International)
DOT SHIPPING LABEL:	None

Placard (International Only):

Use Combustible Placard if shipping in bulk domestically

15. REGULATORY INFORMATION

U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION

This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other regulations at the state and/or local level. Consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

The CERCLA definition of hazardous substances contains a “petroleum exclusion” clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

SARA SECTION 311/312 - HAZARD CLASSES

ACUTE HEALTH	CHRONIC HEALTH	FIRE	SUDDEN RELEASE OF PRESSURE	REACTIVE
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product may contain listed chemicals below the *de minimis* levels which therefore are not subject to the supplier notification requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372. If you may be required to report releases of chemicals listed in 40 CFR 372.28, you may contact Hess Corporate Safety if you require additional information regarding this product.

CALIFORNIA PROPOSITON 65 LIST OF CHEMICALS

This product contains the following chemicals that are included on the Proposition 65 "List of Chemicals" required by the California Safe Drinking Water and Toxic Enforcement Act of 1986:

INGREDIENT NAME (CAS NUMBER)	**Date Listed**
Diesel Engine Exhaust (no CAS Number listed)	10/01/1990

CANADIAN REGULATORY INFORMATION (WHMIS)

Class B, Division 3 (Combustible Liquid) and Class D, Division 2, Subdivision B (Toxic by other means)

16. OTHER INFORMATION

NFPA® HAZARD RATING		
	HEALTH:	0
	FIRE:	2
	REACTIVITY:	0

Refer to NFPA 704 “Identification of the Fire Hazards of Materials” for further information

HMIS® HAZARD RATING			
	HEALTH:	1 *	* Chronic
	FIRE:	2	
	PHYSICAL:	0	

SUPERSEDES MSDS DATED: 02/28/2001

ABBREVIATIONS:

AP = Approximately
< = Less than
> = Greater than
N/A = Not Applicable
N/D = Not Determined
ppm = parts per million

ACRONYMS:

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute (212) 642-4900
API	American Petroleum Institute (202) 682-8000
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act
DOT	U.S. Department of Transportation [General info: (800) 467-4922]
EPA	U.S. Environmental Protection Agency
HMIS	Hazardous Materials Information System
IARC	International Agency For Research On Cancer
MSHA	Mine Safety and Health Administration
NFPA	National Fire Protection Association (617)770-3000
NIOSH	National Institute of Occupational Safety and Health
NOIC	Notice of Intended Change (proposed change to ACGIH TLV)
NTP	National Toxicology Program
OPA	Oil Pollution Act of 1990
OSHA	U.S. Occupational Safety & Health Administration
PEL	Permissible Exposure Limit (OSHA)
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit (NIOSH)
SARA	Superfund Amendments and Reauthorization Act of 1986 Title III
SCBA	Self-Contained Breathing Apparatus
SPCC	Spill Prevention, Control, and Countermeasures
STEL	Short-Term Exposure Limit (generally 15 minutes)
TLV	Threshold Limit Value (ACGIH)
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average (8 hr.)
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Canadian Workplace Hazardous Materials Information System

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

MSDS Number: **I8840** * * * * * *Effective Date:* ***08/27/04*** * * * * * *Supercedes:* ***05/07/03***

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

MSDS ***Material Safety Data Sheet***

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

ISOPROPYL ALCOHOL (90 - 100%)

1. Product Identification

Synonyms: 2-Propanol; sec-propyl alcohol; isopropanol; sec-propanol; dimethylcarbinol
CAS No.: 67-63-0
Molecular Weight: 60.10
Chemical Formula: (CH3)2 CHOH
Product Codes:
J.T. Baker: 0562, 5082, 9037, 9080, U298
Mallinckrodt: 0562, 3027, 3031, 3032, 3035, 3037, 3043, 4359, 6569, H604, H982, V555, V566, V681

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Isopropyl Alcohol	67-63-0	90 - 100%	Yes
Water	7732-18-5	0 - 10%	No

3. Hazards Identification

Emergency Overview

WARNING! FLAMMABLE LIQUID AND VAPOR. HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM. MAY BE HARMFUL IF ABSORBED THROUGH SKIN. MAY CAUSE IRRITATION TO SKIN.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 2 - Moderate
Contact Rating: 3 - Severe
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER
Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:
Inhalation of vapors irritates the respiratory tract. Exposure to high concentrations has a narcotic effect, producing symptoms of dizziness, drowsiness, headache, staggering, unconsciousness and possibly death.
Ingestion:
Can cause drowsiness, unconsciousness, and death. Gastrointestinal pain, cramps, nausea, vomiting, and diarrhea may also result. The single lethal dose for a human adult = about 250 mls (8 ounces).
Skin Contact:
May cause irritation with redness and pain. May be absorbed through the skin with possible systemic effects.
Eye Contact:
Vapors cause eye irritation. Splashes cause severe irritation, possible corneal burns and eye damage.
Chronic Exposure:
Chronic exposure may cause skin effects.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or impaired liver, kidney, or pulmonary function may be more susceptible to the effects of this agent.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:

Give large amounts of water to drink. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes. Call a physician if irritation develops.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

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5. Fire Fighting Measures

Fire:
Flash point: 12C (54F) CC
Autoignition temperature: 399C (750F)
Flammable limits in air % by volume:
lel: 2.0; uel: 12.7
Listed fire data is for Pure Isopropyl Alcohol.
Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Contact with strong oxidizers may cause fire or explosion. Vapors can flow along surfaces to distant ignition source and flash back. Sensitive to static discharge.
Fire Extinguishing Media:
Water spray, dry chemical, alcohol foam, or carbon dioxide. Water spray may be used to keep fire exposed containers cool, dilute spills to nonflammable mixtures, protect personnel attempting to stop leak and disperse vapors.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

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6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! If a leak or spill has not ignited, use water spray to disperse the vapors, to protect personnel attempting to stop leak, and to flush spills away from exposures.

J. T. Baker SOLUSORB® solvent adsorbent is recommended for spills of this product.

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7. Handling and Storage

Protect against physical damage. Store in a cool, dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from incompatibles. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product. Small quantities of peroxides can form on prolonged storage. Exposure to light and/or air significantly increases the rate of peroxide formation. If evaporated to a residue, the mixture of peroxides and isopropanol may explode when exposed to heat or shock.

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8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Isopropyl Alcohol (2-Propanol):
-OSHA Permissible Exposure Limit (PEL):
400 ppm (TWA)

-ACGIH Threshold Limit Value (TLV):
200 ppm (TWA), 400 ppm (STEL), A4 - not classifiable as a human carcinogen.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a full facepiece respirator with organic vapor cartridge may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact. Neoprene and nitrile rubber are recommended materials.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.
Odor:
Rubbing alcohol.
Solubility:
Miscible in water.
Specific Gravity:
0.79 @ 20C/4C
pH:
No information found.
% Volatiles by volume @ 21C (70F):

100
Boiling Point:
82C (180F)
Melting Point:
-89C (-128F)
Vapor Density (Air=1):
2.1
Vapor Pressure (mm Hg):
44 @ 25C (77F)
Evaporation Rate (BuAc=1):
2.83

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Heat and sunlight can contribute to instability.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Heat, flame, strong oxidizers, acetaldehyde, acids, chlorine, ethylene oxide, hydrogen-palladium combination, hydrogen peroxide-sulfuric acid combination, potassium tert-butoxide, hypochlorous acid, isocyanates, nitroform, phosgene, aluminum, oleum and perchloric acid.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Oral rat LD50: 5045 mg/kg; skin rabbit LD50: 12.8 gm/kg; inhalation rat LC50: 16,000 ppm/8-hour; investigated as a tumorigen, mutagen, reproductive effector.

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--------\Cancer Lists\------------------------------------------------------
                                       ---NTP Carcinogen---
Ingredient                             Known    Anticipated    IARC Category
------------------------------------   -----    -----------    -------------
Isopropyl Alcohol (67-63-0)             No          No              3
Water (7732-18-5)                       No          No            None
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12. Ecological Information

Environmental Fate:
When released into the soil, this material is expected to quickly evaporate. When released into the soil, this material may leach into groundwater. When released into the soil, this material may biodegrade to a moderate extent. When released to water, this material is expected to quickly evaporate. When released into the water, this material is expected to have a half-life between 1 and 10 days. When released into water, this material may biodegrade to a moderate extent. This material is not expected to significantly bioaccumulate. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life between 1 and 10 days. When released into the air, this material may be removed from the atmosphere to a moderate extent by wet deposition.
Environmental Toxicity:
The LC50/96-hour values for fish are over 100 mg/l. This material is not expected to be toxic to aquatic life.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: ISOPROPANOL
Hazard Class: 3
UN/NA: UN1219
Packing Group: II
Information reported for product/size: 200L

International (Water, I.M.O.)

Proper Shipping Name: ISOPROPANOL
Hazard Class: 3
UN/NA: UN1219
Packing Group: II
Information reported for product/size: 200L

15. Regulatory Information

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--------\Chemical Inventory Status - Part 1\---------------------------------
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Ingredient	TSCA	EC	Japan	Australia
Isopropyl Alcohol (67-63-0)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
Isopropyl Alcohol (67-63-0)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.
Isopropyl Alcohol (67-63-0)	No	No	Yes	No
Water (7732-18-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

		-RCRA-	-TSCA-
Ingredient	CERCLA	261.33	8(d)
Isopropyl Alcohol (67-63-0)	No	No	No
Water (7732-18-5)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: Yes
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Mixture / Liquid)

Australian Hazchem Code: 2[S]2
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **1** Flammability: **3** Reactivity: **0**
Label Hazard Warning:
WARNING! FLAMMABLE LIQUID AND VAPOR. HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM. MAY BE HARMFUL IF ABSORBED THROUGH SKIN. MAY CAUSE IRRITATION TO SKIN.
Label Precautions:
Keep away from heat, sparks and flame.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Avoid breathing vapor or mist.
Avoid contact with eyes, skin and clothing.
Label First Aid:
If swallowed, give large amounts of water to drink. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 16.
Disclaimer:
****
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Appendix F

Job Hazard Analysis Forms

CRETE CONSULTING, INC.

Job Hazard Analysis

JHA Type: ☒ Investigation ☐ O&M ☐ Office ☒ Construction	☒ New ☐ Revised	Date: 6/22/2021

Office: Seattle Client: Port of Friday Harbor/Leon Environmental Location: Jensen's Shipyard and Marina, Friday Harbor, WA

Work Type: Remedial Investigation	Work Activity: Site Inspection, Investigation, Sampling, Design

Personal Protective Equipment (PPE): Minimum PPE is Level D including: Hard hat, safety glasses or goggles, steel-toed boots, high visibility safety vest, hearing protection as needed, and gloves as needed (type dependent on job-specific requirements).

Additional PPE may be required in any site-specific Health & Safety Plan (HASP) available. Also refer to the HASP for air monitoring and emergency procedures.

Development Team	Position/Title	Reviewed By	Position/Title	Date
Rusty Jones	Project Geologist	Jamie Stevens	Senior Engineer	6/22/21

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
1. All Onsite Activities	Slips/Trips/Falls Heat/Cold Stress Biological Hazards	• Keep all areas free of excess materials and debris and clear all walking paths. • Monitor onsite workers for signs of heat/cold stress and ensure that necessary breaks are taken. • Use insect repellant and check areas for signs of snakes, spiders, poisonous plants, ticks and mosquitoes • Maintain a clear line of sight.
2. Utility Locate	Explosion, electrocution, injury, death or property damage	• Contact public utility locate and have utilities marked out around the site. • Oversee a private onsite utility locate. • Review locations against construction drawings and known utilities • If necessary, clear upper eight feet of intended drilling location with an air/knife/vacuum truck
3. Equipment Inspections	Leaks, defective or damaged parts, slip/trip/fall hazards, fuel/oil spills, fire hazards, pinch points	• Conduct thorough inspections of all equipment at the beginning of each day and throughout the day, as appropriate. • Check for leaking hoses or fittings, loose connections, functional controls, functional emergency shutoff and damaged equipment • Identify pinch points • Check that a spill kit is available for use on site in the event of a spill or that secondary containment is provided. • Clear working areas of all unnecessary equipment.

4. Equipment Set Up	Flying debris, pinch points	• Identify pinch points • Use a spotter to locate drill rig • Delineate work area with delineators or equivalent • Establish a support zone and set up sampling equipment outside of drill rig work zone • Use designated hand signals to approach drill crew • Engage outriggers • Lower drill rig derrick prior to moving the rig
5. Concrete Coring (if necessary)	Sharp objects, rotating parts, electric tools and power equipment, hot objects	• Buddy system lifting heavy objects (drill press). • Drill in marked, approved (utility and rebar cleared) areas only. • Anchor/bolt/clamp drill machine to ground or other secure objects to prevent movement while in use. • Keep hands and feet away from the rotating drill bit at all times. Avoid loose fitting clothes around powered machine. • Use water or non-toxic, approved coolant to cool drill bits, parts, and coring surface, vacuuming/recovering the coolant during and after use. • Wear hearing protection as needed in proximity to loud equipment.
6. Drilling Operation	Flying debris, pinch points, back strain, cross-contamination, struck by drill rig derrick, chemical exposure, clothing caught in rotating equipment, hearing loss	• Keep hands and feet away from the drill stem while in motion • Wear all appropriate PPE (incl. hearing protection) • Decontamination all equipment prior to use. • Avoid lifting heavy equipment and use the buddy system for heavy objects • Assure that the drill rig derrick is secured • Make sure all guards are in place while drilling operations are underway. • Do not wear loose fitting clothes or jewelry
7. Collecting soil and/or samples	Pinch points, back strain, knee strain, chemical exposure	• Identify pinch points • Wear all appropriate PPE • Place soil core samples on an elevated surface (portable table) to avoid bending. • Keep hands clear while core samples are removed from the drill stem • Sample containers may be glass and can break if handled roughly. Look into coolers before reaching into coolers in case broken glass. • Sample jars may contain acid preservatives. Wear nitrile gloves and safety glasses and check containers lids frequently.

8. Monitoring well construction	Back strain, pinch points, chemical exposure, hearing loss	• Identify pinch points • Wear all appropriate PPE • Use proper lifting technique and avoid lifting more than one bag of sand or bentonite at a time • Avoid bending while pouring sand pack or bentonite seal • Keep hands and feet clear as drill stem is raised out of the borehole
9. Well Box Construction	Back strain, knee strain, vehicle hazards	• Delineate work area with delineators or equivalent so you can be seen when vehicles or equipment are being moved. • Avoid lifting heavy objects without assistance • Avoid bending while laying the concrete • Wear knee pads when kneeling.
10. Backfilling soil borings	Back strain	• When soil borings are not completed as monitoring wells, borings must be backfilled with bentonite. • Avoid lifting more than one bag of bentonite at a time • Take breaks as necessary.
11. Equipment Decontamination	Cross-contamination, chemical exposure, back strain	• Use Alconox or Liquinox to decontaminate all equipment with potential to contact soil or groundwater • Ask for help when moving heavy or awkward equipment. • Wear all appropriate PPE
12. Debris and Waste Management	Spills, chemical exposure, regulatory infractions, back strain, pinch points	• Ensure that all soil cuttings, decontamination water and purge water are properly contained and labeled • Use a drum dolly or lift to move any drums onsite. • Clear a path before moving drums • Prepare a bill of lading for all waste to be moved from site.
13. Demobilization	Chemical exposure, back strain, pinch points	• Avoid lifting heavy or awkward objects without help. • Wear all appropriate PPE • Ensure that all equipment has been decontamination prior to repacking. • Ensure that all equipment is securely put away and tied down.

Appendix G

Cold Stress Indicators

Cold Stress

These Threshold Limit Values (TLVs) are intended to protect workers from the severe effects of cold stress (hypothermia) and cold injury and to describe exposures to cold working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects. The TLV objective is to prevent the deep body core temperature from falling below 36ºC and to prevent cold injury to body extremities. Deep body temperature is the core temperature of the body as determined by rectal temperature measurements. For a single, occasional exposure to a cold environment, a drop in core temperature to no lower than 35ºC should be permitted. In addition to provisions for total body protection, TLV objective is to protect all parts of the body, with emphasis on hands, feet, and head, from cold injury.

Introduction

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or from immersion in low temperature water. The single most important aspect of life-threatening hypothermia is the fall in the deep core temperature of the body. The clinical presentations of victims of hypothermia are shown in Table 1 (taken from Dembert in AFP, January 1982). Workmen should be protected from exposure to cold so that the deep core temperature does not fall below 36ºC (96.8ºF); lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision-making, or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body temperature has fallen to 35ºC (95ºF). This must be taken as a sign of danger to the workers and exposure to cold should be immediately terminated for any workers when severe shivering becomes evident. Useful physical or mental work is limited when severe shivering occurs.

Since prolonged exposure to cold air or to immersion in cold water in temperatures well above freezing can lead to dangerous hypothermia, whole body protection must be provided.

1. Adequate insulating clothing to maintain core temperatures above 36ºC must be provided to workers if work is performed in air temperatures below 4ºC (40ºF). Wind chill factor[1] or the cooling power of the air is a critical factor. An equivalent chill temperature chart relating the actual dry bulb air temperature and the wind velocity is presented in Table 2. The equivalent chill temperatures on exposed skin are determined by estimating the combined cooling effect of wind and low air temperatures.

2. Unless there are unusual or extenuating circumstances, cold injury to other than hands, feet, and head is not likely to occur without the development of the initial signs of hypothermia. Older workers or workers with circulatory problems require special precautionary protection against cold injury. The use of extra insulating

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[1] Wind chill factor is a unit of heat loss from a body defined in watts per meter squared per hour being a function of the air temperature and wind velocity upon the exposed body.

clothing and/or a reduction in the duration of the exposure period are among the special precautions, which should be considered. The precautionary action to be taken will depend upon the physical condition of the worker and should be determined with the advice of a physician with knowledge of the cold stress factors and the medical condition of the worker.

Evaluation and Control

For exposed skin, continuous exposure should not be permitted when the air speed and temperature result in an equivalent chill temperature of -32ºC (-25ºF). Superficial or deep local tissue freezing will occur only at temperatures below -1ºC regardless of wind speed.

At air temperatures of 2ºC (35.6ºF) or less, it is imperative that workers who become immersed in water or whose clothing becomes wet be immediately provided a change of clothing and be treated for hypothermia.

Table 1 Progress Clinical Presentations of Hypothermia[2]

Core Temperature		**Clinical Signs**
ºC ºF		
37.6	99.6	“Normal” rectal temperature
37.0	98.6	“Normal” oral temperature
36.0	96.8	Metabolic rate increases in an attempt to compensate for heat loss
35.0	95.0	Maximum shivering
34.0	93.2	Victim conscious and responsive, with normal blood
33.0	91.4	Severe hypothermia below this temperature
32.0 31.0	89.6 87.8	Consciousness clouded; blood pressure becomes difficult to obtain; pupils dilated but react to light; shivering ceases
30.0 29.0	86.0 84.2	Progressive loss of consciousness; muscular rigidity increases; pulse and blood pressure difficult to obtain; respiratory rate decreases
28.0	82.4	Ventricular fibrillation possible with myocardial irritability
27.0	80.6	Voluntary motion ceases; pupils non-reactive to light; deep tendon and superficial reflexes absent
26.0	78.8	Victim seldom conscious
25.0	77.0	Ventricular fibrillation may occur spontaneously
24.0	75.2	Pulmonary edema
22.0 21.0	71.6 69.8	Maximum risk of ventricular fibrillation
20.0	68.0	Cardiac standstill
18.0	64.4	Lowest accidental hypothermia victim to recover
17.0	62.6	Isoelectric electroencephalogram
9.0	48.2	Lowest artificially cooled hypothermia patient to recover

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[2] Presentations approximately related to core temperature. Reprinted from the January 1982 issue of American Family Physician published by the American Academy of Fandly Physicians.

Table 2 Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)

Est. Wind Speed (mph)	**Actual Temperature Reading (ºF)**											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (ºF)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-131
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect).	**Little Danger** In < 1 hr. with dry skin. Maximum danger of false sense of security.				**Increasing Danger** Danger from freezing of exposed flesh within one minute.			**Greater Danger** Flesh may freeze within 30 seconds.				
	Trench foot and immersion foot may occur at any point on this chart.											

Note:

Developed by U.S. Army Research Institute of Environmental Medicine, Natick, MA.

Recommended limits for properly clothed workers for periods of work at temperatures below freezing are shown in Table 3. Special protection of the hands is required to maintain manual dexterity for the prevention of accidents:

1. If fine work is to be performed with bare hands for more than 10 to 20 minutes in an environment below 16ºC (60ºF), special provisions should be established for keeping the workers' hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be utilized. Metal handles of tools and control bars shall be covered by thermal insulating material at temperatures below -1ºC (30ºF).

To prevent contact frostbite, the workers should wear anti-contact gloves.

1. When cold surfaces below -7ºC (20ºF) are within reach, a warning should be given to each worker by his supervisor to prevent inadvertent contact by skin.

2. If the air temperature is -17.5ºC (9ºF) or less, the hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens.

Provisions for additional total body protection are required if work is performed in an environment at or below 4ºC (40ºF). The workers shall wear cold protective clothing appropriate for the level of cold and physical activity:

1. If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind shall be reduced by shielding the work area, or by wearing an easily removable outer windbreak layer garment. Wind chill cooling rates are illustrated in Table 4.

2. If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing used may be of a type impermeable to water. With more severe work under such conditions, the outer layer should be water repellent and the outerwear should be changed as it becomes wet. The outer garments must include provisions for easy ventilation in order to prevent wetting of inner layers by sweat. If work is done at normal temperatures or in a hot environment before entering the cold area, and the clothing is wet, the employee shall change into dry clothes before entering the cold area. The workers shall change socks and any removable felt insoles at regular daily intervals or use vapor barrier boots. The optimal frequency of change shall be determined empirically and will vary individually and according to the type shoe worn and how much the individual's feet sweat.

3. If extremities (ears, toes, and nose) cannot be protected sufficiently to prevent sensation of excessive cold or frostbite by handwear, footwear, and facemasks, these protective items shall be supplied in auxiliary heated versions.

4. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve.

5. Workers handling evaporative liquid (gasoline, alcohol, or cleaning fluids) at air temperature below 4ºC (40ºF) shall take special precautions to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling. Special note should be taken of the particularly acute effects of splashes of "cryogenic fluids" or those liquids with a boiling point only just above ambient temperatures.

Table 3 Threshold Limit Values Work/Warm-up Schedule for Four-Hour Shift

Air Temp – Sunny Sky		Non-Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
ºC ºF		Max. Work Period (min.)	No. of Breaks	Max. Work Period (min.)	No. of Breaks	Max. Work Period (min.)	No. of Breaks	Max. Work Period (min.)	No. of Breaks	Max. Work Period (min.)	No. of Breaks
-26º to -28º	-15º to -1º	Normal Breaks		Normal Breaks		75	2	55	3	40	4
-29º to -31º	-20º to -24º	Normal Breaks		75	2	55	3	40	4	30	5
-32º to -34º	-25º to -29º	75	2	55	3	40	4	30	5	Non-emergency work should cease	
-35º to -37º	-30º to -34º	55	3	40	4	30	5	Non-emergency work should cease			
-38º to -39º	-35º to -39º	40	4	30	5	Non-emergency work should cease					
-40º to -42º	-40º to -44º	30	5	Non-emergency work should cease							
-43º & below	-45º & below	Non-emergency work should cease									

Notes:

1. Schedule applies to moderate-to-heavy work activity with warm-up breaks of ten (10) minutes in a warm location. For light-to-moderate work (limited physical movement): apply the schedule one step lower. For example, at 30ºF with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (5).

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph - light flag moves; 10 mph - light flag fully extended; 15 mph - raises newspaper sheet; 20 mph - blowing and drifting snow.

3. If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be:
   (1) special warm-up breaks should be initiated at a wind chill of about 1720 Wm/2
   (2) all non-emergency work should have ceased at or before a wind chill of 2250 W/m2.

   In general, the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.

   Adapted from Occupational Health & Safety Division, Saskatchewan Department of Labor.

Table 4 Wind Chill Cooling Rate Effects*

Wind Chill Rates (Watts/m^3)	Comments/Effects
700	Conditions considered comfortable when dressed skiing.
1200	Conditions no longer pleasant for outdoor activities on overcast days.
1400	Conditions no longer pleasant for outdoor activities on sunny days.
1600	Freezing of exposed skin begins for most people depending on the degree of activity and the amount of sunshine.
2300	Conditions for outdoor travel such as walking become dangerous. Exposed areas of the face freeze in less than 1 minute for the average person.
2700	Exposed flesh will freeze within half a minute for the average person.

**Adapted from Canadian Department of the Environment, Atmospheric Environment Service.*

Work-Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) or below -7ºC (20ºF), heated warming shelters (tents, cabins, rest rooms, etc.) shall be made available nearby and the workers should be encouraged to use these shelters at regular intervals, the frequency depending on the severity of the environmental exposure. The onset of heavy shivering, frostbite, the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for the immediate return to the shelter. When entering the heated shelter, the outer layer of clothing shall be removed and the remainder of the clothing loosened to permit sweat evaporation. Also, a change of dry work clothing may be provided. A change of dry work clothing shall be provided as necessary to prevent workers from returning to their work with wet clothing. Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited because of the diuretic and circulatory effects.

For work practices at or below -12ºC (10ºF) ECT, the following shall apply:

1. The worker shall be under constant protective observation (buddy system or supervision).
2. The work rate should not be so high as to cause heavy sweating that will result in wet clothing; if heavy work must be done, rest periods must be taken in heated shelters and opportunity for changing into dry clothing shall be provided.
3. New employees shall not be required to work full time in cold in the first days until they become accustomed to the working conditions and required protective clothing.

4. The weight and bulkiness of clothing shall be included in estimating the required work performance and weights to be lifted by the worker.

5. The work shall be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats shall not be used. The worker should be protected from drafts to the greatest extent possible.

6. The workers shall be instructed in safety and health procedures. The training program shall include, at a minimum, instruction in:

    a) Proper re-warming procedures and appropriate first aid treatment

    b) Proper clothing practices

    c) Proper eating and drinking habits

    d) Recognition of impending frostbite

    e) Recognition of signs and symptoms of impending hypothermia or excessive cooling of body even when shivering does not occur

    f) Safe work practices

Special Workplace Recommendations

Special design requirements for refrigerator rooms include the following:

1. In refrigerator rooms, the air velocity should be minimized as much as possible and should not exceed 1 meter per second (200 fpm) at the job site. This can be achieved by properly designed air distribution systems.

2. Special wind-protective clothing shall be provided based upon existing air velocities to which workers are exposed.

Special caution shall be exercised when working with toxic substances and when workers are exposed to vibration. Cold exposure may require reduced exposure limits.

Eye protection for workers employed outdoors in a snow and/or ice-covered terrain shall be supplied. Special safety goggles to protect against ultraviolet light and glare (which can produce temporary conjunctivitis and/or temporary loss of vision) and blowing ice crystals are required when there is an expanse of snow coverage causing a potential eye exposure hazard.

Workplace Monitoring is Required as Follows:

1. Suitable thermometry should be arranged at any workplace where the environmental temperature is below 16ºC (60ºF) to enable overall compliance with the requirements of the TLV to be maintained.

2. Whenever the air temperature at a workplace falls below -1ºC (30ºF), the dry bulb temperature should be measured and recorded at least every 4 hours.
3. In an indoor workplace, the wind speed should also be recorded at least every 2 hours whenever the rate of air movement exceeds 2 meters per second (5 miles per hour).
4. In an outdoor work situation, the wind speed should be measured and recorded together with the air temperature whenever the air temperature is below -1ºC (30ºF).
5. The equivalent chill temperature shall be recorded with the other data whenever the equivalent chill temperature is below -7ºC (20ºF).

Employees shall be excluded from work in cold at -1ºC (30ºF) or below if they are suffering from diseases or taking medication, which interferes with normal body temperature regulation or reduces tolerance to work in cold environments. Workers who are routinely exposed to temperatures below -24ºC (-10ºF) with wind speeds less than 5 miles per hour should be medically certified as suitable for such exposures.

Trauma sustained in freezing or subzero conditions requires special attention because an injured worker is predisposed to secondary cold injury. Special provisions must be made to prevent hypothermia and secondary freezing of damaged tissues, in addition to providing first aid treatment.

Appendix H

Incident and Near Miss Forms

Incident Report

Section One: Background Information

Your Name	______________	Today's Date	______________
Project Name	______________	Site Name	______________
Project Manager	______________	Project Number	______________

Were there any witnesses to the incident? ☐Yes ☐No

If yes, list name(s)/office locations (including subcontractors):

____

____

Was weather a factor? ☐Yes ☐No

If yes, please describe weather conditions:

____

____

____

Section Two: Injury, Illness and Exposure

Was there an injury, illness or exposure associated with this incident?

☐ Yes ☐ No

If yes, please complete this section.
If no, please proceed to Section Three.

Name of Injured:	__________	Job Title:	__________
Male/Female:	__________	Date of Hire:	__________
Date of Birth:	__________	SSN:	__________
Date/Time of Injury/Exposure:	__________	Time Employee Began Work:	__________
Supervisor:	__________	H&S Coordinator:	__________
Log Number:	__________	SSN:	__________

Employee's Home Address: __________

NOTE: The Occupational Safety and Health Administration requires the above information for regulatory reporting.

Where did the incident occur (place name, address)?

Please describe the incident:

Was injured person/persons using required PPE? ☐Yes ☐No

Were there any unsafe conditions at the time of the incident? ☐Yes ☐No

If yes, please describe:

Please describe what the employee was doing just before the incident (was there an unsafe act involved?):

What was the severity of the injury / exposure:

☐First Aid Only ☐Medical Treatment Only ☐Fatality ☐Non-Occupational

What was the nature of the injury / exposure (please check):

☐Fractures
☐Respiratory Allergy
☐Heat Burns
☐Chemical Burns
☐Radiation Burns
☐Bruises
☐Bites
☐Blisters
☐Toxic Respiratory
☐Toxic Ingestion
☐Cold Exposure
☐Frostbite
☐Heatstroke
☐Other:
☐Heat Exhaustion
☐Exposure
☐Faint/Dizziness
☐Toxic Respiratory
☐Dermal Allergy
☐Ergonomic
☐Dislocations
☐Concussion
☐Abrasions
☐Lacerations
☐Punctures
☐Sprains

Parts of Body Affected (Specify Right/Left):

Date medical care was received:

Was employee taken to the emergency room? ☐Yes ☐ No

Was employee hospitalized overnight as an in-patient? ☐Yes ☐ No

Facility Where Medical Care Was Received:

Clinic/Hospital Name:
Name of Attending Physician:
Clinic/Hospital Address:
Clinic/Hospital Telephone Number:

Section Three: Environmental Incident

Did one of the following occur: a spill to land over one quart, any spill to surface water, a significant release to the air, a violation of permit conditions, receipt of Notice of Violation, or an event that causes potentially significant damage to the environment?

☐Yes ☐No

Did a CRETE employee directly contribute to the incident?

☐ Yes ☐ No

If yes to both, please complete this section. If no to either, the incident is not required to be reported to the CRETE Project Manager. Continue to Section Four.

What type of environmental incident occurred?

☐Spill to Land ☐Spill to Water ☐Release to Air ☐Permit Violation ☐Notice of Violation ☐Other

If other, specify:

Please describe the incident in detail:

If the incident was a spill or release, what material was involved and what amount?

Was there a violation of permit limits associated with the incident? ☐Yes ☐No

If yes, list permits and issuing agencies:

Were the required regulatory agencies notified? ☐Yes ☐No

If yes, which agencies were notified?

Section Four: Property Damage / Loss

Did the damage exceed $500.00?
☐ Yes ☐ No

If yes, please complete this section.
If no, the incident is not required to be reported to the CRETE Project Manager. Continue to Section Five.

What type of loss and/or property damage occurred?

☐Equipment Failure ☐Collision ☐Contamination ☐Weather ☐Fire ☐Vandalism/Theft ☐Other

If other, specify:

Describe the incident of loss or damaged property in detail (CRETE):

Describe the incident of loss or damage of property in detail (3rd Party):

Was a CRETE insurance representative ☐Yes ☐No

contacted? If yes, list name of agent and time

What was the approximate cost of the loss / property damage?

Section Five: Analysis and Corrective Action

Were there any behavioral factors that contributed to the incident? ☐Yes ☐No

If yes, please describe (describe any unsafe acts or conditions):

What can be done to prevent a recurrence of this type of incident?

List corrective actions that were taken to prevent this type of incident in the future:

Person Responsible for taking corrective action:

Forward this form within 24 hours to:

☐ Grant Hainsworth

Employee's Signature Date

Employee's Supervisor Signature Date

Opportunity or Near Miss Report

Reported by: ______________________ Incident Date/Time: __________________________

Date Reported: ______________________ Site Location: __________________________

Report Type (please check one):

☐ Opportunity (*suggestion for improvement, good EHS idea to share, or EHS observation*)
☐ Near-Miss (*event that could have resulted in an incident under different circumstances)*

Event Description:

Describe key aspects such as the operation in progress, worker experience, potential outcome of event, and any contributing conditions. Use additional sheets as necessary.

____
____
____
____
____
____

Hazard Category (check all that apply):

☐ Slip/trip/fall
☐ Chemical
☐ Weather
☐ Improper PPE
☐ Other: ____

☐ Traffic/vehicle
☐ Electrical
☐ Not following procedures
☐ Improper body position/tool use

☐ Plant/Animal
☐ Faulty equipment
☐ Fire

Possible Outcome (check all that apply):

☐ Injury/illness ☐ Property damage ☐ Environmental release

Were you able to correct the problem?

☐ Yes ☐ No If no, whom did you inform:____________ ☐ N/A

Potential Outcome if Circumstances Occurred:

____
____
____

Corrective Action Taken:

____
____
____

Submit to: ☐ Grant Hainsworth

Appendix D

In-Water Sampling and Analysis Plan
In-Water Quality Assurance Project Plan
In-Water Health and Safety Plan

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PORT OF FRIDAY HARBOR
ALBERT JENSEN AND SONS INC. BOATYARD AND MARINA
FRIDAY HARBOR, WA

MODEL TOXICS CONTROL ACT (MTCA)
AGREED ORDER NO. DE 18071

IN-WATER SAMPLING AND ANALYSIS PLAN
ALBERT JENSEN AND SONS INC. BOATYARD AND MARINA IN-WATER AREA
SHIPYARD COVE, PUGET SOUND

Prepared for
The Port of Friday Harbor
Friday Harbor, WA

Prepared by
Leon Environmental, LLC
Seattle, WA

July 2022

LEON
Environmental, LLC

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Abbreviations and Acronyms

°C	degree Celsius
AET	Apparent Effects Threshold
COC	chain-of-custody
County	San Juan County
DGPS	differential global positioning system
DMMP	Dredged Material Management Program
DMR	discharge monitoring report
Ecology	Washington Department of Ecology
EIM	Environmental Information Management
EPA	United States Environmental Protection Agency
HASP	Health and Safety Plan
Jensen's	Albert Jensen and Sons Inc. Boatyard and Marina
L-E	Leon Environmental, LLC
m	meter
m/s	meters per second
MGD	million gallons per day
MLLW	mean lower low water
MTCA	Model Toxics Control Act
NOAA	National Oceanic and Atmospheric Administration
PARIS	Permitting and Reporting Information System
PCB	polychlorinated biphenyl
Port	Port of Friday Harbor
PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCW	Revised Code of Washington
SAP	Sampling and Analysis Plan
SCUM	Sediment Cleanup User's Manual
Site	Albert Jensen and Sons Inc. Boatyard and Marina
SIZ	sediment impact zone
SMS	Sediment Management Standards
SQS	sediment quality standards
SVOC	semivolatile organic compound
TOC	total organic carbon

1. Introduction and Background Information

The overall goal of this project is to clean up the historic contamination associated with Albert Jensen & Sons Inc. Boatyard and Marina (Jensen's) and redevelop this formerly-thriving industrial facility into a revitalized community and economic hub that honors the site's history and its central role in shaping the Friday Harbor community, while providing: environmental restoration; public access and educational opportunities; outdoor-oriented recreation; affordable housing; live-work space; and a platform to provide the economic opportunity local businesses need to thrive. The steps planned during the 2021 - 2023 biennium to achieve this goal are focused on collaborating with Ecology to deliver work described in AO No. DE 18071, including: completion of a robust RI/FS; design, permitting and construction of Interim Actions to address the most immediate risks to human health and the environment; completion of a DCAP; execution of an effective public participation plan; and strategic planning for the design and construction that is anticipated in subsequent biennia.

1.1 Site History and Current Conditions

The Jensen's is located at 1293 Turn Point Road, on the southern shore of Shipyard Cove of the Salish Sea, on San Juan Island, San Juan County (County). Turn Point Road provides a direct connection from the City of Friday Harbor (City) to the Project site, which is located approximately 1.5 miles southeast of downtown. Turn Point Road continues to the east to Kansas Cove, and then becomes Pear Point Road as it follows the Island's southern shoreline to circle back to the City. The Project site is located entirely within Shipyard Cove, a relatively shallow embayment that faces northward on the eastern side of San Juan Island. Shipyard Cove is generally protected by Brown Island; however, the Project site is exposed to roughly 2.5 miles of fetch from a northerly direction (Figure 1, Site and Vicinity Map).

The site was first developed as a shipyard before 1941; anecdotal evidence suggests that operations began as early as 1910. Originally, wooden boats were manufactured and repaired at the site, but when wooden boats were phased out in the middle of the 20th century, the site use moved from shipbuilding to boat repair and maintenance. Additional facilities, including a marina extending from the central shoreline into deeper intertidal and subtidal areas, and an upland fill area along the western property boundary extending from the upland into shallow intertidal areas, were built sometime between 1941 and 1972.

The property encompasses one parcel (351341005000) of approximately 4.8 acres of upland with 652 linear feet of shoreline, and approximately 5 acres of aquatic lands currently managed under a Port Management Agreement (PMA) (PMA No. 20-080023) with the Washington State Department of Natural Resources (WDNR). The Project site is zoned as Rural Industrial (RI). This zoning designation allows for light industrial, light manufacturing, seasonal residential[1], public, and some institutional uses. The Project site is partially developed and consists of three distinct areas: a boatyard, a marina, and an undeveloped upland and shoreline area (Figure 2, Existing Conditions).

1.1.1 Boatyard

The existing boatyard is located in the southwestern portion of the parcel. It encompasses approximately 1.5 acres of level work areas including boat storage, a laydown area and a wash pad. Four buildings are associated with current boatyard operations: an office/retail building, a machine shop, a storage building and a water treatment building through which water from the wash pad is circulated and then discharged into an evaporating pond on site. The boatyard infrastructure also includes a 35-ton travel lift that needs maintenance or replacement in the near future. The marine services provided at the boatyard include haul-out, pressure wash, bottom paint, light mechanical, chandlery and parts, and

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[1] Vacation rental; Farmworker housing

boat storage. The boatyard area has several areas where maintenance was deferred by the prior owner. Ongoing releases from the degraded structures (e.g., visible sheen associated with the creosote pilings) have been observed. The Port anticipates that at least some of these deferred maintenance projects will need to be completed on an expedited basis to sustain current and future operations. These projects may be the subject of interim actions proposed under a subsequent remedial action grant application.

1.1.2 Marina

The existing marina includes approximately 50 slips; just over half are wood-framed, covered moorage. The structure consists of creosote-treated piles and wood floats on unwrapped Styrofoam. The structure itself, as well as the associated electrical system, is in very poor condition, and reconstruction and expansion of the marina is anticipated as part of the redevelopment of the property. Coordinating subsequent remedial actions with marina maintenance and redevelopment is a key consideration for this project.

1.1.3 Undeveloped Upland and Shoreline Areas

The undeveloped area in the eastern portion of the property consists of approximately 2 acres of open grassy field and gravel parking areas. This area slopes moderately from Turn Point Road toward the waterfront and terminates at a low bank.

A derelict boat building structure is located near the shoreline east of the current boatyard area. The marine rails waterward of this structure were originally used to launch boats and were later used to pull out boats for repair. The concrete pad at this location was added later and is not original to the marine rail system. The undeveloped area also contains the remnants of a small derelict cabin, a small oil storage building further east and a shallow dug well. The Port has not identified a final use for this area of the Project site; however, it is anticipated that some of the area will be used to meet requirements associated with marina redevelopment like restrooms, parking, and other support infrastructure.

Compatibility of the ongoing boatyard operations with the planned marina improvements, public access to parts of the site, and other potentially developed businesses and facilities (especially around issues such as safety, parking, and access) will be addressed as part of the master planning effort that is currently underway. The master plan will be coordinated with Ecology and the public. Marina improvements may also be compatible and conducted co-incident with anticipated remedial actions for the site.

The site was first developed as a shipyard before 1941; anecdotal evidence suggests that operations began as early as 1910. Originally, wooden boats were manufactured at the site, but when wooden boats were phased out in the middle of the 20th century, the site use moved from shipbuilding to boat repair and maintenance.

1.2 Regulatory Framework

Agreed Order No. DE 18071 (Order) was issued pursuant to the Model Toxics Control Act (MTCA), RCW 70.105D.050(1). The Order requires the Port of Friday Harbor to perform a Remedial Investigation and Feasibility Study (RI/FS) and to prepare a draft Cleanup Action Plan (dCAP), addressing both upland and in-water contamination for the Albert Jensen and Sons, Inc. Boatyard and Marina Site. This SAP was prepared as part of the Work Plan in compliance with WAC 173-340-820 and WAC 173-204-600 for defining the nature and extent of contamination in the in-water area of the site.

1.3 Summary of Previous Sediment Investigations

1.3.1 Upland

This In-Water Sampling and Analysis Plan specifically addresses the initial in-water work proposed for the Remedial Investigation at Albert Jensen and Sons Inc. Boatyard and Marina. The past field investigation of the upland areas, which are defined as areas of the Site that fall outside of the In-Water Area as generally depicted in Exhibit A of the Agreed Order, are discussed in [reference CRETE IOSA/upland documents].

1.3.2 In-Water

The past field investigations of the in-water areas were primarily conducted by Whatcom Environmental Services (WE) as part of preliminary redevelopment planning. These data are summarized in the *Intertidal and Subtidal Conceptual Site Model and Data Gaps Report* (L-E, 2019), and in three reports WE prepared previously: *Phase I Environmental Site Assessment* (WE, 2017a), *Draft Sediment Data Report* (WE, 2018c), and the *Draft Remedial Investigation Report* (WE, 2018d). Additional data were acquired from publicly available information sources.

Table 1-1. Previous Sediment Investigations

Author	Year	Report
Washington Department of Ecology	2001	Concentrations of Selected Chemicals in Sediments from Harbors in the San Juan Islands
Whatcom Environmental Services	2017	Phase I Environmental Site Assessment, Jensen’s Shipyard, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2017	Sediment Sampling and Analysis Plan, Jensen’s Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Initial Investigation Report, Jensen’s Shipyard, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Sediment Investigation, Sediment Sampling and Analysis Plan, Jensen’s Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Draft Sediment Data Report, Jensen’s Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Draft Remedial Investigation Report, Jensen’s Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
San Juan Surveying	2018	Topographic Survey for Port of Friday Harbor – Jensen’s Shipyard Planning Map
Leon Environmental, LLC	2019	Intertidal and Subtidal Conceptual Site Model and Data Gaps Report, Jenson and Sons Boatyard and Marina, Friday Harbor, Washington.
Fairbanks Environmental Services, Inc.	2020	Port of Friday Harbor Albert Jensen and Sons Boatyard and marina Eelgrass and Macroalgae Survey
Marine Surveys & Assessments	2021	Jensen Marina Habitat Survey Report

2. Objectives and Design of the In-Water Investigation

2.1 Objectives of the In-Water Investigation

The mutual objective of the State of Washington, Department of Ecology (Ecology) and the Port of Friday Harbor (PFH) under Agreed Order No. DE 18071 (Order) is to provide for remedial action at the Albert Jensen & Sons Inc. site (Facility Site ID 42226979) (site) where there has been a release or threatened release of hazardous substances. The work under the Order involves conducting a Remedial Investigation (RI) and Feasibility Study (FS), conducting interim actions if required or agreed to by Ecology, and preparing a preliminary Draft Cleanup Action Plan (DCAP) to select a cleanup alternative. The purpose of the RI/FS, and preliminary DCAP for the Site, is to provide sufficient data, analysis, and evaluations to enable Ecology to select a cleanup alternative for the Site.

The objective for this remedial investigation is to address identified data gaps and refine the nature and extent of sediment contamination exceeding preliminary Model Toxics Control Act (MTCA) cleanup levels, preliminary Sediment Management Standards (SMS) cleanup standards, and other regulatory requirements. This sediment investigation is focused on the in-water areas of the Albert Jensen and Sons, Inc. Boatyard and Marina, which are defined as the intertidal (areas exposed to air at low tide) and subtidal (areas always covered by water) areas associated with adjacent marine waters. This effort is expected to:

- Delineate the nature and extent of debris throughout sampling areas.
- Establish vertical contamination profiles in areas where surface sediments exceed SQS.
- Include additional samples (depth and surface) along the eastern shoreline area.
- Delineate the vertical and horizontal extent of dioxins/furans beyond the surface concentrations measured along the central marina shoreline, which may correlate with observed PCB surface exceedances.
- Focus PCB analysis on areas showing benthic exceedances in surface sediments to facilitate subsequent background/human health evaluations.
- Delineate the vertical and horizontal extent of pesticides measured in surface sediments.

2.2 Overall Design of the In-Water Investigation

The in-water investigation will focus initially on defining the nature and extent of potential sediment contamination, and will generally follow guidance provided in Ecology's current Sediment Cleanup User's Manual (SCUM) (Ecology 2021). Sampling procedures and collection will follow current Puget Sound Estuary Program (PSEP) protocols. If supplemental sampling is required, a SAP addendum may be prepared.

Debris appears to be present throughout intertidal elevations out to at least shallow subtidal depths, and also within the boathouse areas. These are the areas where the sediment investigation is required to delineate the nature and extent of contaminants of potential concern (COPCs); however, debris is expected to interfere with the collection of sediment grab samples and cores. Prior to initiating sediment sample collection, a sub-bottom profile survey using a high-resolution, low frequency sub-bottom sonar is proposed to measure the distribution and concentration of debris. These data will be used to identify specific locations where sediment grab samples and cores may be collected.

The overall design of this initial study is intended to determine the nature and extent of sediment contamination at Albert Jensen and Sons Boatyard and Marina. To meet the remedial investigation objectives, surface sediment grab samples (sample depth of 0 – 10 cm) will be collected from seven (7) sampling stations and core samples (sample depth of 0 - 6 ft) will be collected from twelve (12) sampling stations located within the study area (Figure 3, Sampling Station Locations and 2018 Chemical

Exceedances). We propose to reoccupy ten (10) previous sampling locations (WE 2018c) and sample nine (9) new sampling locations around Jensen's. Samples will be analyzed for known contaminants of potential concern (COPCs), the full suite of SMS chemical analytes, and conventional sediment parameters. The need for additional sampling and analysis (including bioassays and/or bioaccumulation testing) will be evaluated if samples exceed the numerical chemical concentration criteria identified in WAC 173-204-320.

2.3 Chemical Analytes

Sediment samples will be analyzed for known contaminants of potential concern (COPCs) (WE 2018c), and conventional sediment parameters. Table 2-1 shows the COPCs identified in previous sediment investigations. As shown in Table 2-2, conventional sediment parameters are measured to characterize sediments and aid in interpreting chemical tests. Conventional parameters include total organic carbon (TOC), grain size, percent solids (total solids), ammonia, and total sulfides. SMS chemical sediment parameters are shown in Table 2-3; however, only those chemicals identified in Tables 2-1 and 2-5 are proposed to delineate the nature and extent of COPCs identified previously.

Table 2-1. Chemicals of Potential Concern Identified in Previous Sediment Investigations (WE 2018c)

Chemical of Potential Concern	Included in SMS Chemicals	CAS Number	Chemical Criteria	Screening Level
COPCs that do not have an established SQS numeric criteria value				
Tributyltin (TBT)	No	36643-28-4	DMMP (USACE 2021)	73 µg/kg dry weight
Dioxins/Furans	No	--	DMMP (USACE 2021)	4-10 ng/kg dry weight[1]
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane)	No	5103-71-9 5103-74-2 5103-73-1 39765-80-5 27304-13-8	DMMP (USACE 2021)	2.8 µg/kg dry weight
COPCs that established SQS numeric criteria value				
Polychlorinated Biphenyls (PCBs; total Aroclors[2])	Yes	--	SQS	See Table 2-3
Metals (copper, mercury, zinc)	Yes	7440-50-8 7439-97-6 7440-66-6	SQS	See Table 2-3
Organic Chemicals (benzyl alcohol)	Yes	100-51-6	SQS	See Table 2-3
Phthalates (butylbenzyl phthalate, dimethyl phthalate)	Yes	85-68-7 131-11-3	SQS	See Table 2-3
Polycyclic Aromatic Hydrocarbons (PAHs)	Yes	See Table 2-3	SQS	See Table 2-3
Chlorinated Organics	Yes	See Table 2-3	SQS	See Table 2-3

Notes:
1. See Table 8-3 in the DMMP User Manual (USACE, 2021).
2. Phase I sampling will evaluate samples for PCB Aroclors; however, if PCB Congeners are required, they will be collected in subsequent sampling events. A SAP addendum will be prepared if supplemental sampling is required.

Table 2-2. Conventional Sediment Variables

Conventional Parameter	Use
Total organic carbon (TOC)	• Normalization of the concentrations of nonionizable organic compounds • Identification of appropriate reference sediments for biological tests • Presence of eutrophic and/or low dissolved oxygen conditions • Understand contaminant availability and toxicity
Sediment grain size	• Identification of appropriate reference sediments for biological tests • Interpretation of sediment toxicity data • Evaluation of sediment transport and deposition
Total solids	• Expression of chemical concentrations on a dry-weight basis
Ammonia	• Interpretation of sediment toxicity test data and/or other deleterious substances
Total sulfides	• Interpretation of sediment toxicity test data and/or other deleterious substances

Table 2-3. Marine Sediment Quality Standards--Chemical Criteria WAC 173-204-320

Chemical Parameter	CAS Number	Sediment Quality Standards WAC 173-204-320[a]	Sediment Impact Zone Maximum Level, WAC 173-204-420[a]
SMS Metals		**mg/kg dw (ppm dw)**	
ARSENIC	7440-38-2	57	93
CADMIUM	7440-43-9	5.1	6.7
CHROMIUM	7440-47-3	260	270
COPPER	7440-50-8	390	390
LEAD	7439-92-1	450	530
MERCURY	7439-97-6	0.41	0.59
SILVER	7440-22-4	6.1	6.1
ZINC	7440-66-6	410	960
PAHs		**mg/kg OC[c] (ppm OC)**	
LPAH[b,d]		370	780
NAPHTHALENE	91-20-3	99	170
ACENAPHTHYLENE	208-96-8	66	66
ACENAPHTHENE	83-32-9	16	57
FLUORENE	86-73-7	23	79
PHENANTHRENE	85-01-8	100	480
ANTHRACENE	120-12-7	220	1,200
2-METHYLNAPHTHALENE	91-57-6	38	64
HPAH[b,e]		960	5,300
FLUORANTHENE	206-44-0	160	1,200
PYRENE	129-00-0	1,000	1,400
BENZ(A)ANTHRACENE	56-55-3	110	270
CHRYSENE	218-01-9	110	460
TOTAL BENZOFLUORANTHENES[b,f]	205-99-2; 205-82-3 207-08-9	230	450
BENZO(A)PYRENE	50-32-8	99	210
INDENO (1,2,3,-C,D) PYRENE	193-39-5	34	88
DIBENZO (A,H) ANTHRACENE	53-70-3	12	33
BENZO(G,H,I)PERYLENE	191-24-2	31	78
Chlorinated Hydrocarbons		**mg/kg OC[c] (ppm OC)**	
1,2-DICHLOROBENZENE	95-50-1	2.3	2.3
1,4-DICHLOROBENZENE	106-46-7	3.1	9
1,2,4-TRICHLOROBENZENE	120-82-1	0.81	1.8
HEXACHLOROBENZENE	118-74-1	0.38	2.3
Phthalates		**mg/kg OC[c] (ppm OC)**	
DIMETHYL PHTHALATE	131-11-3	53	53
DIETHYL PHTHALATE	84-66-2	61	110
DI-N-BUTYL PHTHALATE	84-74-2	220	1,700
BUTYL BENZYL PHTHALATE	85-68-7	4.9	64
BIS (2-ETHYLHEXYL) PHTHALATE	117-81-7	47	78
DI-N-OCTYL PHTHALATE	117-84-0	58	4,500
DIBENZOFURAN	132-64-9	15	58
HEXACHLOROBUTADIENE	87-68-3	3.9	6.2
N-NITROSODIPHENYLAMINE	86-30-6	11	11
TOTAL PCBs[b]		**12**	**65**

Table 2-3. Marine Sediment Quality Standards--Chemical Criteria WAC 173-204-320 (continued)

Chemical Parameter	CAS Number	Sediment Quality Standards WAC 173-204-320[a]	Sediment Impact Zone Maximum Level, WAC 173-204-420[a]
Phenols and Misc. Extractables		**µg/kg dw (ppb dw)**	
PHENOL	108-95-2	420	1,200
2-METHYLPHENOL	95-48-7	63	63
4-METHYLPHENOL	106-44-5	670	670
2,4-DIMETHYL PHENOL	105-67-9	29	29
PENTACHLOROPHENOL	87-86-5	360	690
BENZYL ALCOHOL	100-51-6	57	73
BENZOIC ACID	65-85-0	650	650

Notes:

[a] Where laboratory analysis indicates a chemical is not detected in a sediment sample, the detection limit shall be reported and shall be at or below the Marine Sediment Quality Standards chemical criteria value set in this table.

[b] Where chemical criteria in this table represent the sum of individual compounds or isomers, the following methods shall be applied:

(i) Where chemical analyses identify an undetected value for every individual compound/isomer then the single highest detection limit shall represent the sum of the respective compounds/isomers; and

(ii) Where chemical analyses detect one or more individual compound/isomers, only the detected concentrations will be added to represent the group sum.

[c] The listed chemical parameter criteria represent concentrations in parts per million, "normalized," or expressed, on a total organic carbon basis. To normalize to total organic carbon, the dry weight concentration for each parameter is divided by the decimal fraction representing the percent total organic carbon content of the sediment.

[d] The LPAH criterion represents the sum of the following "low molecular weight polynuclear aromatic hydrocarbon" compounds: Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, and Anthracene. The LPAH criterion is not the sum of the criteria values for the individual LPAH compounds as listed.

[e] The HPAH criterion represents the sum of the following "high molecular weight polynuclear aromatic hydrocarbon" compounds: Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Total Benzofluoranthenes, Benzo(a)pyrene, Indeno(1,2,3,-c,d)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene. The HPAH criterion is not the sum of the criteria values for the individual HPAH compounds as listed.

[f] The TOTAL BENZOFLUORANTHENES criterion represents the sum of the concentrations of the "B," "J," and "K" isomers.

2.4 Biological Tests

In marine and estuarine environments, biological testing will be implemented if SMS chemical criteria are exceeded for the 47 SMS chemicals (or chemical groups) listed in Table 2-3. Biological testing is not included in the initial sediment characterization, but will be included in subsequent efforts if SMS chemicals exceed screening criteria. In the event that biological testing is required, the SMS require the use of two acute effects biological tests and one chronic effects biological test for each of the following purposes:

- To determine whether the SQS biological effects level is exceeded [WAC 173-204-310(2)(a)]
- To determine whether the SIZmax biological effects level is exceeded [WAC 173-204-420(3)(a)]

Acute Effects Tests

- Amphipod: A 10-day acute sediment toxicity test that assesses mortality of one of the following amphipods: *Rhepoxynius abronius*, *Ampelisca abdita*, or *Eohaustorius estuaries*, which is chosen based on the interstitial water salinity and the percentage of sediment fines.
- Larval: Any one of several acute sediment toxicity tests that assess mortality and/or abnormality of larvae of the following organisms:
  - Pacific oyster, *Crassostrea gigas*
  - Blue mussel, *Mytilus galloprovincialis*
  - Purple sea urchin, *Strongylocentrotus purpuratus*
  - Green sea urchin, *Strongylocentrotus droebachiensis*
  - Pacific sand dollar, *Dendraster excentricus*

Chronic Effects Tests

- Juvenile polychaete: A 20-day sublethal sediment toxicity test that assesses decreases in biomass of the juvenile polychaete *Neanthes* sp.

2.5 Sampling Station Locations

To meet the remedial investigation objectives, surface sediment grab samples (sample depth of 0 – 10 cm) will be collected from seven (7) sampling stations and core samples (sample depth of 0 - 6 ft) will be collected from twelve (12) sampling stations located within the study area (Table 2-4, Figure 3).

Stations SED-1 through SED-17 were reported in WE 2018a, WE 2018c, and WE 2018d. Resampling at ten (10) of the seventeen (17) previous sampling locations is proposed to define the nature and extent of potential contamination. No resampling is proposed at seven (7) of the previous sampling locations. Stations SED-18 through SED-26 are new sampling locations proposed to define the nature and extent of potential contamination. The locations of previous and proposed new sampling stations are provided in Table 2-4; however, these locations will be relocated the minimum distance necessary to collect an acceptable sample if the sub-bottom profile survey shows that high density of debris is present at the target sampling location. Sample relocation, if required, will be determined in consultation with Ecology.

Table 2-4. Previous (WE 2018c) and Proposed Sediment Sample Location Coordinates

Sample Station	Sample Type[1]	Northing (ft.)	Easting (ft.)	Latitude (NAD83)	Longitude (NAD83)
SED-1	Core	564577.70	1115755.95	48.5274908	-122.998782
SED-2	N/A	564595.96	1116041.40	48.52756284	-122.997607
SED-3	Core	564437.42	1115844.30	48.52711326	-122.998401
SED-4	N/A	564340.59	1115603.42	48.52682935	-122.999384
SED-5	Core	564288.64	1115797.22	48.52670196	-122.998578
SED-6	N/A	564283.69	1115905.01	48.52669671	-122.998133
SED-7	Core	564115.38	1115473.10	48.52620222	-122.999895
SED-8	Core	564090.06	1115530.40	48.52613728	-122.999656
SED-9	Core	564057.95	1115594.68	48.52605424	-122.999387
SED-10	Core	564036.61	1115682.78	48.52600256	-122.999021
SED-11	Core	564045.21	1115718.42	48.52602889	-122.998875
SED-12	Core	564032.00	1115777.80	48.52599726	-122.998628
SED-13	N/A	563999.37	1115675.97	48.52590001	-122.999045
SED-14	Core	564162.12	1115715.16	48.52634897	-122.998902
SED-15	N/A	564161.08	1115609.68	48.52633799	-122.999337
SED-16	N/A	564180.22	1115513.50	48.52638300	-122.999736
SED-17	N/A	564168.18	1115436.07	48.52634403	-123.000054
SED-18	Grab	564576.19	1115694.41	48.52748193	-122.999036
SED-19	Grab	564614.89	1115813.31	48.52759713	-122.998550
SED-20	Grab	564476.99	1115906.18	48.52722643	-122.998151
SED-21	Grab	564365.82	1115754.91	48.52691016	-122.998762
SED-22	Grab	564369.34	1115891.42	48.52693033	-122.998199
SED-23	Grab	564245.50	1115708.47	48.52657691	-122.998939
SED-24	Grab	564233.54	1115835.82	48.52655396	-122.998413
SED-25	Core	564116.04	1115602.23	48.52621399	-122.999362
SED-26	Core	564106.18	1115687.36	48.52619356	-122.999010

Notes:

1. All 2018 sampling locations (WE 2018c) are summarized above; however, sample locations that are not proposed for re-sampling are indicated as N/A.

2.6 Rationale for Station Locations

The initial sediment sampling is proposed to reoccupy ten (10) previous sampling locations and sample nine (9) new sampling locations around Jensen's. The sampling locations were selected to determine the nature and extent of sediment contamination exceeding preliminary Model Toxics Control Act (MTCA) cleanup levels, preliminary Sediment Management Standards (SMS) cleanup standards, and other regulatory requirements. The proposed COPC list for each sample location and depth interval is provided in Table 2-5, and the rationale for each sampling station is summarized below in Table 2-6. The purpose for the proposed sampling locations is to define the nature and extent of chemicals detected during the initial sediment characterization (WE 2018c) that exceeded relevant regulatory criteria. A summary of surface sediment chemical exceedances of SMS and DMMP criteria measured during the initial surface sediment characterization (WE 2018c) is provided in Attachment A.

Table 2-5. Sampling Type and Chemical Parameters

<table>
<tr><th rowspan="2">Sample Location</th><th rowspan="2">Sample Type</th><th colspan="8">Sample Interval and Chemical Analyses</th></tr>
<tr><th colspan="2">0 – 1 ft (core)
0 – 10 cm (grab)</th><th colspan="2">1 – 3 ft</th><th colspan="2">3 – 5 ft</th><th colspan="2">5 – 6 ft</th></tr>
<tr><td>SED-1</td><td>Core</td><td colspan="2">Pest</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-2</td><td colspan="9">N/A</td></tr>
<tr><td>SED-3</td><td>Core</td><td colspan="2">SVOC, Pest</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-4</td><td colspan="9">N/A</td></tr>
<tr><td>SED-5</td><td>Core</td><td colspan="2">SVOC, Pest</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-6</td><td colspan="9">N/A</td></tr>
<tr><td>SED-7</td><td>Core</td><td colspan="2">TBT, SVOCs</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-8</td><td>Core</td><td colspan="2">TBT, SVOCs, Pest, PCBs, D/F</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-9</td><td>Core</td><td colspan="2">Metals, Hg, TBT, SVOCs, Pest, PCBs, D/F</td><td colspan="2">Metals, Hg, TBT, SVOCs, Pest, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-10</td><td>Core</td><td colspan="2">Metals, Hg, TBT, SVOCs, Pest, PCBs, D/F</td><td colspan="2">Metals, Hg, TBT, SVOCs, Pest, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-11</td><td>Core</td><td colspan="2">Metals, Hg, SVOCs, Pest, PCBs, D/F</td><td colspan="2">Hg, SVOCs, Pest, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-12</td><td>Core</td><td colspan="2">D/F, PCBs</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-13</td><td colspan="9">N/A</td></tr>
<tr><td>SED-14</td><td>Core</td><td>Metals, Hg, TBT, SVOCs, Pest, PCBs</td><td>A</td><td>Hg, TBT, SVOCs, Pest, PCBs</td><td>A</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-15</td><td colspan="9">N/A</td></tr>
<tr><td>SED-16</td><td colspan="9">N/A</td></tr>
<tr><td>SED-17</td><td colspan="9">N/A</td></tr>
<tr><td>SED-18</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-19</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-20</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-21</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-22</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-23</td><td>Grab</td><td colspan="2">Pest, PCBs</td><td colspan="6">N/A</td></tr>
<tr><td>SED-24</td><td>Grab</td><td colspan="2">Pest, PCBs</td><td colspan="6">N/A</td></tr>
<tr><td>SED-25</td><td>Core</td><td colspan="2">Metals, Hg, TBT, SVOCs, PCBs, D/F</td><td colspan="2">Metals, Hg, TBT, SVOCs, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-26</td><td>Core</td><td colspan="2">Metals, Hg, TBT, SVOCs, PCBs, D/F</td><td colspan="2">Metals, Hg, TBT, SVOCs, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
</table>

Table Notes:

- **Abbreviations:** A = Archive; Core = Vibracore; D/F = Dioxins/furans; Grab = Surface grab sample; Hg = Silver; N/A = not applicable because no sample is proposed; PCBs = Polychlorinated biphenyls; Pest = Pesticides (Total Chlordane); SVOC = Semi volatile organic compounds; TBT = tributyl tin.

Table 2-6. Sampling Station Rationale

Sample Station	Sample Type	Rationale
SED-1	Core	Vertical and horizontal extent of pesticides. Bound SED-3, SED-18, SED-19, SED-20.
SED-2	N/A	No chemical exceedances detected at or near sample location.
SED-3	Core	Vertical and horizontal extent of pesticides, SVOCs. Bound SED-1, SED-20, SED-21, SED-22.
SED-4	N/A	No chemical exceedances detected at or near sample location.
SED-5	Core	Vertical & horizontal extent of pesticides, SVOCs. Bound SED-21, SED-22, SED-23, SED-24.
SED-6	N/A	No chemical exceedances detected at or near sample location.
SED-7	Core	Vertical & horizontal extent of TBT, SVOCs. Bound SED-8.
SED-8	Core	Vertical & horizontal extent of TBT, pesticides, PCBs, dioxins/furans, SVOCs. Bound SED-7, SED-9, SED-25.
SED-9	Core	Vertical & horizontal extent of metals, Hg, TBT, pesticides, PCBs, dioxins/furans, SVOCs. Bound SED-8, SED-10, SED-25, SED-26.
SED-10	Core	Vertical & horizontal extent of metals, Hg, TBT, pesticides, PCBs, dioxins/furans, SVOCs. Bound SED-9, SED-11, SED-25, SED-26.
SED-11	Core	Vertical & horizontal extent of metals, Hg, pesticides, PCBs, dioxins/furans, SVOCs. Bound SED-10, SED-12, SED-26.
SED-12	Core	Vertical & horizontal extent of dioxins/furans. Bound SED-11.
SED-13	N/A	Known exceedances, which will be bounded by cores at SED-10, SED-11, and SED-12.
SED-14	Core	Vertical & horizontal extent of Hg, TBT, pesticides, PCBs, SVOCs. Bound SED-23, SED-24, SED-25, SED-26.
SED-15	N/A	No chemical exceedances detected at or near sample location.
SED-16	N/A	No chemical exceedances detected at or near sample location.
SED-17	N/A	No chemical exceedances detected at or near sample location.
SED-18	Grab	Horizontal extent of pesticides. Bound SED-1.
SED-19	Grab	Horizontal extent of pesticides. Bound SED-1.
SED-20	Grab	Horizontal extent of pesticides. Bound SED-1, SED-3.
SED-21	Grab	Horizontal extent of pesticides. Bound SED-3, SED-5, SED-22.
SED-22	Grab	Horizontal extent of pesticides. Bound SED-3, SED-5, SED-21.
SED-23	Grab	Horizontal extent of pesticides, PCBs. Bound SED-5, SED-14, SED-24.
SED-24	Grab	Horizontal extent of pesticides, PCBs. Bound SED-5, SED-23.
SED-25	Core	Vertical & horizontal extent of metals, Hg, TBT, PCBs, dioxins/furans, SVOCs. Bound SED-8, SED-9, SED-10, SED-15, SED-26.
SED-26	Core	Vertical & horizontal extent of metals, Hg, TBT, PCBs, dioxins/furans, SVOCs. Bound SED-9, SED-10, SED-11, SED-14, SED-25.

2.7 Proposed Reference Stations

If additional sampling for toxicity testing is required, we propose to collect reference samples in Carr Inlet; however, this sampling effort would be described in an addendum to this sediment sampling and analysis plan. The reference area will be selected based upon sample grain size and input provided by the bioassay laboratory around the time reference sediments are collected. Reference sediment coordinates will be determined based on grain size results and bathymetry from on-site sample locations. Standard field procedures will be followed to ensure that the quality of the sample will not be compromised (PSEP 1997). Bioassay testing requires that test sediments be matched and run with appropriate reference sediment to factor out background conditions and sediment grain-size effects on bioassay organisms. If reference sediments are collected at the same time that other samples are collected for supplemental chemical analyses, test samples (project) and reference samples will be wet-sieved in the field to determine grain size (% fines) required to identify a suitable reference location within Carr Inlet. These wet-sieving results will be recorded and submitted with the sample analysis results. If reference sediments are collected by the bioassay laboratory at a later time, as a result of chemistry failures, the reference location will be identified based on results provided by the chemical analytical laboratory (PSEP, 1986/ASTM D-422).

3. Field Sampling Methods

3.1 Sub-Bottom Profile Sonar Survey

Prior to finalizing sediment sample locations, the Port is considering implementing a sub-bottom profile sonar survey using an EdgeTech SB216S sub-bottom sonar to provide sediment stratigraphy data for the sediment sampling area. Unlike a multibeam survey that fully covers a survey area, the sub-bottom profile sonar survey is similar to a conventional single-beam survey. Data collection occurs on transect lines spaced at consistent distant intervals throughout the sediment sampling area.

The sub-bottom profile data, if collected, will be processed to digitize the presence of debris layers and assign horizontal and vertical locations of each layer. The digitized layers will then be exported to a GIS platform to create a digital elevation model (DEM) of each of the identified debris layers. Calculations can then be made to infer the concentration and thickness of the debris. This will assist in finalizing sediment sample locations that are more likely to result in the collection of suitable sediment samples.

3.2 Station Positioning Methods

The objective of the sampling station positioning procedures is to collect each sample within 3 m of the proposed position, and to record the actual positions where samples were collected.

3.2.1 Horizontal Positioning in Open Water – Vibracores and Power Grabs

Horizontal station positioning will be accomplished from the sampling vessel using a differential global positioning system (DGPS) or similar to locate and document the coordinates of each sample location. If it is not possible to obtain coordinates of the sample locations because of signal interference by structures, then the sample locations will be mapped relative to an identifiable landmark or a position for which coordinates can be obtained.

The DGPS data logger will be loaded with the proposed coordinates of each pre-determined sampling location (station). Using the navigation mode of the DGPS, each station will be located.

The sampling vessel will approach each station and position the sediment sampling device, stainless-steel pneumatic power grab or equivalent, directly over the desired sample location. As the grab sample is collected, the DGPS will log the final coordinates of the actual sampling position. Should wind interfere with positioning and/or holding on station, the vessel will be anchored in such a way as to position the sampling equipment directly over the sample location. The actual latitude and longitude of all final sampling positions will be recorded to the nearest 0.01 foot in the NAD 83, Washington State North Zone horizontal datum.

3.2.2 Vertical Positioning in Water

The vertical control parameters measured are depth to sediment (mudline) and the current water elevation, which will be recorded from the Friday Harbor station (Station ID#: 9449880). Tidal elevations at the project site may be established using the most recent version of Tides and Currents Pro to determine the National Oceanic and Atmospheric Administration (NOAA) tide elevation data for Friday Harbor. The actual tidal elevation data for Friday Harbor can be determined using the NOAA National Water Level Observation Network available at https://tidesandcurrents.noaa.gov/waterlevels.html?id=9449880. The mudline elevation of each sampling station will be determined relative to MLLW by measuring the water depth with a lead line or calibrated fathometer (accounting for the depth of the transducer) and subtracting the tidal elevation at the time of sampling.

3.3 Sampling Equipment

The following items will be needed in the field for sediment collection:

Plans and Field Documentation
- SAP
- Study area maps and coordinates for sampling stations
- Field notebooks and pens/pencils/Sharpies®
- Field collection forms
- Chain-of-custody (COC) forms
- Clipboard

Safety
- HASP
- Health & Safety Field Meeting form
- Flashlights and temporary work lights
- First aid kit

PPE
- Personal flotation devices
- Hard hats
- Safety glasses
- Powder-free nitrile exam gloves
- Heavy work gloves
- Steel-toed work or rubber boots
- Foul weather gear (rain jacket/pants)
- Hat and sun screen

Electronic Equipment and Hand Tools
- Cellular phone
- Digital camera
- Tape measure
- Siphon hose(s)
- Battery powered drill and extra charged batteries
- Box cutter set and extra blades

Sampling Equipment and Supplies
- Sub-bottom sonar
- Pneumatic power grab
- Vibracore head
- Decontaminated 3 or 4-inch diameter core barrels
- Core caps

Decontamination
- Alconox® detergent
- Scrub brushes
- Tap water
- Distilled water
- Spray bottles for tap and distilled water

Sample Processing & Storage
- Stainless-steel bowls and spoons
- Stainless-steel ruler
- Bubble wrap
- Sample jars
- Heavy poly bags
- Custody seals
- Wet ice or frozen gel packs
- Coolers

Supplies
- Waterproof adhesive labels
- Clear packing tape and/or tape strips
- Duct tape
- Ziplock® bags
- Garbage bags (large and small)
- Aluminum foil
- Paper towels
- Batteries

Prior to mobilization, the Sediment Sampling Equipment Checklist will be consulted to ensure all equipment is available and pre-cleaned. As part of the mobilization process, each item will be double-checked by the field coordinator.

3.4 Decontamination Procedures

All sediment sampling and homogenizing equipment, including the mixing bowl and stainless-steel implements, will either be decontaminated between sampling stations or prior to sampling. Decontamination protocols will adhere to PSEP guidelines (1997).

The following procedures apply to field decontamination between sampling stations:

- Rinse with site water and wash with a scrub brush until free of sediment.
- Wash with a scrub brush and phosphate-free detergent.
- Rinse with site water.
- Rinse with distilled water.

Acid or solvent washes will not be used in the field because of safety considerations and problems associated with rinsate disposal and sample integrity.

Alternatively, all sediment sampling equipment may be decontaminated *prior* to the sampling event. In this case, a sufficient number of complete sets of decontaminated sampling utensils will be available on board the sampling vessel to avoid field decontamination requirements. The sampling equipment decontamination steps are as follows:

- Scrub with a laboratory grade soap (Alconox®) solution to remove any residual materials.
- Rinse equipment with tap water five times.
- Rinse equipment with a 10% nitric acid solution.
- Rinse equipment with tap water five times.
- Rinse equipment with methanol contacting all surfaces.
- Rinse equipment with tap water ten times.
- Rinse equipment with deionized water three times.
- Wrap equipment with aluminum foil.

Additional precautions will be taken to minimize the possibility of cross-contamination. Between surface grab sample collection stations, the power grab will be scrubbed with Alconox and rinsed with site water. The grab sampler will be visually inspected to ensure that all sediment has been removed before collecting the next grab.

Any sampling equipment that is not cleaned to the satisfaction of the Sampling Project Manager or Field Operations Coordinator will not be used for further sampling activities.

3.5 Sample Collection Procedure

3.5.1 Vibracore Sampling Procedure

Sediment cores for chemical analysis will be collected from open water areas using a generator-powered vibracorer, deployed by hydraulic winch from the A-frame of a 25-foot or greater, shallow draft sampling vessel, or similar. Cores will be collected using decontaminated 3 or 4-inch diameter core barrels (tubes), pre-cleaned cellulose acetate butyrate (CAB) liners inside a metal core tube, or similar.

The general vibracoring procedure will be as follows:

- After the sampling station has been located (Section 3.1), a 6-foot long, decontaminated core barrel, with core nose in place, will be secured to the vibracorer head.
- The vibracorer head and core barrel will be suspended from the A-frame of the vessel and the weight package will be attached to complete the coring assembly.
- The sampling vessel will position the coring assembly over the sampling position and deploy the assembly, using the weight package to maintain the coring assembly in an upright position.

- The cable umbilical to the A-frame and core assembly will be drawn in taut and perpendicular, as the core nose rests on the mudline.
- The location of the umbilical hoist will be measured and recorded and the depth to the core head assembly at full penetration or refusal will be measured with a survey tape attached to the head assembly.
- The core tube will be vibrated into the sediment so that a continuous core sample is collected to a 6-foot depth or until refusal.
- The depth of core penetration will be measured and recorded.
- The core barrel will be extracted from the sediment using the hydraulic winch.
- While suspended, the assembly and core barrel will be sprayed off with site water, and then placed on the vessel deck.

The core barrel will be removed from the sampler, inspected and photographed. The recovered core material remaining in the core barrel following retrieval will be measured to determine sediment recovery and aid in determining whether any compaction has occurred. Every effort will be made to retain as much material in the core as possible. The overlying water and core nose will be removed. Each core will be capped at both ends with aluminum foil and core barrel caps, and labeled for transport to the on-shore processing location. Cores will be placed in an upright position in an insulated cool box with ice until transported to the core processing location.

If sample acceptance criteria are not achieved, the sample will be rejected and the location re-sampled. In the event that the required penetration depth or sufficient sample volume cannot be achieved upon three successive attempts, the sample station will be relocated. The new sampling location will be recorded and the repositioning process will be noted in the field logbook. If unable to obtain a sample that meets the appropriate acceptance criteria within 50 feet of the proposed location, the sample will be relocated as determined by the Project Manager or Task Manager, as appropriate.

3.5.2 Surface Sediment Grab Sampling Procedure

Sediment samples will be collected using a stainless-steel pneumatic power grab, or equivalent, deployed by hydraulic winch from the A-frame of a 25-foot or greater, shallow draft sampling vessel, or similar.

The general procedure for collecting sediment samples using this type of grab sampler is described below:

- Maneuver the sampling vessel to the pre-identified sampling location.
- Open the grab sampler jaws into the deployment position.
- Guide the sampler overboard until it is clear of the vessel.
- Lower the sampler through the water column to the bottom.
- Once sampler is in position on the sediment surface, signal hydraulic control operator to close the sampler jaws.
- Record the location of the grab when the sampler is closed and the A-frame is centered directly over the sampler (the cable will be perpendicular to the boat deck).
- Retrieve the sampler.
- Guide the sampler aboard the vessel and place it on the work stand on the deck; use care to avoid jostling that might disturb sample integrity.
- Examine the sample using the following sediment acceptance criteria:
    - The sample does not contain foreign objects;
    - The sampler is not over-filled with sediment so that the sediment surface presses against the top of the sampler;

  - No leakage has occurred, as indicated by overlying water on the sediment surface;
  - No sample disturbance has occurred, as indicated by limited turbidity in the overlying water;
  - No winnowing has occurred, as indicated by a relatively flat, undisturbed surface; and
  - A penetration depth of at least 11 cm has been achieved.

If the first grab at an approved sampling station fails to meet acceptance criteria for any reason, two additional attempts will be made to collect the grab at that location. If these additional attempts fail, the Sampling Project Manager will exercise best professional judgment to move the station as necessary, in order to obtain a representative and adequate sample. Surface conditions that may prevent collection of a grab sample include hard substrate, debris, or other causes.

3.5.3 Sampling Logs

As samples are collected, and after the sulfides subsamples have been taken, logs and field notes of all samples will be recorded. The sediment within each core or grab will be described throughout the full penetration depth. All observations will be recorded on a sediment core or grab log sheet. Photographs of the exposed sediment core (Section 3.4) will further document sediment conditions. A description of each core sample will be recorded on the sediment core log sheet for the following parameters, as appropriate and present:

- Sample recovery (depth in feet of penetration and estimated sample compaction).
- Physical sediment description in accordance with the Unified Soil Classification System (includes type, density/consistency, color).
- Description of any large debris/coarse gravel including size of debris and an estimate of percent by volume in each core section.
- Odor (e.g., hydrogen sulfide, petroleum).
- Biological activity (e.g., vegetation, live or dead organisms, shells, tubes, bioturbation, or organic detritus).
- Any other distinguishing characteristics or features.

3.6 Sample Processing Procedure

3.6.1 Grab Sample Compositing

Ideally, chemical analyses will be conducted on discrete sediment samples collected from a single cast of the sampling device at each station. In practice, it is often necessary to collect more than one cast of sediment sample per station when the proposed analyses (including chemical analyses, physical analyses, and toxicity testing) require larger volumes of sediment from the targeted depth (e.g., 0–10 cm) than can be acquired in a single cast of the sampling device. In such cases, multiple casts of the sampling device will be made at the same station, taking care to sample as close as possible to other casts at that station. The station and grab number for each grab collected at each station will be logged in the DGPS memory and recorded on a grab sample log. Sediments collected from the targeted depth with each cast of the sampling device will be combined with the other sediments collected from that depth at that station and, after removal of unrepresentative material (e.g., woody debris, shells, rocks) at the discretion of the Sampling Project Manager or the Field Operations Coordinator, homogenized to a uniform appearance by stirring. Subsamples will be taken from this composite sediment sample for chemical analyses, physical analyses, and toxicity testing.

If these analyses are required, sediment samples collected for the analysis of potentially volatile chemicals (e.g., total sulfides) will not be composited and/or homogenized. Instead, samples for total sulfide analyses will be taken from the first acceptable grab (e.g., of sufficient grab depth, no leaking, sediment undisturbed) at each station immediately after retrieval and placed in appropriate sample containers prior to homogenization and subsampling for other analyses. Remaining sediment from the targeted depth will be placed in a decontaminated stainless-steel mixing bowl and the bowl covered with aluminum foil between casts. Additional casts will be made at that station until a sufficient volume of sediment from the targeted depth is collected for all chemical and physical analyses.

3.6.2 Vibracore Sample Processing Procedure

Sediment cores will be processed as soon after collection as feasible. The capped, labeled, 6-foot core sections will be transported to the core processing facility. Each core section will be removed from the 4°C refrigerator and placed horizontally onto the core processing table. The cores will either be extruded directly onto the core processing table (preferred) or split longitudinally with a circular saw or box cutter with a roofing blade, taking care not to contaminate the sediment with excessive core tube debris.

If these analyses are required, sediment samples collected for the analysis of potentially volatile chemicals (e.g., total sulfides) will not be composited and/or homogenized. Instead, samples for total sulfide analyses will be taken from each sampling interval immediately after extrusion and placed in appropriate sample containers prior to homogenization and subsampling for other analyses.

After volatile samples have been collected (if total sulfides analyses are required), each core will be divided into the following sampling intervals:

- 0 – 1 foot: Surface sediments
- 1 – 3 feet: Shallow subsurface interval
- 3 – 5 feet: Mid subsurface interval (archive)
- 5 – 6 feet: Deep subsurface interval (archive)

Using data from the appropriate sediment core log sheet, the material for each sampling interval will be determined. Sediments from each target depth interval will be placed into a decontaminated, stainless steel bowl for homogenization, taking care not to collect material that was in direct contact with the core barrel. Sediments will be homogenized using a decontaminated stainless-steel spoon. Homogenized sediments will then be distributed to the appropriate sample containers. Containers will be secured with lids, and completed sample labels will be affixed to the containers. Clear tape may be placed over the labels to prevent damage from melt water while in the cooler.

3.6.3 Surface Sediment Grab Sample Processing Procedure

Sediment processing for grab samples is described below:

- Siphon off any standing water from the surface of the sediment using a hose primed with site water. Be careful during siphoning not to disturb the integrity of the sediment surface.
- No material that has been in contact with any interior sampler surface may be collected or composited for analysis.
- For sulfides analysis, a stainless-steel spoon will be used to transfer sediments representing the upper 10 cm *immediately* to clean, laboratory-supplied sample containers pre-labeled for sulfides.
- Collect the remaining upper 10 cm of sediments from the sampler using a stainless-steel spoon. Place the sediment in a stainless-steel mixing bowl.
- Cover the bowl of sediment with a sheet of aluminum foil if additional sediment grabs must be collected before processing.
- Thoroughly rinse the interior of the sampler with site water until all loose sediment has been washed off.

- Repeat the sampling process until sufficient sediment volume is obtained from the station to satisfy the analytical requirements.
- Homogenize the sediment using a stainless-steel spoon.
- Distribute the homogenized sediment to appropriate sample containers, secure the container lids, and ensure that sample labels are completely and correctly filled out and affixed to the containers. Clear tape may be placed over the labels to prevent damage from melt water while in the cooler.
- Clean the exterior of all sample containers and store in an ice chest at 4 degrees Celsius (°C).
- Thoroughly decontaminate the sampler and homogenization equipment.
- Ensure that all logbook and grab sample log sheet entries are complete.
- Proceed to the next proposed sampling location.

3.7 Sample Identification

A sample identification system will be used to track all environmental samples and their analytical results. This identification system is designed to maintain unique sample designations in the electronic data transfers anticipated for this project. All samples will be designated with a unique alpha-numeric identification, which will be used on sample labels and all other applicable documentation. The sample identification system is as follows:

SED-##: *-* (i.e., SED-01:0-1)
SED = Sample origin designation (SED = sediment)
= Sample location designation number (Table 3-2)
- = Samples depth in feet or centimeters below mudline.

For example, sample designation SED-01:0-1 would represent a sediment sample obtained from the vibracore sample location 01, at a depth of 0-1 feet below mudline. Similarly, SED-18:0-10 would represent a sediment surface sample obtained from the grab sample location 18, at a depth of 0-10 cm.

3.8 Sample Containers and Labels

Table 3-1 describes sample container requirements. Sample containers will be provided by the analytical laboratory.

Table 3-1. Container Size and Field Preservation

Sample Type	Container	Field Preservation
Grain size	16 oz P	4°C
Ammonia	4 oz G	4°C
Total Solids*		
Total Volatile Solids*		
Total Organic Carbon		
Sulfides (Total)	4 oz GS	4°C, 2N ZnOAc, no headspace
Metals	4 oz G	4°C
Volatile Organics*	4 oz G	4°C, no headspace
Semivolatiles	16 oz G	4°C
PCBs		
Sediment Toxicity	3 L PB	4°C
Tributyltin	4 oz G	4°C
Dioxins/Furans	8 oz AG	4°C
Pesticides (Total Chlordane)	8 oz G	4°C

Abbreviations and Acronyms:
* – Not proposed for this sampling event.
AG – Amber Glass Jar
G – Glass Jar
GS – Glass Jar with Septa
P – Linear polyethylene
PB – Polyethylene Bag
2 N ZnOAc – 2 N zinc acetate

Water-resistant, self-adhesive labels will be attached to the outside of all sediment sample containers. The following information should be provided on each sample label in waterproof ink: a sample identification number, the site or project name, the station number, sampling date and time, sampling personnel, and preservative (if appropriate).

3.9 Field Documentation Procedures

As samples are collected, and after the sulfides subsamples have been taken, logs and field notes of all samples will be recorded. Field documentation will include a field log, core or grab sample log, and COC form.

A daily field log will be used to record general information, including names of field crew members, sampling dates, arrival and departure times, weather conditions, sample equipment performance, and other observations.

Sample collection logs will be maintained throughout grab sampling activities. Each log will include station ID, sample location coordinates, grab number, date, time, and water depth. Sample observations will be recorded, including color, sediment type(s), odor, type and amount of any debris present, obvious evidence of contamination (e.g., sheen), and any deviations from the SAP necessitated by field conditions.

COC requirements are described further in Section 4.2.

3.10 Procedures for Disposal of Excess Sediment

Excess sediment remaining after all sampling is completed will be returned to the collection site. All disposable sampling materials and personnel protective equipment used in sample processing, such as disposable coveralls, gloves, and paper towels, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal as solid waste.

4. Sample Handling Procedures

Sample handling procedures are designed to ensure sample integrity between the time of collection and the time that laboratory analysis begins. These procedures include sample storage, chain-of-custody, and sample delivery.

4.1 Sample Storage Requirements

Chemical and Physical Analyses: All sediment samples will be placed on ice in a cooler and held at approximately 4°C until they are received by the analytical laboratories. Upon sample receipt, the laboratories will comply with storage temperatures and maximum holding times required for the specific analyses to be performed (Table 4-1). Samples for mercury analysis will be frozen by the analytical laboratory if not immediately analyzed; however, chemistry analyses are expected to proceed as soon as possible after sample collection.

Sediment samples may be archived for later analysis by freezing them and holding them at -18°C except for the analyses of grain size, ammonia, total sulfides and volatile organic compounds; allowance for expansion of the sample should be made to prevent breakage of the sample bottles upon freezing. The archived samples may be thawed within the maximum holding times and analyzed for any of the analytes, except for ammonia, total sulfides, volatile organic compounds, and grain size.

Biological Analyses: No sampling for biological testing is anticipated during this mobilization. If biological testing is required for potential future sampling, all sediment samples intended for toxicity testing will be transported to the toxicology laboratory on ice at 4°C. The samples will be held in the laboratory in the dark at 4°C and should not be frozen. According to the PSEP (1995) toxicity test guidelines, all toxicity tests should be initiated as soon as possible (ideally within 2 weeks of collecting the samples in the field).

Maximum holding times will be considered as part of this tiered testing event, in which toxicity testing will only occur if triggered by prior chemical analyses. This tiered approach is used by the Dredged Material Management Program (DMMP) for evaluating dredged sediments for unconfined, open-water disposal in Puget Sound. The DMMP allows sediment samples to be held at 4°C in the dark in a nitrogen atmosphere up to 8 weeks prior to toxicity testing. Because the results of recent studies evaluating the effects of sediment holding time on sediment toxicity have been variable, sediments will be stored for as short time as possible after field collection. If there are no other compelling reasons based on the best professional judgment of regional investigators and on logistical constraints, a maximum holding time of 2 weeks will be observed. If logistical constraints mandate a holding time greater than 2 weeks, the DMMP sample storage requirements should be followed.

Actual holding times and conditions will be reported along with the toxicity test results.

Table 4-1. Sample Handling Requirements

Parameter	Sample Preservation	Holding Time
Grain size	Cool/4 °C	6 months
Total solids*	Cool/4 °C Freeze, -18 °C	14 days 6 months
TOC	Cool/4 °C Freeze, -18 °C	14 days 6 months
Ammonia	Cool/4 °C	7 days
Total sulfides	Cool/4°C 2N ZnOAc, no headspace	7 days
Mercury	Freeze, -18 °C	28 days
Other metals	Cool/4 °C Freeze, -18 °C	6 months 2 years
SVOCs, PCBs (Aroclors)	Cool/4 °C Freeze, -18 °C	14 days 1 year
After extraction	Cool/4 °C	40 days
VOCs*	Cool/4°C, no headspace	14 days
Sediment toxicity*	Cool/4°C Cool/4°C, nitrogen atm	2 weeks 8 weeks
Tributyltin	4 ± 2°C	6 months
Dioxins/Furans	4 ± 2°C -18 ± 2°C	14 days 1 year
Pesticides (Total Chlordane)	4 ± 2°C -18 ± 2°C	14 days 1 year
After extraction	4 ± 2°C	40 days

* – Not proposed for this sampling event.

4.2 Chain-of-Custody Procedures

COC procedures will document the transfer of all samples from the Field Operations Coordinator to the analytical laboratories. Duplicate or triplicate COC forms will be used to record each sample container at the end of each sampling day. At a minimum, the forms will identify the sample collection date and times, the project name and number, and the number of preserved and unpreserved sample containers. It is the Field Operations Coordinator's responsibility to ensure that each form is accurately completed and signed at the time of sample transfer. One copy of each form will be placed in a waterproof bag and taped to the inside of each sample cooler. The Field Operations Coordinator will retain one copy of each form. Sample coolers will be sealed with chain-of-custody tape and kept in a secure location when not in the presence of the Field Operations Coordinator or an assigned sampling crew member.

4.3 Delivery of Samples to Analytical Laboratories

All samples will be delivered to the laboratories within 24 hours following completion of the sample processing. Individual sample containers will be placed in individual plastic bags, and packed to prevent breakage in transport coolers. Sufficient ice will be sealed in plastic bags and packed in the coolers to maintain samples at 4°C. One copy of the chain-of-custody form will be sealed in a waterproof bag and taped to the inside of the cooler lid. A chain-of-custody seal will be placed on the outside of the cooler any time it is not with the Field Operations Coordinator or assigned crew. Upon receipt of the samples at the laboratories, the condition of the samples will be inspected and recorded, and the chain-of-custody form will be signed by the receiving laboratory staff.

5. Laboratory Analytical Methods

5.1 Chemical Analyses and Target Detection Limits

Analyses of sediment samples will include contaminants of potential concern (COPCs) and conventional sediment parameters. Table 5-1 summarizes the COPCs to be analyzed for each sample location. Table 5-2 summarizes the recommended sample preparation methods, cleanup methods, analytical methods, and recommended reporting limits for COPCs and conventional sediment variables (Table 5-2 includes chemicals and conventionals that are not required under this sampling framework, but include the complete SMS chemical list). Achieving the quantitation limits in Table 5-2 will generally allow comparison with most numerical criteria. However, if the sediments contain low TOC, the TOC-normalized limits for certain chemicals may be above the numerical criteria expressed on a TOC-normalized basis. Samples may be analyzed using additional cleanup steps or alternative test methods to achieve lower detection limits. For example, hexachlorobenzene, trichlorobenzene, and hexachlorobutadiene may be analyzed by GC/ECD (EPA Method 8081) as an alternative to 8270C. Detection limits should be at a level sufficient to meet the SMS chemical criteria for TOC levels as low as 0.5 percent. If, after using appropriate sample cleanup procedures, the analytical laboratory is unable to achieve sufficiently low detection limits to allow comparisons with TOC-normalized criteria, then the laboratory will contact the Sampling Project Manager to report the difficulty before completing analyses. If lower detection limits cannot be reliably attained, then non-normalized detection limits will be compared to the 1988 dry weight normalized Apparent Effects Thresholds (AETs) criteria (SCUM Table A-1; Ecology 2021).

Table 5-1. Proposed Chemical Analyses by Sample Location

<table>
<tr><th rowspan="2">Sample Location</th><th rowspan="2">Sample Type</th><th colspan="8">Sample Interval and Chemical Analyses</th></tr>
<tr><th colspan="2">0 – 1 ft (core)
0 – 10 cm (grab)</th><th colspan="2">1 – 3 ft</th><th colspan="2">3 – 5 ft</th><th colspan="2">5 – 6 ft</th></tr>
<tr><td>SED-1</td><td>Core</td><td colspan="2">Pest</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-2</td><td colspan="9">N/A</td></tr>
<tr><td>SED-3</td><td>Core</td><td colspan="2">SVOC, Pest</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-4</td><td colspan="9">N/A</td></tr>
<tr><td>SED-5</td><td>Core</td><td colspan="2">SVOC, Pest</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-6</td><td colspan="9">N/A</td></tr>
<tr><td>SED-7</td><td>Core</td><td colspan="2">TBT, SVOCs</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-8</td><td>Core</td><td colspan="2">TBT, SVOCs, Pest, PCBs, D/F</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-9</td><td>Core</td><td colspan="2">Metals, Hg, TBT, SVOCs, Pest, PCBs, D/F</td><td colspan="2">Metals, Hg, TBT, SVOCs, Pest, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-10</td><td>Core</td><td colspan="2">Metals, Hg, TBT, SVOCs, Pest, PCBs, D/F</td><td colspan="2">Metals, Hg, TBT, SVOCs, Pest, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-11</td><td>Core</td><td colspan="2">Metals, Hg, SVOCs, Pest, PCBs, D/F</td><td colspan="2">Hg, SVOCs, Pest, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-12</td><td>Core</td><td colspan="2">D/F, PCBs</td><td colspan="2">A</td><td colspan="2">A</td><td colspan="2">A</td></tr>
<tr><td>SED-13</td><td colspan="9">N/A</td></tr>
<tr><td>SED-14</td><td>Core</td><td>Metals, Hg, TBT, SVOCs, Pest, PCBs</td><td>A</td><td>Hg, TBT, SVOCs, Pest, PCBs</td><td>A</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-15</td><td colspan="9">N/A</td></tr>
<tr><td>SED-16</td><td colspan="9">N/A</td></tr>
<tr><td>SED-17</td><td colspan="9">N/A</td></tr>
<tr><td>SED-18</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-19</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-20</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-21</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-22</td><td>Grab</td><td colspan="2">Pest</td><td colspan="6">N/A</td></tr>
<tr><td>SED-23</td><td>Grab</td><td colspan="2">Pest, PCBs</td><td colspan="6">N/A</td></tr>
<tr><td>SED-24</td><td>Grab</td><td colspan="2">Pest, PCBs</td><td colspan="6">N/A</td></tr>
<tr><td>SED-25</td><td>Core</td><td colspan="2">Metals, Hg, TBT, SVOCs, PCBs, D/F</td><td colspan="2">Metals, Hg, TBT, SVOCs, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
<tr><td>SED-26</td><td>Core</td><td colspan="2">Metals, Hg, TBT, SVOCs, PCBs, D/F</td><td colspan="2">Metals, Hg, TBT, SVOCs, PCBs, D/F</td><td>Hg</td><td>A</td><td>Hg</td><td>A</td></tr>
</table>

Table Abbreviations: A = Archive; Core = Vibracore; D/F = Dioxins/furans; Grab = Surface grab sample; Hg = Silver; N/A = not applicable because no sample is proposed; PCBs = Polychlorinated biphenyls; Pest = Pesticides (Total Chlordane); SVOC = Semi volatile organic compounds; TBT = tributyl tin.

Table 5-2. Sample Preparation Methods, Analytical Methods, and Reporting Limits

Chemical	Preparation Method	Analytical Methods	Reporting Limits
Metals			**mg/kg dw**
Arsenic	EPA 6010/6020/3050B	EPA 6010/6020	57
Cadmium	EPA 6010/6020/3050B	EPA 6010/6020	5.1
Chromium	EPA 6010/6020/3050B	EPA 6010/6020	260
Copper	EPA 6010/6020/3050B	EPA 6010/6020	390
Lead	EPA 6010/6020/3050B	EPA 6010/6020	450
Mercury	EPA 7471	EPA 7471	0.41
Silver	EPA 6010/6020/3050B	EPA 6010/6020	6.1
Zinc	EPA 6010/6020/3050B	EPA 6010/6020	410
LPAHs[a]			**µg/kg dw**
Naphthalene	EPA 3550-mod[b,c]	EPA 8270	2100
Acenaphthylene	EPA 3550-mod[b,c]	EPA 8270	1300
Acenaphthene	EPA 3550-mod[b,c]	EPA 8270	500
Fluorene	EPA 3550-mod[b,c]	EPA 8270	540
Phenanthrene	EPA 3550-mod[b,c]	EPA 8270	1500
Anthracene	EPA 3550-mod[b,c]	EPA 8270	960
2-Methylnaphthalene	EPA 3550-mod[b]	EPA 8270	670
HPAHs[a]			**µg/kg dw**
Fluoranthene	EPA 3550-mod[b,c]	EPA 8270	1700
Pyrene	EPA 3550-mod[b,c]	EPA 8270	2600
Benzo(a)anthracene	EPA 3550-mod[b,c]	EPA 8270	1300
Chrysene	EPA 3550-mod[b,c]	EPA 8270	1400
Total benzofluoranthenes[d]	EPA 3550-mod[b,c]	EPA 8270	3200
Benzo(a)pyrene	EPA 3550-mod[b,c]	EPA 8270	1600
Indeno(1,2,3-cd)pyrene	EPA 3550-mod[b,c]	EPA 8270	600
Dibenzo(a,h)anthracene	EPA 3550-mod[b,c]	EPA 8270	230
Benzo(g,h,i)perylene	EPA 3550-mod[b,c]	EPA 8270	670
Chlorinated Hydrocarbons[a]			**µg/kg dw**
1,2-Dichlorobenzene	EPA 3550-mod[b]	EPA 8270	35
1,4-Dichlorobenzene	EPA 3550-mod[b,c]	EPA 8270	110
1,2,4-Trichlorobenzene	EPA 3550-mod[b,c]	EPA 8270	31
Hexachlorobenzene	EPA 3550-mod[b,c]/3540	EPA 8270/8081	22
Phthalates[a]			**µg/kg dw**
Dimethyl phthalate	EPA 3550-mod[b,c]	EPA 8270	71
Diethyl phthalate	EPA 3550-mod[b,c]	EPA 8270	200
Di-n butyl phthalate	EPA 3550-mod[b,c]	EPA 8270	1400
Butyl benzyl phthalate	EPA 3550-mod[b,c]	EPA 8270	63
Bis(2-ethylhexyl)phthalate	EPA 3550-mod[b,c]	EPA 8270	1300
Di-n-octyl phthalate	EPA 3550-mod[b,c]	EPA 8270	6200
Phenols[a]			**µg/kg dw**
Phenol	EPA 3550-mod[b,c]	EPA 8151/8270	420
2-Methylphenol	EPA 3550-mod[b,c]	EPA 8151/8270	63
4-Methylphenol[e]	EPA 3550-mod[b,c]	EPA 8151/8270	670
2,4-Dimethylphenol	EPA 3550-mod[b,c]	EPA 8151/8270	29
Pentachlorophenol	EPA 3550-mod[b,c]	EPA 8151/8270	360
Misc. Extractables[a]			**µg/kg dw**
Benzyl alcohol	EPA 3550-mod[b]	EPA 8151/8270	57
Benzoic acid	EPA 3550-mod[b]	EPA 8151/8270	650
Dibenzofuran	EPA 3550-mod[b]	EPA 8270	540
Hexachlorobutadiene	EPA 3550-mod[b]	EPA 8270	11
N-nitrosodiphenylamine	EPA 3550-mod[b]	EPA 8270	28

Table 5-2. Sample Preparation Methods, Analytical Methods, and Reporting Limits (continued)

Chemical	Preparation Method	Analytical Methods	Reporting Limits
Polychlorinated biphenyls (PCBs)			**µg/kg dw**
PCB Aroclors/Congeners[f]	EPA 3540[c,f] /3550-mod	EPA 8082/1668	130
Conventionals			
Ammonia	[g]	Plumb (1981)	100 mg/L
Grain size[h]	[g]	PSEP, 1986/ASTM D-422	1%
Total solids	[g]	PSEP, 1986	0.1% (wet wt)
Total organic carbon (TOC)	[g]	EPA 9060	0.1%
Total sulfides	[g]	Plumb (1981)/9034/9030B	10 mg/kg
Bioaccumulative Chemicals of Concern			
Tributyltin (bulk sediment)	EPA 3550B or NMFS	Krone/Unger	10 µg/kg
Dioxins/Furans	EPA 1613B	EPA 1613B	0.5-5 or 1 ng/kg
Pesticides (Chlordane)	3540C, 3541, or 3550B	EPA 8081	2 µg/kg

Abbreviations and Acronyms:
EPA – U.S. Environmental Protection Agency
HPAH – high molecular weight polycyclic aromatic hydrocarbon
LPAH – low molecular weight polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PSEP – Puget Sound Estuary Program
TOC – total organic carbon

Notes:

[a] Selected ion monitoring may improve the sensitivity of EPA Method 8270 and is recommended in cases when detection limits must be lowered to human health criteria levels or when TOC levels elevate detection limits above ecological criteria levels. See PSEP organics chapter, Appendix B, Guidance for Selected Ion Monitoring (1997b).

[b] EPA Method 3550 is modified to add matrix spikes before the dehydration step.

[c] If sulfur is present in the samples (as is common in most marine sediment), cleanup procedures specified by EPA SW-846 Method 3660B should be used.

[d] Total benzofluoranthenes represent the sum of the b, j, and k isomers. Some laboratories report total benzofluoranthenes concentration rather than concentrations of individual isomers since isomers may not be able to be separated.

[e] In some instances, 3-methylphenol and 4-methylphenol may not be able to be separated. In this case methylphenol may be reported as the sum of the 3-methyl and 4-methylphenol isomers.

[f] PCB Congeners are not proposed in the initial sampling event, but may be collected if supplemental sampling is required. A SAP addendum will be prepared if subsequent sampling is required. All PCB extracts should be subjected to sulfuric acid/permanganate cleanup as specified by EPA SW-846 Method 3665A.

[g] Sample preparation methods for sediment conventional analyses are described in the analytical methods.

[h] Sternberg, D. (2006). Reporting of sediment-bound contaminants: standardization of sieving and analytical procedures. DMMP/SMS clarification paper on converting phi, mm, or microns to the standard “gravel, sand, silt, clay” groups. See Appendix B.

5.2 Biological Analyses and Testing

PSEP (1995) provides guidelines for conducting the amphipod, larval, and juvenile polychaete tests for marine sediments.

Table 5-3. Bioassay Suite

Bioassay Test	Test Organism
10-day Amphipod Mortality Test	*Ampelisca abdita;* *Eohaustorius estuarius;* *Rhepoxynius abronius*
48-hour Larval Development Test (echinoderm or bivalve)	*Mytilus galloprovincialis*; *Dendraster excentricus*
20-day Juvenile Polychaete Growth Test	*Neanthes arenaceodentata*

No biological testing is proposed for this field mobilization. If potential future biological testing is required, bioassay testing requires that test sediments be matched and run with appropriate reference sediment to factor out background conditions and sediment grain-size effects on bioassay organisms. Reference sediments are expected to be collected at the same time that other samples are collected; however, reference sediments may be collected by the bioassay laboratory at a later time, in the event that bioassays are triggered by potential chemistry failures. Reference sediments are expected to be collected within 7 days of sample collection, if possible. Wet-sieving of surface sediment samples is conducted in the field at the time of collection so that a reference sample(s) with similar (within 20%) grain size distribution (as percent fines) can be targeted for the bioassays. Test sediments (project) will be wet-sieved after compositing and potential reference sediments should been wet-sieved, as collected, to identify adequate matches to the project samples. Wet-sieving results should be recorded and submitted with the sample analysis results. The location of the reference sediment sampling location will be recorded to the nearest 0.1 second (NAD 83).

All sediment samples collected for potential bioassays will be stored at 4°C, either with no headspace or under a nitrogen atmosphere (i.e., nitrogen-purged headspace) pending completion of chemical analyses and initiation of any required biological testing. All bioassays, including retests, should commence within 56 days from collection of the first grab sample in the sediment composite to be tested. The laboratory will maintain chain-of-custody procedures throughout biological testing. Bioassay testing will be initiated as soon as possible after the first chemical results become available and the decision is made to conduct bioassays. This includes obtaining test organisms and control and reference sediments in a timely manner. This approach will support the opportunity for any second-round (additional) biological testing within the allowable 56-day holding period, if such need arises. As initial chemistry data become available, the project manager and the bioassay laboratory representative will maintain close coordination with the client to expedite biological testing decisions.

5.3 Corrective Actions

The analytical laboratory may be required to implement corrective actions and reanalyze samples if data quality assurance reviews indicate that specific control limits were not met in sample analyses. SCUM (Ecology 2021) summarizes quality control procedures, control limits, and corrective actions for analyses of organic chemicals, metals and conventional sediment parameters in Tables 5-3, 5-4 and 5-5. SCUM (Ecology 2021) summarizes the SMS performance standards for toxicity testing control and reference sediment in Table 5-9.

6. Quality Assurance and Quality Control (QA/QC) Requirements

This section provides an overview of the QA/QC checks consist of measurements performed in the field and laboratory; details are provided in the Quality Assurance Project Plan (Attachment B).

The analytical methods referenced in Section 5.1 specify routine methods required to evaluate data precision and accuracy, and determine whether the data are within the QC limits. Guidelines for minimum samples for field QA/QC sampling and laboratory analysis are summarized in Table 6-1.

Table 6-1. Guidelines for Minimum QA/QC Samples for Field Sampling and Laboratory Analysis

Field			Laboratory				
Media	**Field Duplicate**	**Rinsate Blank**	**Matrix Duplicate**[a]	**MS**	**MSD**[b]	**Method Blank**	**LCS**[c]
Sediment	1 in 20[d]	1 in 20	1 in 20	1 in 20	1 in 20	1 in 20	1 in 20

Notes:

[a] Matrix duplicate analyzed for metals.

[b] MSD analyzed for organic analyses.

[c] Laboratory Control Sample.

[d] All frequencies of 1 in 20 indicate 1 per batch, when the batch is less than 20 samples.

6.1 QA/QC for Field Methods

The QC samples specified in Table 6-1 will be evaluated to verify accuracy and precision of laboratory results and ensure the quality of the sampling effort and the analytical data for this project. Field QC samples may include field duplicates, equipment rinsate, and rinsate blanks. QC samples are to be handled in the same manner as the environmental samples collected. The frequency of QC sample evaluation may be adjusted when the final sampling schedule is determined. The frequencies of QC sample evaluation described here should be considered a minimum.

6.2 QA/QC for Chemical Analyses

QA/QC procedures for chemical analyses include analytical instrument calibration, sample holding times, blank analyses to identify potential sample contamination in the laboratory, duplicate analyses to test analytical precision, and analyses of spikes and standards to test analytical accuracy. Laboratory QA/QC procedures are discussed in detail in the analytical protocols and laboratory standard operating procedures for each chemical test. The recommended frequency of specific quality control procedures and associated control limits are summarized in Tables 5-3 through 5-5 of SCUM (Ecology 2021):

- Table 5-3 summarizes organic compounds analyses,
- Table 5-4 summarizes metals analyses, and
- Table 5-5 summarizes conventional analyses.

Minimum laboratory QA/QC is documented in Table 6-2.

Table 6-2. Minimum Laboratory QA/QC

Analysis Type	Method Blank[b]	LCS or OPR (Blank Spike)[c]	Replicate[b]	RM[b,d]	Matrix Spikes[b]	Matrix Spike Duplicate[b]	Surrogates[g]	Puget Sound Ref. Material
Volatile Organics[a]*	X	X			X	X	X	
Semivolatiles[a]	X	X		X[e]	X	X	X	
Aroclor PCBs[a]	X	X		X	X	X	X	
Metals	X	X		X[f]	X			
Total Organic Carbon	X	X	X	X[f]				
Total Solids*	X		X					
Particle Size*			X					
Tributyltin	X		X[h]		X	X	X	
Dioxins/Furans	X		X[h]				X[i]	X
Pesticides[a]**	X		X[h]	X	X	X	X	

Notes:

[a] Initial calibration is required before any samples are analyzed, after each major disruption of equipment, and when ongoing calibration fails to meet criteria. Ongoing calibration is required at the beginning of each work shift, every 10-12 samples or every 12 hours (whichever is more frequent), and at the end of each shift.

[b] Frequency of Analysis = 5 percent or one per batch, whichever is more frequent.

[c] Laboratory Control Sample or Ongoing Precision and Recovery

[d] Reference Material

[e] Canadian standard SRM-1 or other available sediment SRM.

[f] NIST certified reference material 2704 or other available sediment SRM.

[g] Surrogate spikes will be included with every sample, including matrix-spiked samples, blanks and reference materials.

[h] Matrix spike duplicates may be used.

i Labeled compounds are spiked into each analytical sample.

* Not proposed for analysis as part of the initial sampling effort.

** Total Chlordane.

The laboratory, which has not yet been selected, is responsible for monitoring the analysis, identifying analytical problems and taking corrective actions prior to the expiration of sample holding times. The laboratory will communicate analytical problems to the project manager during the analysis when the laboratory is having difficulty in meeting any project specific requirements, including detection limits. When reasonable corrective actions do not bring QC sample results into control limit, resulting data may need to be qualified, depending on specific project requirements as documented in the project planning document.

6.3 QA/QC for Biological Testing

QA/QC requirements for the various biological tests are described in detail in the protocols for each type of test (PSEP 1987; PSEP 1995; ASTM 2002; ASTM 2010; U.S. EPA 1994; Nebeker et al. 1984; Microbics Corporation 1992). QA/QC requirements for marine sediment toxicity tests generally deal with ensuring that water quality conditions remain within acceptable limits throughout testing. This minimizes contributions to observed effects that could otherwise confound toxicity interpretations. Control limits for temperature, salinity, and dissolved oxygen are shown in Table 5-9 of SCUM (Ecology 2021); there are generally no control limits specified for pH except for Microtox®, although measurements of pH may sometimes be useful in interpreting test results. There are also recommendations for selecting test species based on grain size of the sediments for the amphipod test. Monitoring of sulfides and ammonia in the test chambers is required for marine sediments where either of these chemicals is suspected as being a problem, and is also useful for interpreting test results. The marine sediment toxicity test protocols also require the testing of negative controls, positive controls, and reference sediments, as shown in Table 5-9 of SCUM (Ecology 2021). The reference sediments should have the percent fines within 20% of the sample percent fines. The SMS include marine sediment performance standards for control and reference sediment toxicity test results (WAC 173-204-315(2)).

6.4 Data Quality Assurance Review Procedures

The project QA/QC coordinator will conduct an independent internal quality assurance review. The internal review of analytical data will follow QA1 review procedures (PTI 1989) and will be documented using checklists to identify verified quality control procedures. This internal review will validate external reviews of chemistry data performed by EcoChem, Inc. (EcoChem), and bioassay and/or bioaccumulation data sets (if required) performed by EcoAnalysts, Inc. (EcoAnalysts).

A QA1 chemistry data review evaluates field collection and handling; completeness; data presentation; reporting limits (the practical quantitation limit [PQL] shall not be greater than the SQS of the SMS.); and the acceptability of test results for method blanks, certified reference materials, analytical replicates, matrix spikes, and surrogate recoveries. A QA1 review of bioassay data covers similar field and reporting elements and evaluates the acceptability of test results for positive controls, negative controls, reference sediment, replicates, and experimental conditions (temperature, salinity, pH, dissolved oxygen). Detailed guidance on QA1 review procedures is provided in PTI (1989) and is available from Ecology.

All chemistry and conventionals data will undergo a quality assurance review and data validation by EcoChem, Inc. (EcoChem). EcoChem validation shall include a minimum Stage 2b validation for all chemical data. Ten percent of the dioxin/furan congener data will undergo Stage 4 validation, in addition to the Stage 2b validation. Validation will be conducted using the most recent EPA (EPA 2005, 2008, 2009, 2010) guidelines. EcoAnalysts will perform a QA1 review of bioassay data.

The analytical laboratory will provide full-level, Stage 4 chemistry data packages that will allow for examination of the complete analytical process from calculation of instrument and MSDs, RLs, final dilution volumes, samples sizes, and wet-to-dry ratios to quantification of calibration compounds and all analytes detected in blanks and environmental samples.

7. Data Analysis, Record Keeping, and Reporting

Laboratory results will be evaluated using general descriptions of the sediment chemistry data. Any stations exceeding applicable sediment quality criteria for individual chemicals will be clearly identified. This section describes how data analysis, record keeping, and reporting will occur.

7.1 Analysis of Sediment Chemistry Data

Sediment chemistry results will be tabulated for all measured analyses, including conventional sediment variables. For organic chemicals with TOC-normalized numerical criteria, tables will report TOC-normalized concentrations. Site sediments are expected to be in the range of 3% – 5% TOC, but in the event that TOC values are either very high (> 3.5%) or very low (< 0.5%), dry-weight concentrations may be compared with the dry-weight AET values (Barrick et al. 1988). The data tables will identify the sampling locations, laboratory sample identification numbers, water depth, sample collection date, sampling interval, replicates, chemistry results (same units as numeric SMS criteria, as well as dry weight concentrations for organic compounds), and practical quantitation limits. Appropriate data qualifiers will be attached to chemical concentrations, and detection limits will be reported for undetected analyses. Numerical criteria will be included in the tables, and values that exceed the criteria will be highlighted. For criteria that apply to the sum of individual compounds, isomers, or groups of congeners, the sums and their applicable criteria will be reported as recommended in SCUM (Ecology 2021).

7.2 Analysis of Biological Test Data

If required under a subsequent sampling effort, laboratory bioassay test data will be tabulated and reported in hard-copy and electronic formats to Ecology. Reported data will include all test, reference, negative control and positive control data. The laboratory bioassay test, control and reference results will be tabulated in the EIM Bioassay data spreadsheets following Ecology's EIM data submittal guidelines. The EIM spreadsheets and Data Entry Help documents are available through the following two links.

- https://ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database
- https://apps.ecology.wa.gov/eim/help/

7.3 Data Interpretation

Results from this sediment investigation will be summarized in a data report that interprets chemical and/or biological test results compared to the legally applicable or recommended chemical and/or biological effects criteria identified in the SMS rule. Samples that exceed criteria and their respective values will be identified by footnoting, underlining, shading, or other similar means in the hardcopy data report summary. Bioassay laboratories are required to conduct evaluations of positive control data for all laboratory bioassay animals. Bioassay laboratories should maintain a "running account" of the mean + 2 standard deviation for each animal type and each positive control result. As required by Ecology, the report will interpret the laboratory reported data. The MyEIM analysis tools report export formats will be used to create and report interpretation results.

7.4 Record Keeping and Reporting Procedures

Record Keeping: Sampling and analysis records will be kept in accordance with SMS requirements. Records will include copies of this SAP, field logs, sediment sample log sheets, chain-of-custody forms, laboratory reports, summary tables, and interpretive reports. We recommend that PoFH retain copies of the following for at least 10 years from report submittal to Ecology:

- Final and Ecology-approved SAP;
- Field records that document any departures from the SAP; and
- Analytical results, including laboratory reports, summary tables and data reports.

Reporting: The results of the sediment sampling and analysis will be provided to Ecology, and other interested agencies as directed by PoFH, in a sediment characterization report. This report will be provided in both paper and electronic format, and shall include (at minimum) a statement of purpose, a description of any deviations from this SAP in sampling and analysis, a sampling station map, coordinates for all sampling locations, sediment data tables summarizing the chemical and conventional variables in the same units as the SQS criteria, and an interpretation of the results. Appendices will include copies of field logs, and copies of chain-of-custody forms.

All data will be uploaded to EIM using JENSEN22 as the EIM Study ID following Ecology’s EIM data submittal guidelines.

8. Health and Safety Plan

The purpose of the site-specific Health and Safety Plan (HASP) (Appendix C, Attachment C of the Remedial Investigation Work Plan) is to set forth appropriate health and safety procedures to be followed during onsite sampling activities at the site. This HASP identifies potential hazards to which L-E personnel may be exposed. This plan works in concert with the L-E Corporate Health and Safety Manual (Attachment C). L-E personnel shall not participate in these sampling activities without having read this HASP and the L-E Corporate Health and Safety Manual. While working at this site, L-E employees shall follow the procedures described in the Corporate Health and Safety Manual and this site-specific HASP. L-E will designate a field safety officer for this project prior to mobilization.

8.1 Description of Tasks

L-E personnel will collect sediment samples using grab samplers and vibracores deployed from a watercraft designed to perform such tasks. Personnel will collect sediment samples, homogenize appropriate aliquots of sediment for sampling, fill sample containers, dispose of excess sample material, write and affix labels to sample containers, decontaminate sampling equipment, prepare sample containers for transport to one or more laboratories using coolers, prepare chain-of-custody paperwork, and transport samples to lab(s).

8.2 Hazard Assessment

L-E employees must be aware of the hazards onsite. The site is known to have contaminants of potential concern in sediment, which are identified and discussed in the Work Plan. Special attention should be given to physical dangers such as slip, trip, and fall hazards when working around water. Other physical hazards may include pinch points, strains due to lifting, noise, heavy equipment located on or suspended above the vessel, and heat and cold stress. Biological hazards may include insect bites/stings and coronavirus (COVID-19).

8.3 Job Safety Analysis

Level D is the minimum acceptable level for sites where petroleum hydrocarbons are the constituents of concern (COC). Upgrades to Modified Level D occur when there is a possibility that contaminated media can contact the skin or work uniform. Upgrades to Level C occur when there is a presence of product odors. Wear hearing protection when there are high noise levels (see Section 5.2.6 in Attachment C – the L-E Corporate Health and Safety Manual). Workers must maintain proficiency in the use and care of PPE that is to be worn.

Table 8-1. Activity Specific PPE/Sediment Monitoring Summary

Job Task	Safety and Health Risks	PPE Level	Special Requirements
Loading and unloading sample coolers, boat equipment, general non- sampling activities on boat	Lifting. Slips/trips/falls. Boating operations. Inclement weather. Material handling. Working over water.	Level D	Hard hat for overhead hazards. PFD when working on or near water.
Operation of sampling vessel from inside boat house	Boating operations. Confined space.	Modified Level D	Should not leave pilot house if overhead hazards, decontamination chemicals, or sediment exposure is possible. PFD when working on or near water.

Table 8-1. Activity Specific PPE/Sediment Monitoring Summary (continued)

Job Task	Safety and Health Risks	PPE Level	Special Requirements
Operation of sampling equipment outside of boat house	Lifting. Slips/trips/falls. Pinch points. Boating operations. Inclement weather. Material handling. Working over water.	Level D with potential upgrade to Level C	Potential upgrade to Level C when handling samples – presence of product odors. Hard hat for overhead hazards. Face shield for splash hazard. PFD when working on or near water.
Decontamination of sampling equipment	Lifting. Slips/trips/falls. Boating operations. Inclement weather. Material handling. Working over water.	Level D with potential upgrade to Level C	Potential upgrade to Level C when handling samples – presence of product odors. Face shield for splash hazard. Hard hat for overhead hazard. PFD when working on or near water.
General site duties, operation of equipment, etc.	Slips/trips/falls. Working over water.	Level D	Hard hat for overhead hazards. PFD when working on or near water.
Travel to/from site	Vehicular travel	None	Seatbelt while vehicle is in motion.

8.4 Health and Safety Requirements

Each contaminant should be investigated, and precautionary measures taken to protect the user being exposed to contaminants. As appropriate, employees should wear:

- Steel-toe leather or rubber boots
- Coveralls or water-proof gear
- Hard hat
- Safety glasses
- Disposable vinyl or nitrile gloves

Additionally, if the Governor’s “Stay Home, Stay Healthy” Proclamation 20-25 remains in effect, employees will keep at least six feet away from coworkers and other people when feasible. When distancing isn’t feasible a barrier such as a face mask will be used to prevent transmission of coronavirus.

Personnel and equipment leaving the project area shall be thoroughly decontaminated. Any excess sediment and water must be returned to the area from which it was collected. Procedures for equipment decontamination include washing with Alconox soap (or equivalent) and rinsing with distilled water. This procedure will be performed on all sample collection and preparation equipment that is not dedicated to an individual sample, personal protective equipment, and any other instruments or equipment that encounter contaminated materials.

Since work will occur around water, special attention must be given to physical dangers such as slip, trip, and fall hazards. In general, it is recommended that the sample collector(s) avoid skin contact with all sediment and inhalation of odors.

When working around equipment it is important to always be alert. Always make eye contact and express your intentions when approaching an operator of any equipment. Make sure they know where you are. Any work such as sample labeling, writing in the field note book, and sample handling should be performed in a safe area. L-E personnel will not operate equipment unless they are qualified to do so.

While working onsite, L-E employees must follow health and safety standards that meet or exceed procedures and requirements in the site-specific HASP and the Corporate Health and Safety Plan.

8.5 Emergency Response

In an emergency, call 911 for assistance. The nearest medical clinic is PeaceHealth Peace Island Medical Center, located at 1117 Spring St, Friday Harbor, WA 98250. It is approximately two miles from Albert Jensen and Sons Inc. Boatyard and Marina and less than a 10-minute drive from the site. The main phone number for the facility is (360) 378-2141.

Driving directions from Albert Jensen and Sons Inc. Boatyard and Marina to the PeaceHealth Peace Island Medical Center in Friday Harbor are as follows:

- Head west on Turn Point Rd toward Harrison St – 0.7 mi
- Continue onto Warbass Way – 0.4 mi
- Turn right onto Harrison St – 289 ft
- Continue onto 1st St S/First St S – 289 ft
- Turn left onto Spring St – 0.9 mi
- Turn left into parking lot where Spring St becomes San Juan Valley Rd – 112 ft
- Take the first left to reach the entrance to the PeaceHealth Peace Island Medical Center

A map showing the route from the Albert Jensen and Sons Inc. Boatyard and Marina parking lot to the PeaceHealth Peace Island Medical Center is provided in Figure 4.

A first aid kit will be available on site.

All accidents and near misses shall be reported promptly to the immediate supervisor for evaluation or investigation.

9. Schedule

The immediate project schedule is likely to be driven by interim actions, which we propose to associate with required maintenance actions. As described previously, a substantial amount of required maintenance was deferred by the previous owner. Several components of the existing marina infrastructure are likely to fail if maintenance is deferred much longer. Failure of this infrastructure will not only handicap marina operations, but will also exacerbate the spread of COPCs in the aquatic environment through the accelerated deterioration of creosote-treated structures and sloughing of contaminated upland soils into intertidal areas.

Under the current work plan, initial sediment sampling is expected to occur during Summer 2022.

9.1 Remedial Investigation Schedule

Summer/fall 2020 – Previously-proposed Marine Technical Center building remedial investigation sampling
Summer 2022 – Uplands remedial investigation sampling
Summer 2022 or 2023 – In-water remedial investigation sampling

9.2 Remedial Investigation/Feasibility Study Deliverables Schedule

RI/FS Deliverables	Completion Times
Agency Review Draft RI Work Plan	Submitted
Final RI Work Plan including Final SAP, QAPP, and HASP	Submitted
Completion of RI/FS Field Work	24 months following completion of the Final SAP, QAPP and HASP
Agency Review Draft RI/FS Report	180 days following receipt of laboratory data
Agency Review Draft Final RI/FS Report	45 calendar days following receipt of Ecology comments on Agency Review Draft RI/FS Report
Public Review Draft RI/FS Report	45 calendar days following resolution of Ecology comments and receipt of Ecology’s written request for Public Review Draft RI/FS Report
Agency Review preliminary Draft Cleanup Action Plan (DCAP)	90 calendar days following submission of the Public Review Draft RI/FS

10. Project Personnel and Responsibilities

At a minimum, the sediment sampling field crew will consist of the Sampling Project Manager, Field Operations Coordinator and a boat driver. Peter Leon, Sampling Project Manager, is responsible for: all aspects of sample collection; reporting; and coordination with PoFH, Ecology, the vessel operator and the analytical laboratory. L-E will designate a field safety officer and Field Operations Coordinator prior to mobilization. The Field Operations Coordinator is responsible for: field activities; ensuring adherence to the SAP; ensuring accurate station locations; summarizing decisions on deviations from the SAP necessitated by field conditions; completing chain-of-custody forms; and keeping field logs and sediment sampling logs. If sediment toxicity testing is triggered by analytical chemistry results, John Malek will oversee bioassays and coordination with the bioassay laboratory. Once field activities are complete, L-E will designate a Data and QA/QC Manager for the project, responsible for verifying that data quality assurance reviews are completed, and reviewing data tables.

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Figures

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Filename: /Friday Harbor/GIS/PoFH_WorkPlan2021/RIWP_Jensens_vicinity date: 6/22/2021

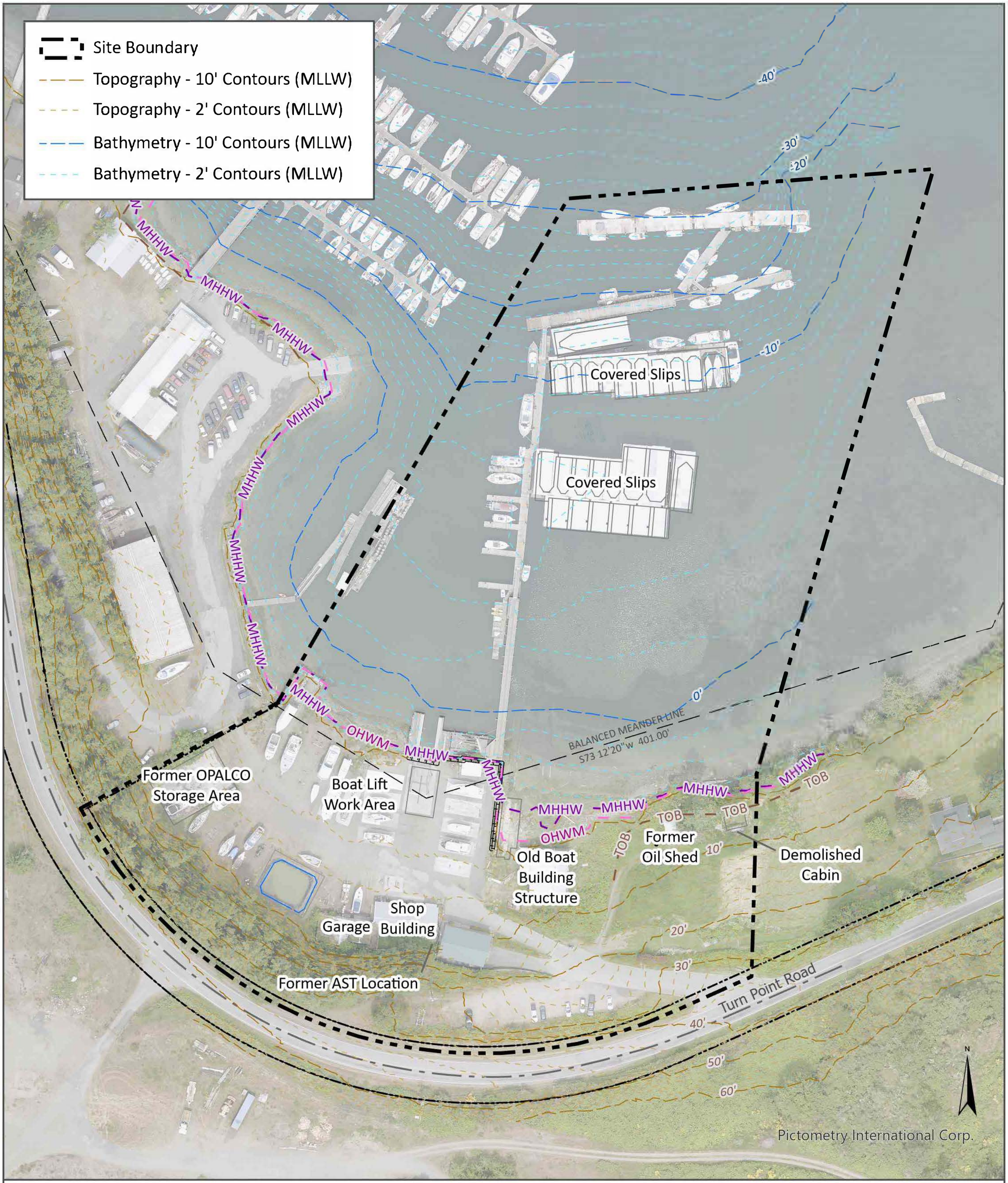
Port of Friday Harbor
Jensen and Sons Boatyard and Marina

In-Water Sampling & Analysis Plan

Figure 1. Site and Vicinity Map

Data Sources:
San Juan County (2019), Whatcom Environmental (2018)

LEON Environmental, LLC



Filename: /Friday Harbor/GIS/PoFH_WorkPlan2021/RIWP_ExistingConditions date: 6/22/2021

Port of Friday Harbor
Jensen and Sons Boatyard and Marina

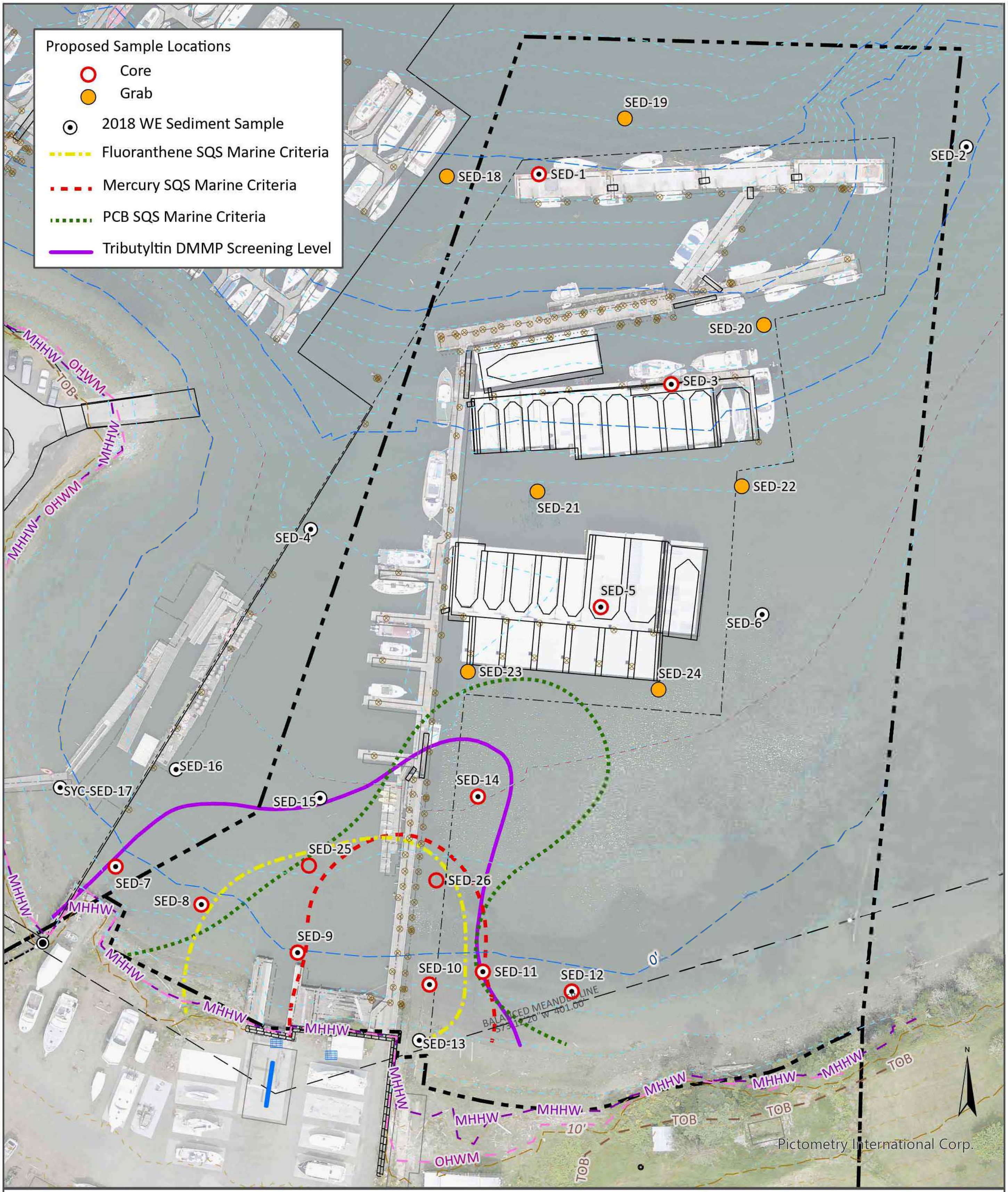
In-Water Sampling & Analysis Plan

Figure 2. Existing Conditions

Data Sources:
Leon Environmental, LLC (2018), San Juan Surveying (2019),
San Juan County (2019), Whatcom Environmental (2018)

0 40 80 160 Feet

LEON
Environmental, LLC



Filename: /Friday Harbor/GIS/PoFH_WorkPlan2021/ProposedSedSamplingPts date: 6/14/2021

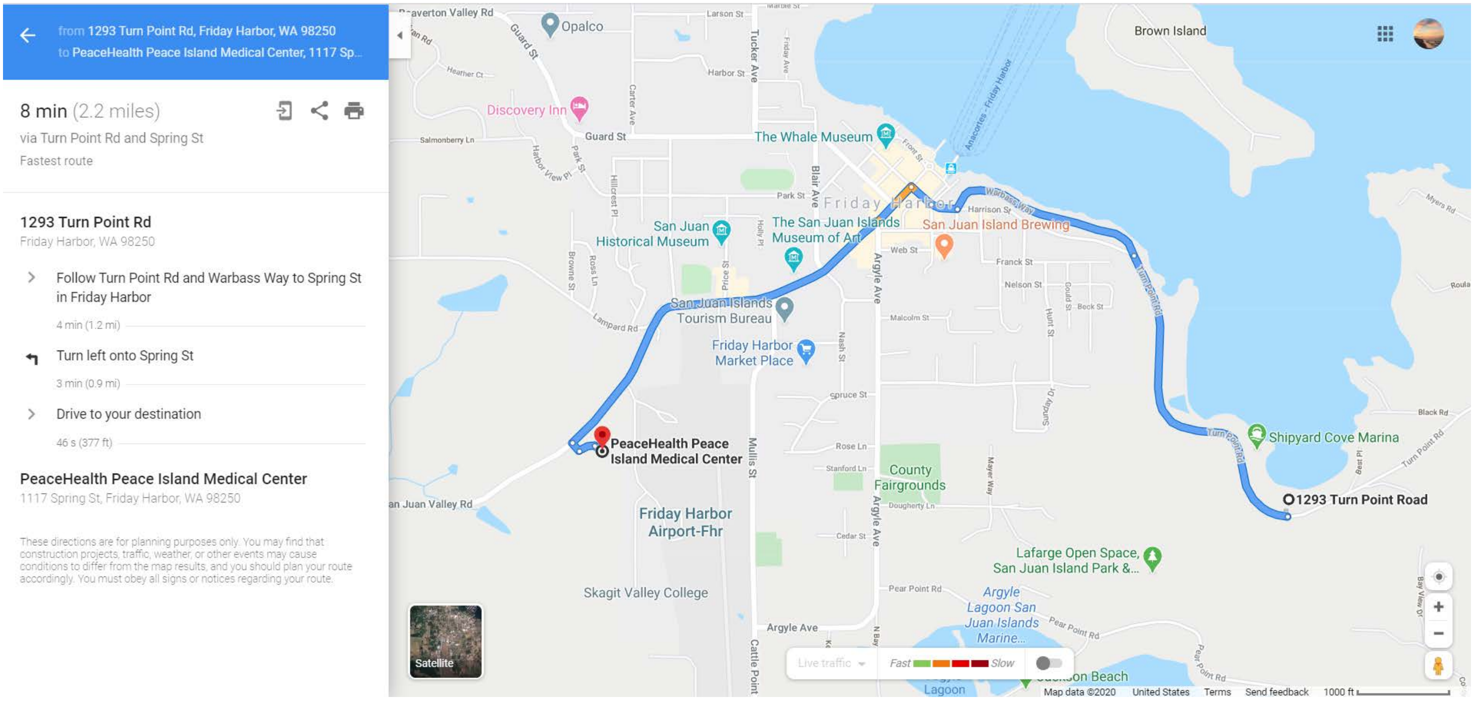
Port of Friday Harbor
Jensen and Sons Boatyard and Marina

In-Water Sampling & Analysis Plan
Figure 3. Sediment Sampling Locations

Data Sources:
Leon Environmental, LLC (2021),
San Juan Surveying (2019), San Juan County (2019),
Shannon and Wilson, Inc. (2019), Whatcom Environmental (2018)

Feet
0 25 50 100

LEON
Environmental, LLC



from 1293 Turn Point Rd, Friday Harbor, WA 98250
to PeaceHealth Peace Island Medical Center, 1117 Sp...

8 min (2.2 miles)
via Turn Point Rd and Spring St
Fastest route

1293 Turn Point Rd
Friday Harbor, WA 98250

- Follow Turn Point Rd and Warbass Way to Spring St in Friday Harbor
  4 min (1.2 mi)
- Turn left onto Spring St
  3 min (0.9 mi)
- Drive to your destination
  46 s (377 ft)

PeaceHealth Peace Island Medical Center
1117 Spring St, Friday Harbor, WA 98250

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Peace Health Peace, Island Medical Center
1117 Spring St
Friday Harbor, WA 98250
(360) 378-2141

Attachment A
Summary of Chemical Exceedances Reported in WE 2018c

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Port of Friday Harbor
Jensen's Surface Sediments
Summary: 2018 SMS Exceedances

Sample Location	TOC (%)	Metals (mg/kg dw)	TBT (ug/kg dw)	Organics (ug/kg dw)	Phthalates (ug/kg dw)	Pesticides (DMMP) (ug/kg)	PCBs (mg/kg OC)	PAHs (mg/kg OC)	Dioxins/Furans (ng/kg dw TEQ)	Chlorinated Organics (mg/kg OC)	Work Needed
SED-1	1.37		3.8			Heptachlor (< 4.2 Ui) Chlordane (2.8 J)	1.2	LPAH = 19.6 HPAH = 154	N/A	1,2,4-Trichlorobenzene (< 2.0 U) Hexachlorobenzene (< 2.6 U)	Core: Pest Bound: SED-3, -18, -19, -20
SED-2	0.80		1.3 J				<0.6 U	LPAH = 81.6 HPAH = 115	N/A	1,2,4-Trichlorobenzene (< 3.3 U) 1,2-Dichlorobenzene (< 3.0 U) Hexachlorobenzene (< 4.1 U)	N/A
SED-3	1.88		7.5	Benzyl alcohol (< 58 U)		Heptachlor (< 2.6 Ui) Chlordane (5.3 J)	1.8	LPAH = 9.8 HPAH = 93	N/A	1,2,4-Trichlorobenzene (< 1.6 U) Hexachlorobenzene (< 2.1 U)	Core: SVOCs, Pest Bound: SED-1, -20, -21, -22
SED-4	1.81		3.8				0.4 JP	LPAH = 17.3 HPAH = 75	N/A	1,2,4-Trichlorobenzene (< 1.5 U) Hexachlorobenzene (< 1.9 U)	N/A
SED-5	1.92		25	Benzyl alcohol (< 65 U)		Heptachlor (< 3.1 Ui) Chlordane (4.9 JP)	2.9	LPAH = 4.0 HPAH = 55	N/A	1,2,4-Trichlorobenzene (< 1.8 U) Hexachlorobenzene (< 2.3 U)	Core: Pesticides, SVOCs Bound: SED-21, -22, -23, -24
SED-6	2.21		10	Benzyl alcohol (< 66 U)			1.2	LPAH = 9.4 HPAH = 67	N/A	1,2,4-Trichlorobenzene (< 1.6 U) Hexachlorobenzene (< 2.0 U)	N/A
SED-7	1.41		75				1.6 JP	LPAH = 11.8 HPAH = 111	N/A	1,2,4-Trichlorobenzene (< 0.9 U) Hexachlorobenzene (< 1.2 U)	Core: TBT, SVOCs Bound: SED-8
SED-8	2.54		210			Chlordane (< 4.8 UiJ)	5.8	LPAH = 42.4 HPAH = 533	N/A	1,2,4-Trichlorobenzene (< 1.1 U) Hexachlorobenzene (< 1.3 U)	Core: TBT, SVOCs, Pest, PCBs, Dioxins Bound: SED-7, SED-25, SED-9
SED-9	4.29	Copper (578)	300	Benzyl alcohol (68 J) N-nitrosodiphenylamine (<43 U)	Butylbenzyl (70 J) Dimethyl (190)	Heptachlor (< 2.2 Ui) Dieldrin (5.3) Chlordane (< 5.0 UiJ)	252 ug/kg dw	HPAH (20.6 mg/kg dw) Fluoranthene (5.5 mg/kg dw) Pyrene (3.2 mg/kg dw) Benz(a)anthracene (1.9 mg/kg dw) Chrysene (4.1 mg/kg dw) Benzofluoranthenes (3.4 mg/kg dw)	80.3 J	1,2,4-Trichlorobenzene (< 35 ug/kg dw U) Hexachlorobenzene (< 44 ug/kg dw U) Hexachlorobutadiene (< 40 ug/kg dw U)	Core: Metals, TBT, SVOCs, Pest, PCBs, Dioxins Bound: SED-8, -25, -26, -10
SED-10	1.26	Copper (1370) Mercury (1.45) Zinc (589)	4000			Dieldrin (< 4.8 Ui) 4,4'-DDD (19) Chlordane (< 7.5 JP)	51.6 P	Acenaphthene (17.5) Phenanthrene (182.5) HPAH (1678) Fluoranthene (436.5) Benz(a)anthracene (134.9) Chrysene (182.5) Benzofluoranthenes (282.5) Benzo(a)pyrene (134.9) Indeno(1,2,3-c,d)pyrene (95.2) Dibenzo(a,h)anthracene (22.2) Benzo(g,h,i)perylene (111.1)	92.8 J	1,2,4-Trichlorobenzene (< 2.1 U) Hexachlorobenzene (< 2.6 U)	Core: Metals, TBT, SVOCs, Pest, PCBs, Dioxins Bound: SED-9, -25, -26, -11
SED-11	2.69	Mercury (.44)	53			Chlordane (< 4.6 UiJ)	8.7 P	LPAH = 12.0 HPAH = 123	N/A	1,2,4-Trichlorobenzene (< 1.0 U) Hexachlorobenzene (< 1.2 U)	Core: Metals, SVOCs, Pest, PCBs, Dioxins Bound: SED-10, -26, -12
SED-12	1.03		9.3				3.4 J	LPAH = 11.7 HPAH = 119	N/A	1,2,4-Trichlorobenzene (< 2.5 U) 1,2-Dichlorobenzene (< 2.3 U) Hexachlorobenzene (< 3.2 U)	Grab: Dioxins Bound: SED-11
SED-13	1.98	Copper (1380) Mercury (.85) Zinc (928)	4000			Dieldrin (< 4.7 Ui) 4,4'-DDD (36) Chlordane (12 J)	59.6 P	Fluoranthene (171.7) Indeno(1,2,3-c,d)pyrene (48.0) Benzo(g,h,i)perylene (55.6)	72.3 J	1,2,4-Trichlorobenzene (< 1.3 U) Hexachlorobenzene (< 1.7 U)	Bound: SED-10, -11
SED-14	1.87 J		91			N/A	24.8 J	LPAH = 22.0 J HPAH = 140 J	N/A		Core: TBT, SVOCs, Pest, PCBs Bound: SED-23, -24, -25, -26
SED-15	2.08 J		48.8			N/A	1.8 J	LPAH = 12.2 J HPAH = 95 J	N/A		N/A
SED-16	3.30 J		36.9			N/A	1.5 J	LPAH = 32.5 J HPAH = 302 J	N/A		N/A
SED-17	0.49 J		4.31			N/A	7 ug/kg dw	LPAH = 0.1 mg/kg dw HPAH = 0.4 mg/kg dw	N/A		N/A

Attachment B
Quality Assurance Project Plan

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PORT OF FRIDAY HARBOR
ALBERT JENSEN AND SONS INC. BOATYARD AND MARINA
FRIDAY HARBOR, WA

MODEL TOXICS CONTROL ACT (MTCA)
AGREED ORDER NO. DE 18071

IN-WATER SAMPLING AND ANALYSIS PLAN

ATTACHMENT B: IN-WATER QUALITY ASSURANCE PROJECT PLAN (QAPP)

Prepared for
The Port of Friday Harbor
Friday Harbor, WA

Prepared by
Leon Environmental, LLC
Seattle, WA

July 2022

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Abbreviations and Acronyms

AET	Apparent Effect Threshold
COC	Chain-of-Custody
COPC	contaminant of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
DCAP	Draft Cleanup Action Plan
DQO	data quality objective
Ecology	Department of Ecology
FS	Feasibility Study
HAZWOPER	hazardous waste operations
Jensen’s	Albert Jensen & Sons Inc. Boatyard and Marina
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MS	matrix spike
MSD	matrix spike duplicate
MTCA	Model Toxics Control Act
Order	Agreed Order No. DE 18071
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
Port	Port of Friday Harbor
PSEP	Puget Sound Estuary Program
PSEP	Puget Sound Estuary Program
QAPP	Quality Assurance Project Plan
QA	quality assurance
QC	quality control
RI	Remedial Investigation
RPD	Relative Percent Difference
SA	spike added
SAP	Sampling and Analysis Plan
SDG	sample delivery group
SMS	Sediment Management Standards
SOP	Standard Operating Procedure
SQS	Sediment Quality Standard
SR	sample result
SS	Site Supervisor
SSR	spiked sample result
TPH	total petroleum hydrocarbon
WAC	*Washington Administrative Code*
WE	Whatcom Environmental Services

1. INTRODUCTION

The overall goal of this project is to clean up the historic contamination associated with Albert Jensen & Sons Inc. Boatyard and Marina (Jensen's) and redevelop this formerly-thriving industrial facility into a revitalized community and economic hub that honors the site's history and its central role in shaping the Friday Harbor community, while providing: environmental restoration; public access and educational opportunities; outdoor-oriented recreation; affordable housing; live-work space; and a platform to provide the economic opportunity local businesses need to thrive. The steps planned during the 2021 - 2023 biennium to achieve this goal are focused on collaborating with Ecology to deliver work described in AO No. DE 18071, including: completion of a robust RI/FS; design, permitting and construction of Interim Actions to address the most immediate risks to human health and the environment; completion of a DCAP; execution of an effective public participation plan; and strategic planning for the design and construction that is anticipated in subsequent biennia.

This Quality Assurance Project Plan (QAPP) contains the project organization, data quality objectives, activities, and quality assurance (QA) procedures to be implemented during data collection activities for the In-Water Area Remedial Investigation at Jensen's. The QAPP was prepared in accordance with the Guidance for Preparation of Quality Assurance Project Plans, EPA Region 10, Quality Data Management Program, QA/R-5 and requirements of the EPA Contract Laboratory Program; Ecology's Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Revised 2016); and the Sediment Cleanup User's Manual (Revised December 2021). This QAPP is an Appendix to the In-Water Sampling and Analysis Plan (SAP).

2. PROJECT MANAGEMENT

This section identifies key project personnel and their roles, describes the rationale for conducting the remedial investigation, identifies the remedial study to be performed and the respective schedule, outlines project data quality objectives and criteria, lists training and certification requirements, and describes documentation and record-keeping procedures.

2.1 Project Organization

Roles and responsibilities are defined and assigned in the RI Work Plan.

Role	Name and Contact Information
Project Organization	
Port Project Manager (PM)	Todd Nicholson Executive Director, Port of Friday Harbor 204 Front Street Friday Harbor, WA 98250 360.378.2688 toddn@portfridayharbor.org
Ecology Site Manager	John Evered Senior Aquatic Toxicologist, Washington Department of Ecology P.O. Box 47600 Olympia, WA 98504-7600 360.407.7071 john.evered@ecy.wa.gov
Consultant Contract Manager In-Water PM	Peter Leon Principal Scientist, Leon Environmental, LLC Seattle, WA 206.948.5366 peter@leon-environmental.com
Upland PM	Grant Hainsworth, PE Principal, CRETE Consulting Inc. Seattle, WA 253.797.6323 grant.hainsworth@creteconsulting.com
Field Organization	
Site Supervisor (SS)	Todd Nicholson
Laboratory Organization	
Laboratory Manager	TBD
Data Management Organization	
Data processor	TBD
Quality Assurance Officer	John Malek
Data reviewer(s)	Peter Leon

2.2 Problem Definition and Background

The mutual objective of the State of Washington, Department of Ecology (Ecology) and the Port of Friday Harbor (Port) under Agreed Order No. DE 18071 (Order) is to provide for remedial action at a facility where there has been a release or threatened release of hazardous substances. The Order requires the Port to perform a Remedial Investigation and Feasibility Study (RI/FS) and to prepare a draft Cleanup Action Plan (DCAP), addressing both upland and in-water contamination for the Albert Jensen and Sons, Inc. Boatyard and Marina Site. Under the Order, the Port is required to identify specific data collection procedures in a QAPP as part of the Work Plan.

The Intertidal and Subtidal Conceptual Site Model and Data Gaps Report (L-E, 2019) identified several data gaps including the known extent of contaminants of potential concern. The objectives and background information to address these needs are provided in the In-Water SAP and Work Plan. This QAPP addresses quality assurance and quality control procedures that will be used for the remedial investigation for the In-Water Area at Albert Jensen & Sons Inc. Boatyard and Marina (Jensen's).

The objective for the remedial investigation is to address identified data gaps and refine the nature and extent of sediment contamination exceeding preliminary Model Toxics Control Act (MTCA) cleanup levels, preliminary Sediment Management Standards (SMS) cleanup standards, and other regulatory requirements. This QAPP is prepared to address the in-water areas of the Albert Jensen and Sons, Inc. Boatyard and Marina, which are defined as the intertidal (areas exposed to air at low tide) and subtidal (areas always covered by water) areas associated with adjacent marine waters. This effort is expected to:

- Establish horizontal and vertical contamination profiles in areas where surface sediments exceed SQS.
- Delineate the vertical and horizontal extent of dioxins/furans beyond the surface concentrations measured along the central marina shoreline, which may correlate with observed polychlorinated biphenyl (PCB) surface exceedances.
- Focus PCB analysis on areas showing benthic exceedances in surface sediments to facilitate subsequent background/human health evaluations.
- Delineate the vertical and horizontal extent of pesticides measured in surface sediments.
- Delineate the vertical and horizontal extents of metals, carcinogenic polycyclic aromatic hydrocarbon (cPAHs), and total petroleum hydrocarbon (TPH) in soils that exceed screening levels.

2.3 Project and Task Description

The remedial investigation will generally follow guidance provided in the current Sediment Cleanup User's Manual (SCUM)(Ecology 2021). Sampling procedures and collection will follow current Puget Sound Estuary Program (PSEP) protocols.

The overall study design is intended to determine the nature and extent of sediment contamination at Albert Jensen and Sons Boatyard and Marina (see SAP, Figure 1, Site and Vicinity Map). To meet the remedial investigation objectives, the initial sediment sampling effort proposes to collect surface sediment grab samples (sample depth of 0 – 10 cm) from seven (7) sampling stations and core samples (sample depth of 0 – 6 ft) from twelve (12) sampling stations located within the study area (see SAP Figure 3, Sampling Locations). We propose to reoccupy 10 previous sampling locations (WE 2018c) and sample nine new sampling locations around Jensen's. Samples will be analyzed for known contaminants of potential concern (COPCs), and conventional sediment parameters. Should samples exceed the numerical chemical concentration criteria identified in *Washington Administrative Code* (WAC) 173-204-320, potential future sampling events will collect samples to perform supplemental chemical analyses and/or bioassays to evaluate sediment toxicity against biological effects criteria.

The immediate project schedule is likely to be driven by interim actions, which we propose to associate with required maintenance actions. A substantial amount of required maintenance was deferred by the previous owner. Several components of the existing marina infrastructure are likely to fail if maintenance is deferred much longer. Failure of this infrastructure will not only handicap marina operations, but will also exacerbate the spread of COPCs in the aquatic environment through the accelerated deterioration of creosote-treated structures and sloughing of contaminated upland soils into intertidal areas.

Priority investigations include integration of the upland and aquatic data sets, additional sediment sampling to define the nature and extent of contamination, and completion of a cultural resources assessment. In order to meet anticipated timelines associated with federal permitting requirements, we anticipate that these priority investigations be expedited by Summer 2023.

We do not anticipate that the remaining work plan elements must be expedited with the same degree of urgency. We proposed to develop a detailed Work Plan Schedule in consultation with Ecology, with a focus on the availability and schedule for MTCA funding.

2.4 Quality Objectives and Criteria for Measurement Data

Data quality objectives (DQOs) are the quantitative and qualitative terms used to describe how good the data needs to be in order to meet the project's objectives. The overall DQO for this project is to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality. Typical DQOs include precision, accuracy, representativeness, comparability and completeness. Proposed DQOs are summarized and defined below.

Parameter	Method	Precision (RPD; lab/field)	Accuracy	Completeness
Metals	EPA 6010B	35% / 50%	70% - 130%	95%
Mercury	EPA 7471			
PAHs	EPA 8270D			
PCB Aroclors	EPA 8082			
Dioxins/Furans	EPA 1613			
TBT	Krone/Unger			

2.4.1 Precision

Precision is the measure of agreement among repeated measurements of the same property under identical, or substantially similar conditions; calculated as either the range or as the standard deviation. Precision is a measure of the spread of the data set.

Precision will be evaluated using the Relative Percent Difference (RPD) values between the duplicate sample or duplicate Matrix Spike results using the following equation:

$$\text{RPD} = [(\text{ABS}\ (\text{R1} - \text{R2})) / ((\text{R1} + \text{R2}) / 2)] \times 100$$

Where: ABS = Absolute difference between values (meaning no negative values)
R1 = Measured concentration for Matrix Spike or duplicate #1
R2 = Measured concentration for Matrix Spike Duplicate or duplicate #2

2.4.2 Accuracy

Accuracy is a measure of the overall agreement of a measurement to a known value. Accuracy will be evaluated using the percent recovery of the target analyte in spiked samples and, where applicable, the percent recovery of surrogates in all samples and QC samples using the following equation:

$$\text{Percent Recovery} = [(\text{SSR} - \text{SR}) / \text{SA}] \times 100$$

Where: SSR = Spiked sample result
SR = Sample result
SA = Spike added

Alternatively, where reference material is available, accuracy can be evaluated using the percent of true or reference value using the following equation:

$$\text{Percent true value} = (\text{measured value}/\text{true value}) \times 100$$

2.4.3 Representativeness

Representativeness is the degree to which data accurately represent a particular characteristic of the environmental matrix being tested. Representativeness of samples is ensured by adhering to standard field sampling protocols, standard laboratory protocols, and an adequate number of samples.

2.4.4 Comparability

Comparability is the measurement of the confidence in comparing the results of one sampling event with the results of another that were achieved by using the same matrix, sample location, sampling techniques, and analytical methodologies. Comparability can be determined through comparison of sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols. For this investigation, comparability of data will be established through the use of program-defined general methods and reporting formats and the use of common, traceable calibration and reference materials from the National Institute of Standards and Technology or other established sources.

2.4.5 Completeness

Completeness is the percentage of valid results compared to the total number of samples taken for each parameter. Percent completeness may be calculated using the following equation:

$$\text{Percent Completeness} = [(\text{Number of valid results}) / (\text{Number of samples taken})] \times 100$$

Completeness will be calculated per matrix. The DQO for completeness for all components of this project is 90%. Data that have been qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

2.5 Special Training/Certifications

Specific training requirements for personnel working at hazardous sites are:

- All members of the sampling team working at a hazardous site must have received an initial 40 hours of hazardous waste operations (HAZWOPER) training as prescribed by Occupational Safety and Health Administration (OSHA) Regulation 29 CFR 1910.120, and also must complete an annual 8-hour refresher course.
- Employers must make a medical monitoring program available to all crew members who conduct sampling operations at hazardous sites.
- All sampling team members must read and understand the contents of the HASP prior to commencing field work, and verify such by signature on the original HASP document.

Per WAC 173-340-840(2)(a), the laboratories must meet the accreditation standards established in WAC 173-50.

2.6 Documentation and Records

2.6.1 QA Project Plan Distribution

It is the responsibility of the sampling project manager to ensure that project personnel receive the most recently approved QAPP, SAP, Standard Operating Procedures, and other documents used throughout the project.

2.6.2 Field Documentation and Records

It is the responsibility of the sampling project manager to ensure that all necessary forms are completed accurately and that all pertinent information is recorded. Field documentation will include a field log, core or grab sample log, and Chain-of-Custody (COC) form. Details regarding field documentation and COC procedures are available in the SAP.

2.6.3 Laboratory Documentation and Records

All Laboratory deliverables (both hard copy and electronic) with verifiable supporting documentation shall be submitted by the lab to the QA Officer. The following documents will be archived at the Laboratory: 1) signed hard copies of sampling and chain-of-custody records; and 2) electronic and hard copy of analytical data including extraction and sample preparation bench sheets, raw data and reduced analytical data. The laboratory will store all laboratory documentation for sample receipt, sample login, sample extraction, cleanup and analysis and instrument output documentation per laboratory's Standard Operating Procedure (SOP) or QA Manual.

Copies of all analytical reports will be retained in the laboratory files, and at the discretion of the QA Officer, the data will be stored on computer disks for a minimum of 1 year. After one year, or whenever the data become inactive, the files will be transferred to archives in accordance with standard laboratory procedure. Data may be retrieved from archives upon request.

2.6.4 Final Reports

The results of the sediment sampling and analysis will be provided to Ecology, and other interested agencies as directed by the Port, in a sediment characterization report. This report will be provided in both paper and electronic format, and shall include (at minimum) a statement of purpose, a description of any deviations from this SAP in sampling and analysis, a sampling station map, coordinates for all sampling locations, sediment data tables summarizing the chemical and conventional variables in the same units as the Sediment Quality Standard (SQS) criteria, and an interpretation of the results. Appendices will include copies of field logs, and copies of chain-of-custody forms.

The data report will interpret chemical and/or biological test results compared to the legally applicable or recommended chemical and/or biological effects criteria identified in the SMS rule. Samples that exceed criteria and their respective values will be identified by footnoting, underlining, shading, or other similar means in the data report summary. As required by Ecology, the report will interpret the laboratory reported data. The MyEIM analysis tools report export formats will be used to create and report interpretation results.

All data will be uploaded to EIM using JENSENS22 as the EIM Study ID following Ecology’s EIM data submittal guidelines.

3. DATA GENERATION AND ACQUISITION

3.1 Sample Process Design

The remedial investigation will generally follow guidance provided in the current SCUM. Sampling procedures and collection will follow current PSEP protocols. The rationale for the remedial investigation sampling design is detailed in the SAP.

The overall study design is intended to determine the nature and extent of sediment contamination at Albert Jensen and Sons Boatyard and Marina. To meet the remedial investigation objectives, surface sediment grab samples (sample depth of 0 – 10 cm) will be collected from seven (7) sampling stations and core samples (sample depth of 0 – 6 ft) will be collected from twelve (12) sampling stations located within the study area (see SAP Figure 3, Sampling Locations). We propose to reoccupy 10 previous sampling locations and sample nine new sampling locations around Jensen's. Samples will be analyzed for known COPCs and conventional sediment parameters. Should samples exceed the numerical chemical concentration criteria identified in WAC 173-204-320, supplemental sampling to perform bioassays may be conducted to evaluate sediment toxicity against biological effects criteria.

The specific methods and procedures for collection of field samples are also provided in the SAP.

3.2 Sampling Methods, Handling, and Custody

Details of sampling methods, handling, and custody are also provided in the SAP.

3.2.1 Sampling Methods

Details of sample collection and processing methods and procedures, sampling station locations, decontamination procedures, sample identification, sample handling, containers and labels are provided in the SAP.

3.2.2 Field Quality Control Requirements

Field quality control samples are useful in identifying problems resulting from sample collection or sample processing in the field related to analytical samples. The QC samples specified in Table 6-1 in the SAP will be evaluated to ensure the quality of the sampling effort. Field QC samples may include field duplicates, equipment rinsate, and rinsate blanks. QC samples are to be handled in the same manner as the environmental samples collected. The frequency of QC sample evaluation may be adjusted when the final sampling schedule is determined. The frequencies of QC sample evaluation described here should be considered a minimum.

At least one field duplicate sample per 20 environmental samples will be obtained from the material collected and each duplicate will be submitted for the same analyses as the environmental samples. The RPD for homogenate duplicate samples will be within 50% for sediment.

At least one equipment rinsate sample will be collected after decontamination for every 20 sediment samples collected for each type of sampling equipment that comes into contact with sample material, if non-dedicated sampling equipment is used.

3.3 Analytical Methods and Quality Control

3.3.1 Chemical Analyses

Analyses of sediment samples will include COPCs and conventional sediment parameters. Table 5-1 in the SAP summarizes the COPCs to be analyzed for each sample location and interval. Table 5-2 in the SAP summarizes the recommended sample preparation methods, cleanup methods, analytical methods, and recommended reporting limits for all SMS chemicals and conventional sediment variables (Table 5-2 includes chemicals and conventionals that are not proposed under this sampling framework). Achieving the quantitation limits in Table 5-2 will generally allow comparison with most numerical criteria. However, if the sediments contain low TOC, the TOC-normalized limits for certain chemicals may be above the numerical criteria expressed on a TOC-normalized basis. Samples may be analyzed using additional cleanup steps or alternative test methods to achieve lower detection limits. For example, hexachlorobenzene may be analyzed by GC/ECD (EPA Method 8081) as an alternative to 8270C. Detection limits should be at a level sufficient to meet the SMS chemical criteria for TOC levels as low as 0.5 percent. If, after using appropriate sample cleanup procedures, the analytical laboratory is unable to achieve sufficiently low detection limits to allow comparisons with TOC-normalized criteria, then the laboratory will contact the Sampling Project Manager to report the difficulty before completing analyses. If lower detection limits cannot be reliably attained, then non-normalized detection limits will be compared to the 1988 dry weight normalized Apparent Effects Thresholds (AETs) criteria (SCUM Table A-1; Ecology 2021).

The QC samples specified in Table 6-1 in the SAP will be evaluated to verify accuracy and precision of laboratory results and ensure the quality of the analytical data for this project. The frequencies of QC sample evaluation described here should be considered a minimum.

QA/QC procedures for chemical analyses include analytical instrument calibration, sample holding times, blank analyses to identify potential sample contamination in the laboratory, duplicate analyses to test analytical precision, and analyses of spikes and standards to test analytical accuracy. Laboratory QA/QC procedures are discussed in detail in the analytical protocols and laboratory standard operating procedures for each chemical test. The recommended frequency of specific quality control procedures and associated control limits are summarized in Tables 5-3 through 5-8 of SCUM:

- Table 5-3 summarizes organic compounds analyses,
- Table 5-4 summarizes metals analyses,
- Table 5-5 summarizes conventional analyses, and
- Tables 5-6, 5-7, and 5-8 summarize analyses of dioxins/furans.

Minimum laboratory method QA/QC is documented in Table 6-2 in the SAP.

The laboratory is responsible for monitoring the analysis, identifying analytical problems and taking corrective actions prior to the expiration of sample holding times. The laboratory will communicate analytical problems to the project manager during the analysis when the laboratory is having difficulty in meeting any project specific requirements, including detection limits. When reasonable corrective actions do not bring QC sample results into control limit, resulting data may need to be qualified, depending on specific project requirements as documented in the SAP.

- **Initial and continuing calibration:** A calibration standard will be analyzed each time an instrument is calibrated. The instruments used to perform the various analyses will be calibrated and the calibrations verified as required by the respective EPA methodologies. For example, a standard five-point initial calibration will be utilized to determine the linearity of response with the gas chromatograph/electron capture detection. Once calibrated, the system must be verified every 12 hours. All relative response factors, as specified by the analytical method, must be greater than or equal to 0.05. All relative standard deviations, as specified by the analytical method, must be less than or equal to 30 percent for the initial calibration and less than or equal to 25 percent for the continuing calibration.

- **Laboratory control sample:** The laboratory control sample (LCS) will consist of a portion of analyte-free water or solid phase sample that is spiked with target analytes of known concentration. The LCS will be processed through the entire method procedure and the results examined for target analyte recovery (accuracy). Precision evaluations will be generated using a laboratory control sample duplicate (LCSD). The LCS and LCSD results will be used as a fall-back position by the laboratory in cases where the matrix spike has failed to achieve acceptable recovery and/or precision. The laboratory will be expected to re-calibrate the measurement system if unable to obtain acceptable LCS results. One LCS/LCSD pair will be analyzed for each extraction batch.

- **Method blank analysis:** The method blank is utilized to rule out laboratory-introduced contamination by reagents or method preparation. Compounds detected in the blank will be compared in concentration to those found in the samples. Any concentration of common laboratory contaminants (i.e., phthalates, acetone, methylene chloride, or 2-butanone) in a sample at less than 10 times that found in the blank will be considered a laboratory contaminant. For other contaminants, any compounds detected at less than five times that found in the blank will be considered laboratory contamination (EPA, 1994). Values reported for the method blanks are expected to be below the detection limits for all compounds, except the common laboratory contaminants. Deviations from this must be explained in the laboratory project narrative(s). One method blank will be analyzed for each extraction/digestion batch.

- **Matrix spike analysis:** A matrix spike (MS) is the addition of a known amount of target analyte to a sample. Analysis of the sample that has been spiked and comparison with the results from unspiked sample (background) will give information about the ability of the test procedure to generate a correct result from the sample (accuracy). Precision evaluations will be generated using a matrix spike duplicate (MSD). One matrix spike and matrix duplicate will be analyzed per sample delivery group (SDG) or per 20 samples. A SDG is defined as no more than 20 samples or a group of samples received at the laboratory within a two-week period.

- **Surrogate evaluations (organic analyses):** Surrogate recovery is a quality control measure limited to use in organics analysis. Surrogates are compounds added to every sample at the beginning of the sample preparation to monitor the success of the sample preparation on an individual sample basis (accuracy). Although some methods have established surrogate recovery acceptance criteria that are part of the method or contract compliance, for the most part, acceptable surrogate recoveries need to be determined by the laboratory. Recoveries of surrogates will be calculated for all samples, blanks and quality control samples. Acceptance limits will be listed for each surrogate and sample type and will be compared against the actual result.

- **Laboratory management review:** The QA Officer(s) will review all analytical results prior to final external distribution (preliminary results will be reported before this review). If the QA Officer(s) finds the data meet project quality requirements, the data will be released as “final” information. Data which are not acceptable will be held until the problems are resolved, or the data will be flagged appropriately.

3.3.2 Biological Testing

PSEP (1995) provides guidelines for conducting the amphipod, larval, and juvenile polychaete tests for marine sediments. Bioassay testing requires that test sediments be matched and run with appropriate reference sediment to factor out background conditions and sediment grain-size effects on bioassay organisms. If additional sampling is required to collect sediment for bioassays, reference sediments are expected to be collected at the same time that other samples are collected; however, reference sediments may be collected by the bioassay laboratory at a later time, in the event that bioassays are triggered by potential chemistry failures. Wet-sieving of surface sediment samples is conducted in the field at the time of collection so that a reference sample(s) with similar grain size distribution (as percent fines) can be targeted for the bioassays. Test sediments (project) will be wet-sieved after compositing and potential reference sediments should been wet-sieved, as collected, to identify adequate matches to the project samples. Wet-sieving results should be recorded and submitted with the sample analysis results. The location of the reference sediment sampling location will be recorded to the nearest 0.1 second (NAD 83).

QA/QC requirements for the various biological tests are described in detail in the protocols for each type of test (PSEP 1987; PSEP 1995; ASTM 2002; ASTM 2010; U.S. EPA 1994; Nebeker et al. 1984; Microbics Corporation 1992). QA/QC requirements for marine sediment toxicity tests generally deal with ensuring that water quality conditions remain within acceptable limits throughout testing. This minimizes contributions to observed effects that could otherwise confound toxicity interpretations. Control limits for temperature, salinity, and dissolved oxygen are shown in Table 5-9 of SCUM; there are generally no control limits specified for pH except for Microtox®, although measurements of pH may sometimes be useful in interpreting test results. There are also recommendations for selecting test species based on grain size of the sediments for the amphipod test. Monitoring of sulfides and ammonia in the test chambers is required for marine sediments where either of these chemicals is suspected as being a problem, and is also useful for interpreting test results. The marine sediment toxicity test protocols also require the testing of negative controls, positive controls, and reference sediments, as shown in Table 5-9 of SCUM. The reference sediments should have the percent fines within 20% of the sample percent fines. The SMS include marine sediment performance standards for control and reference sediment toxicity test results (WAC 173-204-315(2)).

3.4 Instrument/Equipment Testing, Inspection, and Maintenance

The primary objective of an instrument/equipment testing, inspection, and maintenance program is to help ensure the timely and effective completion of a measurement effort by minimizing the downtime of crucial sampling and/or analytical equipment due to expected or unexpected component failure. Testing, inspection, and maintenance will be carried out on all field and laboratory equipment in accordance with manufacturer's recommendations and professional judgment.

It is the responsibility of the sampling project manager to ensure all field equipment is in working order at the start of the field work. All sediment sampling and homogenizing equipment, including the mixing bowl and stainless-steel implements, will be visually inspected to confirm decontamination procedures (e.g., foil coverings) have been followed. Any sampling equipment that is not cleaned to the satisfaction of the Sampling Project Manager or Field Operations Coordinator will not be used for further sampling activities or will be cleaned and decontaminated in the field. As appropriate, schedules and records of calibration and maintenance of field equipment will be maintained in the field notebook. Equipment that is out of calibration or is malfunctioning will be removed from operation until it is recalibrated or repaired.

It is the responsibility of the laboratory manager to ensure all laboratory equipment is in working order before conducting analyses. Analytical laboratory equipment preventative testing, inspection, and maintenance will be addressed in the laboratories' QA manual, which will be kept on file at the contracted laboratory.

3.5 Instrument/Equipment Calibration and Frequency

Measuring and test equipment used during environmental data collection activities will be subject to the calibration requirements summarized below:

- **Identification:** Either the manufacturer's serial number or the calibration system identification number will be used to uniquely identify measuring and test equipment. This identification, along with a label indicating when the next calibration is due, will be attached to the equipment. If this is not possible, records traceable to the equipment will be readily available for reference.

- **Standards**: Measuring and test equipment will be calibrated, whenever possible, against reference standards having known valid relationships to nationally recognized standards (e.g., National Institute of Standards and Technology) or accepted values of natural physical constraints. If national standards do not exist, the basis for calibration will be described and documented.

- **Frequency:** Measuring and test equipment will be calibrated at prescribed intervals and/or prior to use. Frequency will be based on the type of equipment, inherent stability, manufacturers' recommendations, intended use, and experience. All sensitive equipment to be used at the project site or in the laboratory will be calibrated or checked prior to use.

- **Records:** Calibration records (certifications, logs, etc.) will be maintained for all measuring and test equipment used on the project.

If measuring and test equipment are found to be out of calibration, an evaluation will be made and documented to determine the validity of previous measurements and/or corrective action will be implemented. The QA officer will lead the evaluation process.

All laboratory calibration requirements must be met before sample analysis can begin. The laboratory will follow the calibration procedures found in the analytical methods listed in this QAPP or in the laboratory's SOPs. If calibration non-conformances are noted, samples will be reanalyzed under compliant calibration conditions within method-specified holding times.

As indicated in Table 6-2 in the SAP, initial calibration for volatile organics, semivolatiles, aroclor PCBs, and pesticides is required before any samples are analyzed, after each major disruption of equipment, and when ongoing calibration fails to meet criteria. Ongoing calibration for volatile organics, semivolatiles, aroclor PCBs, and pesticides is required at the beginning of each work shift, every 10-12 samples or every 12 hours (whichever is more frequent), and at the end of each shift.

Reference methods for initial and continuing calibration are in SCUM Table 5-1.

3.6 Inspection/Acceptance of Supplies and Consumables

The Field Manager will be responsible for material procurement and control. The Field Manager will verify upon receipt that materials meet the required specifications and that, as applicable, material or standard certification documents are provided and maintained. The Field Manager will also verify that material storage is properly maintained and contamination of materials is not allowed. Prior to mobilization, the Sediment Sampling Equipment Checklist in the SAP will be consulted to ensure all equipment is available and pre-cleaned. As part of the mobilization process, each item will be double-checked by the field coordinator.

Laboratories contracted for this project must have procedures that are documented and followed that cover the following:

- Checking purity standards, reagent grade water, and other chemicals as appropriate versus intended use
- Preparation and storage of chemicals
- Requirements for disposable glassware (grade and handling).

For this project, the Field Manager or designee will be responsible for procuring and shipping the appropriate sample containers and preservatives to the sampling site. The containers will be pre-cleaned and certified by lot. Reagents provided will be of the appropriate grade for the analysis. Records of these certifications and grades of material will be maintained on file at the laboratory.

3.7 Non-Direct Measurements

Existing chemical data from previous site characterization efforts have been reviewed to assist in identifying proposed sampling locations, discussed in the Work Plan/SAP. The past field investigations of the in-water areas were conducted by Whatcom Environmental Services (WE) as part of preliminary redevelopment planning. At this time, only a limited number of surface sediment samples (22) have been collected for this location, and no data quality review has been completed. These data are summarized in three reports that WE prepared for the Jensen's site: *Phase I Environmental Site Assessment* (WE, 2017a), *Draft Sediment Data Report* (WE, 2018c), and the *Draft Remedial Investigation Report* (WE, 2018d). Additional data and information were acquired from publicly available information sources and references cited below.

Author	Year	Report
Washington Department of Ecology	2001	Concentrations of Selected Chemicals in Sediments from Harbors in the San Juan Islands
U.S. Department of Agriculture	2009	Soil Survey of San Juan County Area, Washington
Whatcom Environmental Services	2017	Phase I Environmental Site Assessment, Jensen's Shipyard, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2017	Sediment Sampling and Analysis Plan, Jensen's Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Initial Investigation Report, Jensen's Shipyard, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Sediment Investigation, Sediment Sampling and Analysis Plan, Jensen's Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Draft Sediment Data Report, Jensen's Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
Whatcom Environmental Services	2018	Draft Remedial Investigation Report, Jensen's Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington
San Juan Surveying	2018	Topographic Survey for Port of Friday Harbor – Jensen's Shipyard Planning Map
Fairbanks Environmental Services, Inc.	2020	Port of Friday Harbor Albert Jensen and Sons Boatyard and marina Eelgrass and Macroalgae Survey
Marine Surveys & Assessments	2021	Jensen Marina Habitat Survey Report

3.8 Data Management

Sampling and analysis records will be kept in accordance with SMS requirements. Records will include copies of this SAP, field logs, sediment sample log sheets, chain-of-custody forms, laboratory reports, summary tables, and interpretive reports. We recommend that the Port retain copies of the following for at least 10 years from report submittal to Ecology:

- Final and Ecology-approved SAP;
- Field records that document any departures from the SAP; and
- Analytical results, including laboratory reports, summary tables and data reports.

4. ASSESSMENT AND OVERSIGHT

4.1 Assessments and Response Actions

Assessment of field sample collection methods will be evaluated using the sampling equipment rinsate blank results. If there is a detectable level of the compound of interest in the equipment rinsate blank, samples will be qualified based on possible contamination.

Assessment of the field and laboratory methods will be evaluated using the field duplicate results. A significant variation between the original sample and the field duplicate may be caused by laboratory error or due to field sampling conditions. This variation will be identified during data validation with results compared to both the laboratory reports and field notes.

Nonconforming items and activities are those which do not meet the project requirements or approved work procedures. Non-conformance may be detected and identified by any of the following groups:

- Project Staff: During the performance of field activities and testing, supervision of subcontractors, performance of audits, and verification of numerical analyses
- Laboratory Staff: During the preparation for and performance of laboratory testing, calibration of equipment, and QC activities
- QA Staff: During the performance of audits.
- If possible, action will be taken in the field to correct any nonconformance observed during field activities. If necessary and appropriate, corrective action may consist of re-sampling. If implementation of corrective action in the field is not possible, the nonconformance and its potential impact on data quality will be discussed in the report.

Corrective action to be taken as a result of nonconformance during field activities will be situation-dependent. The laboratory will be contacted regarding any deviations from the QAPP, will be asked to provide written justification for such deviations, and in some instances, will be asked to reanalyze the sample(s) in question. An example of a laboratory nonconformance that would require corrective action is if holding times were exceeded prior to analysis. All corrective actions must be documented. The person identifying the nonconformance will be responsible for its documentation.

Documentation will include the following information:

- Name(s) of the individual(s) identifying or originating the nonconformance
- Description of the nonconformance
- Any required approval signatures
- Method(s) for correcting the nonconformance or description of the variance granted.

Documentation will be made available to project, laboratory, and/or QA management. Appropriate personnel will be notified by the management of any significant nonconformance detected by the project, laboratory, or QA staff. Implementation of corrective actions will be the responsibility of the PM or the QA Officer. Any significant recurring nonconformance will be evaluated by project or laboratory personnel to determine its cause. Appropriate changes will then be instituted in project requirements and procedures to prevent future recurrence. When such an evaluation is performed, the results will be documented. If there are unavoidable deviations from this QAPP, the Project Manager will document the alteration and track the change in the subsequent deliverables.

4.2 Reports to Management

The results of the sediment sampling and analysis will be provided to Ecology, and other interested agencies as directed by the Port, in a sediment characterization report. This report will be provided in electronic format, and shall include (at minimum) a statement of purpose, a description of any deviations from this SAP in sampling and analysis, a sampling station map, coordinates for all sampling locations, sediment data tables summarizing the chemical and conventional variables in the same units as the SQS criteria, and an interpretation of the results. Appendices will include copies of field logs, and copies of chain-of-custody forms.

Deliverables from this project include:

- Sediment characterization report
- Laboratory results and EDDs
- Data validation report(s)

All data will be uploaded to EIM using JENSENS22 as the EIM Study ID following Ecology’s EIM data submittal guidelines.

5. DATA VALIDATION AND USABILITY

5.1 Data Review, Verification, and Validation

The project QA/QC coordinator will conduct an independent internal quality assurance review. The internal review of analytical data will follow QA1 review procedures (PTI 1989) and will be documented using checklists to identify verified quality control procedures. This internal review will validate external reviews of chemistry data performed by EcoChem, Inc. (EcoChem), and bioassay and/or bioaccumulation data sets (if required) performed by EcoAnalysts, Inc. (EcoAnalysts).

A QA1 chemistry data review evaluates field collection and handling; completeness; data presentation; reporting limits (the practical quantitation limit [PQL] shall not be greater than the SQS of the SMS); and the acceptability of test results for method blanks, certified reference materials, analytical replicates, matrix spikes, and surrogate recoveries. A QA1 review of bioassay data covers similar field and reporting elements and evaluates the acceptability of test results for positive controls, negative controls, reference sediment, replicates, and experimental conditions (temperature, salinity, pH, dissolved oxygen). Detailed guidance on QA1 review procedures is provided in PTI (1989) and is available from Ecology.

All chemistry and conventionals data will undergo a quality assurance review and data validation by EcoChem, Inc. (EcoChem). EcoChem validation shall include a minimum Stage 2b validation for all chemical data. Ten percent of the dioxin/furan congener data will undergo Stage 4 validation, in addition to the Stage 2b validation. Validation will be conducted using the most recent EPA (EPA 2005, 2008, 2009, 2010) guidelines. EcoAnalysts will perform a QA1 review of bioassay data.

The analytical laboratory will provide full-level, Stage 4 chemistry data packages that will allow for examination of the complete analytical process from calculation of instrument and MSDs, RLs, final dilution volumes, samples sizes, and wet-to-dry ratios to quantification of calibration compounds and all analytes detected in blanks and environmental samples.

5.2 Reconciliation with User Requirements

The QA Officer will review the field notebooks, laboratory report, and results of the data validation to determine if the data quality objectives have been met. Instances where the data quality objectives were not met will be documented. The usability of the data will depend on the magnitude of the data quality objective exceedance. Data that has been rejected will be flagged as “R” and maintained in the database but will not be used in any decision making.

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Attachment C

Leon Environmental, LLC Corporate Health and Safety Manual

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PORT OF FRIDAY HARBOR
ALBERT JENSEN AND SONS INC. BOATYARD AND MARINA
FRIDAY HARBOR, WA

MODEL TOXICS CONTROL ACT (MTCA)
AGREED ORDER NO. DE 18071

IN-WATER SAMPLING AND ANALYSIS PLAN

ATTACHMENT C: HEALTH AND SAFETY MANUAL

Prepared for
The Port of Friday Harbor
Friday Harbor, WA

Prepared by
Leon Environmental, LLC
Seattle, WA

July 2022

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Appendices

Abbreviations and Acronyms

ACGIH	American Conference of Governmental Industrial Hygiene
ANSI	American National Standards Institute
CFR	*Code of Federal Regulation*
COC	constituents of concern
CRZ	Contaminant Reduction Zone
EMS	Emergency Medical Services
EZ	Exclusion Zone
GFCI	ground fault circuit interrupter
HASP	Health and Safety Plan
HSM	Health and Safety Manager
JHA	Job Hazard Analysis
L-E	Leon Environmental, LLC
MHR	maximum heart rate
MSDS	material safety data sheet
PFD	personal flotation device
PHSM	Project Health and Safety Manager
PM	Project Manager
PPE	personal protective equipment
SHSO	Site Health and Safety Officer
SS	Site Supervisor
SZ	Support Zone
TLV	Threshold Limit Value
WBGT	wet bulb glob temperature
WISHA	Washington Industrial and Health Act

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1. INTRODUCTION

1.1 Overview

The objective of this Health and Safety Plan (HASP) is to establish safe working conditions throughout Leon Environmental, LLC (L-E) operations on- and off-site. The provisions of this plan are mandatory for all personnel and subcontractors assigned to any L-E project. All visitors to work sites must abide by the requirements described in this manual. All work will comply with the Washington Industrial and Safety Health Act of 1973 –RCW 49.17 (WISHA) and other federal, state, and local procedures that require the development and implementation of a HASP.

The goals of this HASP are to:

- Ensure a safe and healthful work environment by identifying and controlling physical and environmental hazards.
- Provide procedures for action, especially in the case of injuries and emergencies
- Provide a means for documenting actions, approaches, and processes related to health and safety compliance during L-E operations.
- Facilitation coordination with clients, subcontractors, and other non-L-E personnel involved with L-E projects.
- Ensure compliance with federal and state regulations and avoid citations and penalties associated with non-compliance.

1.2 Scope of work

This plan addresses health and safety issues involved with environmental monitoring, sediment characterization, and other activities that may pertain to L-E projects. The policies and procedures described here apply to all operating units. Project- and site-specific information will be included in project specific Sampling and Analysis plans.

2. RESPONSIBILITIES OF KEY PERSONNEL

2.1 Firm-wide Key Contacts

Kyla Leon, CEO
206.851.9946
kyla@leon-environmental.com

Peter Leon, Principal Scientist
206.948.5366
peter@leon-environmental.com

Company Health and Safety Manager
TBD

2.2 Project-specific Personnel Responsibilities

2.2.1 Project Manager (PM)

The PM has authority to direct response operations and the PM assumes total control over site activities. In addition, the PM:

- Prepares and organizes background review of the project, the work plan, and the field team.
- Obtains permission for site access and coordinates activities with appropriate officials.
- Briefs the Site Supervisor (SS), Site Health and Safety Officer (SHSO), and field personnel on specific assignments.
- Together with the SS and SHSO, sees that health and safety requirements are met.
- Consults with the Project Health and Safety Manager (PHSM) regarding unsafe conditions, incidents, or changes in site conditions or the scope of work.

2.2.2 Site Supervisor (SS)

The SS Reports to the PM, has authority to direct response operations, and assumes control over on-site activities. In addition, the SS:

- Conducts daily safety meetings.
- Executes the work plan and schedule.
- Manages construction operations.
- In conjunction with the SHSO, conducts periodic field health and safety inspections to ensure compliance with this HASP and with worker protection levels
- Enforces safety procedures and site control
- Notifies, when necessary, local public emergency officials.
- In conjunction with the SHSO, is responsible for following-up on incident reports to the PM.

2.2.3 Site Health and Safety Officer (SHSO)

The SHSO advises the PM and SS on all aspects of health and safety on site. The SHSO stops work if site operations threaten worker or public health and safety and informs the PHSM of any changes in site conditions or project status. In addition, the SHSO:

- Conducts periodic inspections to assess whether the HASP is being followed.
- Periodically inspects protective clothing and equipment, ensures that protective clothing and equipment are properly stored and maintained.
- Controls entry and exit at the access control points.
- Performs air monitoring in accordance with this HASP.
- Maintains and oversees operation of monitoring equipment and interpretation of data from the monitoring equipment.
- Monitors workers for signs of stress, including heat stress, cold exposure, and fatigue.
- Enforces the “buddy” system.
- Is informed of emergency procedures, evacuation routes, and telephone numbers of the local hospital, poison control center, fire department, and police department.
- Notifies, when necessary, local public emergency officials.
- Communicates incidents promptly to SS and PM, maintains communication with PHSM on site activities.
- If applicable, ensures decontamination and disposal procedures are followed.
- Maintains the availability of required equipment.
- Advises appropriate health services and medical personnel of potential exposures.
- Notifies emergency response personnel in the event of an emergency. Coordinates emergency medical care.

2.2.4 Project Health and Safety Manager (HSM)

The specific duties of the HSM include:

- Providing technical input into the design and implementation of the site HASP.
- Advising on potential for worker exposure to project hazards along with appropriate methods and/or controls to eliminate site hazards.
- Ensures that a hazard assessment has been performed and the adequacy of the personal protective equipment (PPE) selected was evaluated as required by 29 *Code of Federal Regulations* (CFR) 1910.132(d), 1910.134, 1926.25, and 1926.55, and is duly noted by the signature(s) and date appearing on the cover page of this document.

2.2.5 Work Team

The Work Team reports to the SS for on-site activities and is responsible for:

- Reading, understanding, and following the project health and safety plan.
- Safely completing on-site tasks required to fulfill the work plan.
- Attending and participating in daily safety meetings.
- Notifying the SS and SHSO of suspected unsafe conditions and reporting all incidents to the SS and SHSO.
- Using PPE.

3. PROJECT HAZARD ANALYSIS

Common L-E work tasks have been evaluated for potential hazards and safety concerns via the Job Hazard Analysis (JHA) process (Appendix A). Any changes to the scope of work will require amendments to this HASP. Any tasks conducted beyond the scope of work described within this manual will be evaluated via the JHA process prior to conducting the work.

The Project Manager and Site Supervisor are responsible for identifying work tasks and site conditions that are beyond previously developed JHA documents.

3.1 Employee Information and Training

All hazards will be communicated to L-E and related subcontracted employees through safety meetings and site orientations.

3.1.1 Safety Meetings

Daily safety meetings will be held each morning prior to site activities. The purposes of these meetings are to make accident prevention a top priority and to ensure that all involved are aware of accident prevention techniques.

Example safety meeting agenda:

(1) Accidents, injuries, and near-misses:
    (a) Discuss any incidents that have occurred in your company since the last meeting,
    (b) Any follow-up that has been done as a result of investigations into incidents,
    (c) Incidents that have happened in other companies, and
    (d) Updates to the company's Accident Prevention Plan from "lessons learned."
(2) Results of safety inspections:
    (a) Discuss the results of recent safety inspections,
    (b) Encourage employees to identify any unsafe conditions or tasks, and
    (c) Discuss ways to eliminate or control the hazards.
    (d) When appropriate, assign responsibilities for eliminating or controlling identified hazards.
(3) Training:
    (a) Discuss any new safe work procedures or other policies and procedures that need to be implemented.
(4) Open forum:
    (a) Allow anyone who has a concern about safety and health to bring it up for discussion.

3.2 Hazard communication procedures

The purpose of hazard communication (Employee Right-to-Know) is to ensure that the hazards of all chemicals located at any field project site are communicated according to 29 CFR 1926.59 to all L-E personnel and L-E subcontractors. Personnel must follow the hazard communication procedures listed in Sections 5.2.12 when handling corrosive materials.

3.3 Site Controls

To prevent contamination from migrating from personnel and equipment, work areas will be clearly specified as an Exclusion Zone (EZ), Contaminant Reduction Zone (CRZ), or Support Zone (SZ) prior to beginning operations. Each work area will be clearly identified using signs or physical barriers.

The primary purpose for site controls is to establish the hazardous area perimeter, to reduce migration of contaminants into clean areas, and to prevent access or exposure to hazardous materials by personnel. At the end of each workday, the site should be secured and/or guarded to prevent unauthorized entry. Site work zones will include:

- **Clean Zone/Support Zone (SZ):** This uncontaminated zone will be the area outside the exclusion and decontamination (decon) zone and within the geographic perimeters of the site (boat and/or processing area). This area is used for staging of materials, parking of vehicles, office and laboratory facilities, sanitation facilities, and receipt of deliveries. Personnel entering this zone may include delivery personnel, visitors, security guards, etc., who will not necessarily be permitted in the exclusion zone.

- **Contaminant Reduction Zone (CRZ):** The contaminant reduction zone will provide a location for removal of contaminated PPE and final decontamination of PPE. A separate decontamination area will be established for heavy equipment. All personnel and equipment must exit via the decon area.

- **Exclusion Zone/Hot Zone (EZ):** The exclusion zone will be the “hot zone” or contaminated area inside the site perimeter. Entry to and exit from this zone will be made through a designated point. Appropriate warning signs to identify the exclusion zone should be posted (i.e., DANGER, AUTHORIZED PERSONNEL ONLY, PROTECTIVE EQUIPMENT BEYOND THIS POINT, etc.). Personnel and equipment decontamination must accompany exit from the exclusion zone.

For sediment investigations, the exclusion zone is defined as the area where individuals may come in direct contact with potentially contaminated sediment (i.e., sampling equipment, decontamination area and chemicals, bow of sampling vessel). For core extrusion activities, the exclusion zone will be defined as the area where extrusion activities occur.

A log of all personnel visiting, entering, or working on the site shall be maintained by the SS or SHSO. No visitor will be allowed in the EZ without showing proof of training and medical certification, per 29 CFR 1910.120 (e), (f). Visitors will attend a site orientation given by the SS/SHSO and sign the HASP.

3.3.1 General site control safety procedures

The following are standard safe work practices that apply to all site personnel; they will be discussed in safety briefings prior to initiating work on site:

- Eating, drinking, chewing gum or tobacco, and smoking is prohibited in the EZ/CRZs.
- Hands and face must be washed upon leaving the EZ and before eating, drinking, chewing gum or tobacco, and smoking.
- A buddy system will be used. Hand signals will be established to maintain communication.
- During site operations, each worker will consider himself as a safety backup to his partner. Off-site personnel will provide emergency assistance.
- Visual contact will be maintained between buddies on-site when performing hazardous duties.

- No personnel will be admitted to the site without the proper safety equipment, training, and medical surveillance certification.
- All personnel must comply with established safety procedures. Any staff member who does not comply with the safety policy, as established by the SS/SSO, will be immediately dismissed from the site.
- Proper decontamination procedures must be followed before leaving the EZ.

3.4 Field communications

Communications between all L-E employees and subcontractors at the work site can be verbal and/or non-verbal. Verbal communication can be affected by on-site background noise and various PPE. All project personnel must be initially briefed on communication methods prior to starting work; communication methods should be reviewed in daily safety meetings. See Table 3-1. for a list of the type of communication methods and equipment to use, depending on site conditions. Communication equipment must be checked daily to ensure proper operation.

At least one cell phone will be available onsite at all times during sampling activities. In the event of an emergency, 911 will be called immediately. If a non-emergency injury occurs that requires treatment, refer to the map and directions to the nearest hospital.

Table 3-1. Site/Field Communication Methods

Communication Device	Type of Communications	Signal
Telephone On-Site or Cellular Telephone	Emergency notification	Initiate phone call using applicable emergency numbers
Two-way Radio	Emergency notification among site personnel	Initiate radio communication with Code Red message
Compressed Air Horn	Hailing site personnel for non-emergency	One long blast, one short blast
Compressed Air Horn	Hailing site personnel for emergency evacuation	Three long continuous blasts
Visual	Hailing site personnel for distress, need help	Arms waved in circle overhead
Visual	Hailing site personnel for emergency evacuation	Arms waved in criss-cross over head
Visual	Contaminated air/strong odor	Hands clutching throat
Visual	Break, lunch, end of day	Two hands together, break apart

4. PERSONAL PROTECTIVE EQUIPMENT

The minimum level of PPE should be selected according to the hazards that may be encountered during site activities in accordance with established U.S. EPA levels of protection (D and C). Only PPE that meets the following American National Standards Institute (ANSI) standards are to be worn:

- Eye protection - ANSI Z87.1-1989.
- Head protection - ANSI Z89.1-1986.
- Foot protection - ANSI Z41-1991.
- Traffic vest in high traffic areas and around heavy equipment.

4.1 Level D protection

Level D protection is the minimum protection required. Level D protection may be sufficient when the atmosphere contains no known hazards, no contaminants are present, and when work operations preclude splashes, immersion, or the potential for unexpected inhalation or contact with hazardous levels of chemicals. Typical Level D protective equipment includes:

- Gloves,
- Coveralls,
- Safety glasses,
- Face shield,
- Chemical-resistant, steel-toe boots or shoes.

4.2 Level C protection

Level C protection is required when the concentration and type of airborne substances is known and the criteria for using air purifying respirators is met. Typical Level C equipment includes:

- Full-face air purifying respirators
- Inner and outer chemical-resistant gloves
- Hard hat
- Escape mask
- Disposable chemical-resistant outer boots

4.3 Activity Specific Levels of Protection

Level D is the minimum acceptable level for sites where petroleum hydrocarbons are the constituents of concern (COC). Upgrades to Modified Level D occur when there is a possibility that contaminated media can contact the skin or work uniform. Upgrades to Level C occur when the results of air monitoring reveals that action levels have been exceeded. Wear hearing protection when there are high noise levels (see Section 5.2.6). Workers must maintain proficiency in the use and care of PPE that is to be worn.

Table 4-1. Activity Specific PPE/Sediment Characterization Summary

Job Task	Safety & Health Risks	PPE Level	Special Requirements
Loading and unloading sample coolers, boat equipment, general non-sampling activities on boat	Lifting. Slips/trips/falls. Boating operations. Inclement weather. Material handling. Working over water.	Level D	• Hard hat for overhead hazards. • PFD when working on or near water.
Operation of sampling vessel from inside the boat house	Boating operations. Confined space.	Modified Level D	• Should not leave pilot house if overhead hazards, decontamination chemicals, or sediment exposure is possible. • PFD when working on or near water.
Operation of sampling equipment outside of boat house	Lifting. Slips/trips/falls. Pinch points. Boating operations. Inclement weather. Material handling. Working over water.	Level D with potential upgrade to Level C	• Potential upgrade to Level C when handling samples – presence of product odors. • Hard hat for overhead hazards. • Face shield for splash hazard. • PFD when working on or near water.
Decontamination of sampling equipment	Lifting. Slips/trips/falls. Boating operations. Inclement weather. Material handling. Working over water.	Level D with potential upgrade to Level C	• Potential upgrade to Level C when handling samples – presence of product odors. • Face shield for splash hazard. • Hard hat for overhead hazard. • PFD when working on or near water.
General site duties, operation of equipment, etc.	Slips/trips/falls. Working over water.	Level D	• Hard hat for overhead hazards. • PFD when working on or near water.
Travel to/from site	Vehicular travel	None	• Seatbelt while vehicle is in motion.

5. PROJECT HAZARD CONTROLS

5.1 General Site Activities

Observe the following general procedures and practices:

- Legible and understandable precautionary labels shall be affixed prominently to containers of potentially contaminated soil, water, and clothing.
- No food or beverages shall be present or consumed in a CRZ or EZ. These are only allowed in designated areas of the SZ.
- No tobacco products shall be present or used, and cosmetics shall not be applied in a CRZ or EZ. These are only allowed in designated areas of the support zone, if areas have been designated.
- Beards, facial hair, or other facial obstructions that interfere with respirator fit will preclude admission to the EZ when respirators are required.
- An emergency eyewash unit shall be located immediately adjacent to employees who handle hazardous or corrosive materials, including decontamination fluids. All operations involving the potential for eye injury, splash, etc., must have approved eyewash units locally available capable of delivering at least 0.4 gallons per minute for at least 15 minutes.
- All on-site activities will be conducted during daylight hours. If work after dusk becomes necessary due to an emergency, adequate lighting must be provided and notification of such activity made to the location contact.
- Hazardous work, such as handling hazardous materials and heavy loads, and equipment operation, etc., should not be conducted during severe storms.
- All temporary electrical power must have a ground fault circuit interrupter (GFCI) as part of its circuit if the circuit is not part of permanent wiring. All equipment must be suitable and approved for the class of hazard present.

5.2 Physical Hazards and Controls

5.2.1 Slips/Trips/Falls

Observe the following practices to prevent slips/trips/falls:

- Inspect work areas for slip/trip/fall potential prior to work tasks.
- Slip/trip/fall hazards must be communicated to all personnel, as well as corrected or labeled with warning signs.
- Keep floors clean and dry; clean all spills immediately and mark spills and wet areas.
- Remove obstacles and obstructions from work areas, walkways, and exits.
  - Secure mats, rugs, and carpets so that they remain flat.
  - Cover any cables that cross walkways.
- Keep work areas and walkways well lit; replace light bulbs and faulty switches.

5.2.2 General Falls/Ladders

Observe the following general falls/ladders procedures and practices:

- Assess work areas for fall hazards. A fall protection system is required if work is conducted six feet or over.
- Maintain ladders in good condition at all times.
  - Ladder rungs should be sturdy and free of cracks.

  - Locks, wheels, and pulleys should be lubricated.
  - Reject ladders with loose or missing parts, and those that sway or lean to the side.
- Do not use a ladder if you feel tired, dizzy, or are prone to losing your balance.
- Wear clean, slip-resistance shoes.
- The top step of a ladder should not be used.
- Do not carry any object or load that could cause a loss of balance or a fall.
- Do not place ladders in front of closed doors that may open towards the ladder.
- During ascent and descent from a ladder:
  - Face the ladder,
  - Use 3 points of contact at all times, and
  - Do not carry objects that interfere with a firm grip on the ladder.

5.2.3 Working On/Near Water

5.2.3.1 Launch Sites and Marinas

Observe the following precautions when conducting boating trailer and launch activities:

- Follow trailer/boat manufacturer instructions for securing boats to trailers and trailers to towing vehicles.
- Wear proper work gloves when pinching or other injury may be caused to do moving/handling large or heavy objects.
- Launch boats one at a time to avoid collision.
- Wear boots with non-slip soles on boats and launch areas.
- Keep ropes and lines coiled and stowed to eliminate trip hazards.
- Maintain 3 points of contact on dock/pier ladders.
- When fall protection is provided on walking/working surfaces located above water, and no drowning hazard exists, employees do not need to wear U.S. Coast Guard-approved life jackets or buoyant work vests.

5.2.3.2 Boating Operations

Observe the following precautions when conducting boating operations:

- Vessel conditions:
  - Keep decks free from hazards.
  - Maintain clean bilges.
  - Engine horsepower should not exceed that shown on the capacity plate.
  - Protect electrical systems with fuses or manual-reset circuit breakers.
  - Protect switches and fuse panels from rain and water spray.
  - Secure system and fuel tanks away from flammable materials.
- Fuel tanks
  - Use a vapor-tight, leak proof cap.
  - Vents must be capable of being closed.
  - Each permanent fuel tank must be properly ventilated.
  - Fuel tanks must be free of corrosion and leaks.
- US Coast Guard sampling vessel safety requirements:
  - Do not exceed vessel safe loading capacity.

- Maintain proper vessel registration, numbering, and documentation (registered with the state, certificate of vessel registration number displayed, and carry valid certificate of number).
- Use USCG approved Personal Floatation Devices (PFDs) for every person on sampling vessel.
  - Type II PFD required, Type 1 preferred
- Use appropriate, non-expired, visual distress devices for day and night use from the following:
  - 3 hand-held red flares (day and night) or:
  - One hand-held red flare and two parachute flares (day and night) or:
  - One hand-held orange smoke signal, two floating orange smoke signals (day) and one electric distress light (night only)
- Fire extinguishers must be U.S. Coast Guard inspected, and properly maintained.
- Gasoline powered vessels must be properly ventilated.
- Carry a sound producing device (whistle, bell, or horn).
- Carry a VHF 2-way radio.
- Use proper navigational light display.
- Carry a throw-able life ring with attached line.

Table 5-1. Recommended Safety Equipment for In-Water Work

Recommended Safety Equipment for In-Water Work

- Marine hardware
- Spare parts
- Tool kit
- Extra visual distress signals
- Flashlight
- Searchlight
- Spare fuel
- Chart and compass
- Boat hook
- Spare propeller
- Mooring line
- Food and water
- Binoculars
- Spare batteries
- Sunglasses
- Extra clothing
- Sunburn lotion

5.2.3.3 Personal Floatation Devices

Personal flotation devices are not required where employees are continuously protected from the hazard of drowning by railings, nets, safety belts or other applicable provisions.
Type III, Type V, or better U.S. Coast Guard approved International Orange PFD shall be provided and properly worn by all personnel in the following circumstances:

- On floating pipelines, pontoons, rafts, or stages,
- On structures extending over or next to water unless guardrails or safety nets are present,
- Working alone at night where there are drowning hazards, regardless of other safeguards,
- In skiffs, small boats, or launches, unless in an enclosed cabin or cockpit, and/or
- Whenever there is a drowning hazard.

The following precautions shall be followed when using PFDs:

- Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects which would alter their strength or buoyancy. Defective devices or devices with less than 13 lbs. of buoyancy shall be removed from service.
- All PFDs shall be equipped with reflective tape as specified in 46 CFR 25.25-15.
- 30-inch U.S. Coast Guard approved ring buoys with at least 150 feet of 600-pound capacity line shall be provided and readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.
- PFD lights conforming to 46 CFR 161.012 shall be required whenever there is potential need for life rings to be used after dark. On shore installations, at least one life ring, and every third one thereafter, shall have a PFD light attached. PFD lights on life rings are required only in locations where adequate general lighting (e.g., floodlights, light stanchions) is not provided.

5.2.3.4 Lifesaving and Safety Boats

Regulations require that a lifesaving boat is available and ready for use under working conditions where there is a potential for employees to fall into swift running water, such as a river or a strait with strong currents. The following precautions shall be followed concerning the use of lifesaving powerboats:

- At least one lifesaving powerboat shall be immediately available at locations where employees work over or immediately next to water, and shall be kept ready for instant launching.
- Personnel trained in launching and operating the powerboat shall be readily available during working hours. Lifesaving personnel shall perform a lifesaving drill before the initiation of work at the project site and periodically thereafter (at least monthly).
- Lifesaving powerboats shall be equipped, at minimum with:
    - Two oars,
    - Oarlocks,
    - One ball-pointed boat hook,
    - One ring buoy with 50 ft of 600lb-capacity line attached,
    - PFDs equal in number to the full capacity of the powerboat, and
    - Permanently mounted or battery-operated navigation lights.

5.2.4 Hand and Power Tools

Observe the following procedures and practices when working with hand and power tools:

- Keep hand tools sharp, clean, oiled, and dressed; do not use tools with worn springs or loose handles.
- Do not force tools beyond their capacity; do not use tools as pry bars.
- Before each use examine power tools for damaged parts, loose fittings, and frayed or cut electrical cords.
- Use proper eye protection when using power tools to protect from the danger of flying objects.

5.2.5 Vehicular Traffic/Streets and Roadways

Observe the following procedures and practices when working in streets and roadways and near vehicular traffic:

- Wear a safety vest and hardhat when vehicle hazards exist.
- Use cones, flag-mounted cones, caution tape, and/or barricades to define work areas.
- Engage police details in high-traffic situations.

- Use a spotter in tight or congested areas.
- Use vehicle strobe lights and block area with truck.
- Develop traffic flow plan for high traffic situations (as appropriate):
  - Use a flag person.
  - Use flashing arrow signs.
  - Use “MEN WORKING” signs liberally.
  - Obtain lane closing permits.
  - Engage police details.

5.2.6 Noise

Observe the following procedures and practices regarding noise at work sites:

- Wear hearing protection when heavy equipment such as drill rigs, jackhammers, cut saws, air compressors, or blowers are in operation.
- Wear hearing protection whenever it is necessary to speak above normal conversation levels due to loud noise – the much noise indicates the need for protection.
- Conduct noise monitoring of suspected high noise operations at the beginning of new operations to verify noise control/hearing protection needs/requirements.

5.2.7 Lifting

Observe the following lifting procedures and practices:

- Use leather gloves when handling metal, wire rope, sharp debris, and when transporting materials such as wood, piping, drums, etc.
- No individual employee should life any object that weighs over 60 pounds; items over 60 pounds must be lifted with multiple people or by using mechanical lifting devices.
- Plan a lift before doing it. Bend at the knees and lift with the legs; do not use back muscles.
- Do not twist body while lifting.
- Know the capacity of any handling device (crane, forklift, chain fall, etc.) before using it.

5.2.8 Fire Control

Observe the following fire control procedures and practices:

- Smoke only in designated smoking areas.
- Keep flammable liquids in closed containers.
- Keep work sites clean; avoid accumulating combustible debris such as paper.
- Follow hot work safety procedures when welding or performing other activities requiring an open flame (see 29 CFR 1910.251-1910.255).
- Isolate flammable and combustible materials from ignition sources.

5.2.9 Static Electricity/Transfer of flammable liquids

Observe the following procedures and practices regarding static electricity when transferring flammable liquids:

- Do not create static discharges in flammable atmospheres.

- Electrically bond and ground pumps, transfer vessels, tanks, drums, bailers, and probes when moving flammable liquids.
- Electrically bond and ground vacuum trucks and the tanks they are emptying.
- Do not splash fill containers with flammable liquids.
- Pour flammable liquids slowly and carefully.
- Two fires extinguishers must be available, charged, inspected, and readily accessible when transferring flammable liquids.

5.2.10 Cleaning equipment

Observe the following procedures when cleaning equipment:

- Wear appropriate PPE to avoid skin and eye contact with isopropyl alcohol and other cleaning materials.
- Stand upwind to minimize inhalation exposure.
- Dispose of spent cleaning solutions and rinses accordingly.

5.2.11 Material Handling and Storage

Observe the following procedures and practices regarding material handling and storage:

- Tie down all light, large surface area material that might be moved by wind.
- When working at heights, secure tools, equipment, and wrenches against falling.
- Do not store material or tools on ducts, light fixtures, beam flanges, hung ceilings, or similar elevated locations.
- Keep storage areas free from accumulated materials that cause tripping, fires, or explosions, or that may contribute to the harboring of rats and other pests.
- All bound material should be stacked, placed on racks, blocked, interlocked, or otherwise secured to prevent it from sliding, falling, or collapsing.
- Drums, barrels, and kegs must be stacked symmetrically. If stored on their sides, the bottom tiers must be blocked to keep them from rolling.

5.2.12 Corrosive Material Handling Procedures

Corrosive materials are those that can cause destruction of tissue or permanent changes in skin tissue at the point of contact. Corrosive materials can be liquids, solids or gases, and can affect the skin, eyes, and respiratory tract. Examples of corrosive chemicals include acids and bases, bromine, and hydrogen peroxide; gases such as chlorine and ammonia; and solids such as phosphorus and phenol. They represent a significant hazard because skin or eye contact can readily occur from splashes, and their effect on human tissue generally takes place very rapidly.

Observe the following procedures when working with corrosive materials:

- Review material safety data sheets (MSDS) prior to using any corrosive material.
- Safety glasses should be worn whenever handling corrosive chemicals. Ordinary prescription glasses **WILL NOT** provide adequate protection unless they also meet this standard. Safety glasses should also be equipped with side shields if there is a possibility of flying particles (i.e., glass, plastics). **When there is the potential for significant splash hazards, additional eye/face protection should be worn in the form of goggles or a face shield.**

- Gloves should be worn when handling corrosive chemicals. Nitrile gloves should be adequate for handling most of these in general laboratory settings. An MSDS should be reviewed if handling may involve extended or high exposure to lab personnel to ensure adequate skin protection is provided.
- A lab coat or apron is advised if exposure could involve more than normal handling operations would expect. No open-toe shoes are allowed.

5.2.12.1 Special Handling

- Never store corrosive liquids above eye level.
- Always add acids or bases to water (and not the reverse).
- Segregate acids and bases in storage.
- When mixing corrosive solids with water, always slowly add the corrosive solid to the water, stirring continuously. Cooling may also be necessary.
- If there is a possibility that you may generate a significant amount of dust, conduct work in a fume hood.
- Store corrosives material away from heat/flames, oxidizers and water sources. Keep containers closed and ensure that manufacturer's labels and warnings remain intact.

5.2.12.2 Container Labeling

L-E personnel must ensure that all drums and containers, including those from manufacturers and those produced on site, are labeled according to contents. All incoming and outgoing labels will be checked for identity, hazard warnings, and name and address of responsible party.

5.2.12.3 Decontamination Procedures

Cleanup and decontamination may require the use of neutralizing agents. Review the MSDS for additional guidance and personal protection.

5.2.12.4 Waste Disposal Requirements

- Handling and disposal of corrosive chemicals should be done in accordance with lab protocol established by the principal investigator.
- Aqueous solutions between pH 6.0 to 10.0 may be disposed of down the sink. Follow MSDS procedures regarding disposal of material other than aqueous solutions described above.

5.2.12.5 Handling Emergencies Involving Corrosive Chemicals

- Anticipate emergency situations, have proper handling equipment in the lab and readily available for spills. Acid and base spill kits and spill control materials should be present on sites dealing with corrosive materials.
- In the event of a spill or adverse reaction, notify site supervisor immediately that an incident has occurred. Do not attempt to handle a large spill/reaction/fire, or one in which you are not trained or equipped for.

5.2.12.6 Employee Information and Training

An ongoing corporate training program will train employees on chemical hazards. In addition, chemical hazards will be communicated to employees through daily safety meetings and by an initial site orientation program. At a minimum, L-E and related subcontractor employees will be instructed on the following:

- Chemicals and their hazards in the work area.
- How to prevent exposure to these hazardous chemicals.
- What the company has done to prevent workers' exposure to these chemicals.
- Procedures to follow if they are exposed to these chemicals.
- How to read and interpret labels and MSDS for hazardous substances found on L-E sites.
- Emergency spill procedures.
- Proper storage and labeling.

5.3 Environmental Hazards and Controls

5.3.1 Heat Stress

Workers exposed to hot indoor environments or hot and humid conditions outdoors are at risk of heat-related illness, especially those doing heavy work tasks or using bulky or non-breathable protective clothing and equipment. Some workers might be at greater risk than others if they have not built up a tolerance to hot conditions, or if they have certain health conditions. Heat stress is one of the most common (and potentially serious) illnesses; regular monitoring and preventative precautions are essential. Table 5-2 shows some environmental and job-specific factors that increase the risk of heat-related illnesses.

Table 5-2. Factors That Put Workers at Risk for Heat-related Illnesses

Factors that put workers at risk for heat-related illnesses:	
Environmental factors	• High temperatures and humidity • Radiant heat sources • Contact with hot objects • Direct sun exposure • Limited air movement (no breeze, wind, or ventilation)
Job-related factors	• Physical exertion • Use of bulky or non-breathable clothing

5.3.1.1 Heat Stroke

Heat stroke is the most serious heat-related disorder. It occurs when the body becomes unable to control its temperature: the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. *This is a medical emergency!* When heat stroke occurs, the body temperature can rise to 106 degrees Fahrenheit or higher within 10 to 15 minutes. Heat stroke can cause death or permanent disability if emergency treatment is not given.

Symptoms:

- High body temperature
- Hallucinations
- Confusion
- Dizziness
- Loss of coordination
- Hot, dry skin or profuse sweating
- Throbbing headache

- Seizures, coma

Treatment:

- Call 911 and notify their supervisor – victims must be transported to a medical facility immediately.
- Prior to transport,
    - Move the sick worker to a cool shaded area.
    - Cool the worker using methods such as:
        - Soaking their clothes with water.
        - Spraying, sponging, or showering them with water.
        - Applying cold packs under arms and around neck
        - Fanning their body

5.3.1.2 Heat Exhaustion

Heat exhaustion is the body's response to an excessive loss of the water and salt, usually through excessive sweating. Workers most prone to heat exhaustion are those that are elderly, have high blood pressure, and those working in a hot environment. Onset of heat exhaustion is gradual, and symptoms should subside within one hour.

Symptoms:

- Heavy sweating
- Extreme weakness or fatigue
- Dizziness, confusion
- Nausea
- Clammy, moist skin
- Pale or flushed complexion
- Muscle cramps
- Slightly elevated body temperature
- Fast and shallow breathing

Treatment:

- Rest in a cool area.
- Drink plenty of water or other cool beverages such as electrolytic fluids
- Take a cool shower, bath, or sponge bath.
- Do not allow victim to become chilled – treat for shock if necessary

5.3.1.3 Heat Cramps

Heat cramps usually affect workers who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture levels. Low salt levels in muscles causes painful cramps. Heat cramps are caused by profuse perspiration without adequate electrolytic fluid replacement. Heat cramps may also be a symptom of heat exhaustion.

Symptoms: Muscle pain or spasms usually in the abdomen, arms, or legs.

Treatment:

- Stop all activity, and sit in a cool place.
- Drink clear juice or a sports beverage.
- Do not return to strenuous work for a few hours after the cramps subside because further exertion may lead to heat exhaustion or heat stroke.
- Seek medical attention if any of the following apply:
  - The worker has heart problems.
  - The worker is on a low-sodium diet.
  - The cramps do not subside within one hour.

5.3.1.4 Preventing heat related illness

Avoid heavy exertion, extreme heat, sun exposure, and high humidity when possible. When these cannot be avoided, take the following preventative steps:

- Monitor your physical condition and that of your coworkers for signs or symptoms of heat illnesses.
- Wear light-colored, loose-fitting, breathable clothing such as cotton.
  - Avoid non-breathable synthetic clothing.
- Gradually build up to heavy work.
- Schedule heavy work during the coolest parts of day.
- Take more breaks when doing heavier work, and in high heat and humidity.
- Take breaks in the shade or a cool area.
- Drink water frequently. Drink enough water that you never become thirsty.
- During periods of high heat, adequate liquids must be provided to replace body fluids. Replacement fluids can be a 0.1% salt-water solution, a commercial mix such as Gatorade, or a combination of these with fresh water.
- Employees should be encouraged to salt their foods more heavily during hot times of the year.
- Be aware that protective clothing or personal protective equipment may increase the risk of heat-related illnesses.
- Implement a buddy system in which workers are responsible for observing fellow workers for early signs and symptoms of heat stress

5.3.1.5 Monitoring for Heat Stress

Heat stress monitoring will be required when employees are working in environments exceeding 90°F ambient air temperature. If employees are wearing impermeable clothing, this monitoring will begin at 78°F. There are two general types of monitoring that the health and safety representative can designate to be used: wet bulb globe temperature (WBGT) and physiological monitoring.

Wet Bulb Globe Temperature (WBGT): The WBGT index is the simplest and most suitable technique to measure the environmental factors which most nearly correlate with core body temperature and other physiological responses to heat. When WBGT exceeds 25.9°C (78°F), the work regiment in Table 5-3 and Figure 1 of the section Heat Stress in the latest edition of the “American Conference of Governmental Industrial Hygiene (ACGIH) Threshold Limit Value (TLV) Booklet” should be followed.

Physiological monitoring: Physiological monitoring can be used in lieu of, or in addition to, WBGT. This monitoring can be self-performed once the health and safety representative demonstrates appropriate techniques to affected employees. Since individuals vary in their susceptibility to heat, this type of monitoring has its advantages. The two parameters that are to be monitored at the beginning of each rest period are:

- Heart Rate – The maximum heart rate (MHR) is the amount of work (beats) per minute a healthy person's heart can be expected to safely deliver. Each individual will count his/her radial (wrist) pulse as early as possible during each rest period. If the heart rate of any individual exceeds 75 percent of their calculated maximum heart rate (MHR = 200 - age) at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same. An individual is not permitted to return to work until his/her sustained heart rate is below 75 percent of their calculated maximum heart rate.
- Temperature – Each individual will measure his/her temperature with a thermometer for one minute as early as possible in the first rest period. If the temperature exceeds 99.6°F at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same. An individual is not permitted to return to work if his/her temperature exceeds 100.4°F.

5.3.2 Cold Stress

In a cold environment, most of the body's energy is used to keep the internal core temperature warm. Over time, the body will begin to shift blood flow from the extremities (hands, feet, arms, and legs) and outer skin to the core (chest and abdomen). This shift allows the exposed skin and the extremities to cool rapidly and increases the risk of frostbite and hypothermia.

What constitutes extreme cold and its effects can vary across different areas of the country. In regions that are not used to winter weather, near freezing temperatures are considered "extreme cold." Wind chill is the temperature your body feels when air temperature and wind speed are combined. For example, when the air temperature is 40°F, and the wind speed is 35 mph, the effect on the exposed skin is as if the air temperature was 28°F.

Table 5-3. Factors the Put Workers at Risk for Cold-related Illnesses

Factors that put workers at risk for cold-related illnesses
• Wetness/dampness, dressing improperly, and exhaustion • Predisposing health conditions such as hypertension, hypothyroidism, and diabetes • Poor physical conditioning

5.3.2.1 Hypothermia

A condition in which the body uses up its stored energy and can no longer produce heat. Hypothermia often occurs after prolonged exposure to cold temperature.

Symptoms:

Symptoms of hypothermia can vary depending on how long you have been exposed to the cold temperatures.

Early Symptoms:

- Shivering
- Fatigue

- Loss of coordination
- Confusion and disorientation

Late Symptoms:

- No shivering
- Blue skin
- Dilated pupils
- Slowed pulse and breathing
- Loss of consciousness

Treatment:

Take the following steps to treat a worker with hypothermia:
- Alert the supervisor and request medical assistance.
- Move the victim into a warm room or shelter.
- Remove their wet clothing.
- Warm the center of their body first-chest, neck, head, and groin-using an electric blanket, if available; or use skin-to-skin contact under loose, dry layers of blankets, clothing, towels, or sheets.
    - Re-warming of victim should be gradual to avoid stroke symptoms.
- Warm beverages may help increase the body temperature, but do not give alcoholic beverages. Coffee and other caffeinated liquids should be avoided because of diuretic and circulatory effects.
- After their body temperature has increased, keep the victim dry and wrapped in a warm blanket, including the head and neck.

5.3.2.2 Frostbite

Frostbite is an injury to the body that is caused by freezing, which most often affects the nose, ears, cheeks, chin, fingers, or toes.

Symptoms:

- Reduced blood flow to hands and feet (fingers or toes can freeze)
- Numbness
- Tingling or stinging
- Aching
- Bluish or pail, waxy skin

Treatment:

- Get into a warm room as soon as possible.
- Unless absolutely necessary, do not walk on frostbitten feet or toes-this increases the damage.
- Immerse the affected area in warm-not hot-water (the temperature should be comfortable to the touch for unaffected parts of the body).
- Warm the affected area using body heat; for example, the heat of an armpit can be used to warm frostbitten fingers.
- Do not rub or massage the frostbitten area; doing so may cause more damage.

- Do not use a heating pad, heat lamp, or the heat of a stove, fireplace, or radiator for warming. Affected areas are numb and can be easily burned.

5.3.2.3 Preventing Cold-related Illnesses

Observe the following procedures and practices regarding cold stress:

- If the air temperature is 32° F or below, hands should be protected
- Implement a buddy system in which workers are responsible for observing fellow workers for early signs and symptoms of cold stress
- When possible, use radiant heater to warm workers in outdoor work spaces and shield work areas from drafts and wind to reduce wind chill.
- It is easy to become dehydrated in cold weather – be sure to consume warm sweetened liquids while working in cold weather.
- Dressing properly is extremely important to preventing cold stress. Cotton loses its insulation value when it becomes wet. Wool, silk and most synthetics, on the other hand, retain their insulation even when wet.

The following are recommendations for working in cold environments:

- Wear at least three layers of loose-fitting clothing:
  - An inner layer of wool, silk or synthetic to keep moisture away from the body.
  - A middle layer of wool or synthetic to provide insulation even when wet.
  - An outer wind and rain protection layer that allows some ventilation to prevent overheating.
- Do not wear tight fitting clothing
- Wear a hat or hood to help keep your whole body warmer. Hats reduce the amount of body heat that escapes from your head.
- Use a knit mask to cover the face and mouth (if needed).
- Use insulated gloves to protect the hands (water resistant if necessary).
- Wear insulated and waterproof boots (or other footwear).

5.3.3 Inclement Weather

Observe the following practices regarding inclement weather:

- Stop outdoor work during electrical storms, hailstorms, and other extreme weather conditions such as extreme heat and cold.
- Take cover indoors or in a vehicle.
- Listen to local forecasts for warnings about specific weather hazards such as tornadoes, hurricanes, and flash floods.

6. DECONTAMINATION

If operations on site have the potential to contaminate field equipment and PPE, see the following sections for decontamination procedures that must be followed to prevent the transfer of contamination to vehicles, administrative offices, and personnel.

6.1 Field Equipment

Field equipment can include bailers, interface probes, hand tools, drill augers, and miscellaneous sampling equipment. Observe the following practices and procedures when decontaminating field equipment:

- Decontaminate with a solution of detergent (Alconox soap or equivalent) and water; rinse with distilled or site water prior to leaving the site.
- Protect from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.

Equipment decontamination will be performed on all sample collection and preparation equipment that is not dedicated to an individual sample, personal protective equipment, and any other instruments or equipment that encounter potentially or known contaminated materials. Any excess sediment and water must be returned to the area from which it was collected or disposed of as otherwise described in the SAP.

6.2 Disposable PPE

Disposable PPE can include Tyvek suits, inner latex gloves, respirator cartridges. Observe the following practices and procedures when decontaminating disposable PPE:

- Dispose of according to the requirements of the client and state and federal agencies.
- Change out respirator cartridges daily and dispose of accordingly.

6.3 Non-disposable PPE

Non-disposable PPE can include respirators and boots and gloves. When decontaminating respirators, observe the following practices and procedures:

- Wipe out respirator with disinfecting pad prior to donning.
- Decontaminate on site at the close of each day with a solution of an approved sanitizing solution.

When decontaminating boots and gloves, observe the following practices and procedures:

- Decontaminate outside with a solution of detergent (Alconox soap or equivalent) and water; rinse with distilled or site water prior to leaving the site.
- Protect from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.

6.4 Emergency Decontamination

Personnel with medical problems or injuries may also require decontamination. There is the possibility that decontamination may aggravate or cause more serious health effects. If prompt lifesaving, first aid, and/or medical treatment are required, decontamination procedures will be omitted. In either case, a member of the site management team will accompany contaminated personnel to the medical facility to advise on matters involving decontamination.

6.5 Sanitizing of Personal Protective Equipment

Respirators, reusable protective clothing, and other personal articles not only must be decontaminated before being reused, but also sanitized. The insides of masks and clothing become soiled due to exhalation, body oils, and perspiration. Manufacturer's instructions should be used to sanitize the respirator masks. If practical, reusable protective clothing should be machine-washed after a thorough decontamination; otherwise, it must be cleaned by hand.

7. ACCIDENTS, INJURY, AND EMERGENCY PROCEDURES

In the event of an emergency, immediate action must be taken by the first person to recognize the event.

7.1 Accident, Injury, and Emergency Procedures to Follow

Observe the following injury management/incident notification procedures and practices:

- Maintain at least one first aid kit and cellular phone on-site and in the company vehicle during on-site activities.
- Survey the situation. Do not endanger your own life. Do not enter a confined space to rescue someone who has been overcome unless properly equipped and trained. Ensure all protocols are followed including that a standby person is pre-sent. If applicable, review MSDS to evaluate response actions for chemical exposures.
- Call 911 (if available) or the fire department immediately. Explain the physical injury, chemical exposure, fire, or release.
- Decontaminate the victim without delaying life-saving procedures.
- If the victim's condition appears to be non-critical, but seems to be more severe than minor cuts, he/she should be transported to the nearest hospital by trained Emergency Medical Services (EMS) personnel: let the doctor assume the responsibility for determining the severity of the injury. If the condition is obviously serious, EMS must transport the victim.
- Notify the PM, SS and the SHSO. Complete the appropriate incident investigation reports.

Provide the following information when calling emergency responders:

- Your Location! Address, cross streets, or landmarks
- Your Phone Number! The phone number you are calling from
- What Happened! Type of injury, type of accident
- How Many Injured! How many persons need help?
- What is Being Done! What is being done for the victim(s)
- YOU HANG UP LAST! Let whomever you called hang up first.

7.2 Incident Notification

Observe the following injury management procedures and practices:

- When a personal injury is discovered the first action will be to ensure the injured party receives appropriate medical attention.
    - If it is safe to do so, the nearest workers should immediately assist any person who shows signs of medical distress or who is involved in an accident.
- The work crew supervisor will be summoned. The work crew supervisor will immediately make contact with the PM or other designated individual to alert them of the medical emergency. The work crew supervisor will record the following “Care of the Employee” information, then escort the injured person to the occupational clinic or hospital or arrange for ambulance.

“Care of the Employee” Information to record:

- The location of the victim at the work site.
- Nature of the emergency.

- Whether the victim is conscious.
- Specific conditions contributing to the injury, if known.

Directly After “Care of the Employee,” make the following notifications, in order:

- Contact the PM and HSM immediately
- PM will contact upper line management
- The HSM will facilitate the incident investigation

All client requirements will also be adhered to pertinent to personal injury incident reporting.

7.3 Incidents Other Than Personal Injury

All incidents including fire, explosion, property damage, environmental release etc., will be responded in accordance with the site-specific Health and Safety Plan located in the SAP. In general, this includes securing the site, turning control over to emergency responders, or summoning appropriate remedial personnel or equipment. L-E will immediately notify the client of any major incident, fire, equipment/ property damage, and environmental incident with a preliminary report. A full report will be provided within 72 hours.

7.4 Specific Emergency and Medical Procedures

7.4.1 Spills and Releases of Hazardous Materials

If hazardous waste has been released or produced through control of the incident, ensure that:

- Waste is collected and contained.
- Containers of waste are removed or isolated from the immediate site of the emergency.
- Treatment or storage of the recovered waste, contaminated soil or surface water, or any other material that results from the incident or its control is provided.
- Ensure that no waste that is incompatible with released material is treated or stored in the facility until cleanup procedures are completed.
- Ensure that all emergency equipment used is decontaminated, recharged, and fit for its intended use before operations are resumed.

When required, notify the National Response Center. The following information should be provided:

- Name and telephone number.
- Name and address of facility.
- Time and type of incident.
- Name and quantity of materials involved, if known.
- Extent of injuries.
- Possible hazards to human health or the environment outside of the facility.

The emergency telephone number for the National Response Center is 800-424-8802.

7.4.2 Guidelines for Bleeding

Perform the following steps to stop bleeding. Responder must have a current certificate to administer first aid.

1. Give medical statement.
2. Assure airway, breathing, and circulation.
3. Use direct pressure over the wound with clean dressing or your hand (use non-permeable gloves). Direct pressure will control most bleeding.
4. Bleeding from an artery or several injury sites may require direct pressure on a pressure point. Use pressure points for 30 to 60 seconds to help control severe bleeding.
5. Continue primary care and seek medical aid as needed.

7.5.3 CPR Guidelines

Perform the following steps to administer CPR. Responder must have a current certificate to administer CPR.

1. Make sure the scene is safe before administering aid to the victim.
2. Arousal: Check for consciousness. If not conscious continue with these CPR instructions.
3. Open airway with chin-lift.
4. Look, listen, and feel for breathing.
5. If breathing is absent, give 2 breaths (1 second each) with visible chest rise. NOTE: Use a CPR mask or other approved barrier device if possible.
6. Bare victim’s chest and locate CPR finger position.
7. Deliver first cycle of 30 chest compressions at a rate of not less than one per second.
8. Repeat Steps 5, 6 and 7 until an AED has arrived and is ready to deliver a shock, or you have been relieved by another CPR-trained person or professional emergency response personnel.

7.6 Emergency Routes

Maps showing the route to the nearest hospitals will be provided in each project-specific safety plan.

7.7 Site Emergency Form

For every project, the following form (Table 7-1) should be filled out as appropriate and be available on site:

Table 7-1. Site Emergency Form

Category	Information
Possible Contaminants of Concern	Tributyltin, Polychlorinated Biphenyls, Dioxins/Furans, Metals (copper, mercury, zinc), benzyl alcohol, butylbenzyl phthalate, dimethyl phthalate, and chlordane
Minimum Level of Protection	Level D
Site(s) Location Address	Albert Jenson and Sons Marina and Boatyard 1293 Turn Point Rd Friday Harbor, WA 98250
Emergency Phone Numbers	
Site Telephone	Todd Nicholson: 360.378.2688
Hospitals and/or Emergency Treatment Facilities	PeaceHealth Peace Island Medical Center 360.378.2141 1117 Spring St Friday Harbor, WA 98250
Ambulance/Fire/Police	911
National Emergency Response Center	800.424.8802
Washington State Emergency Management	800.258.5990
Poison Control	800.222.1212
Sampling Project Manager	Peter Leon: 206.948.5366
L-E Project Manager (PM)	Peter Leon: 206.948.5366
Port Project Manager (PM)	Todd Nicholson: 360.378.2688
Site Supervisor (SS)	Todd Nicholson: 360.378.2688
Site Health and Safety Officer (SHSO)	TBD
Client contacts	Todd Nicholson: 360.378.2688
Client contacts: Corporate Health & Safety Officer	Todd Nicholson: 360.378.2688
Project Health and Safety Manager (PHSM)	TBD

**In the event of any emergency, contact the Project Manager (PM) or the Health and Safety Representatives (SHSO)*

8. REFERENCES/FURTHER INFORMATION

Boating Safety:
U.S. Coast Guard Auxiliary: http://www.cgaux.org/

Cold-related illnesses:
OSHA Cold Stress Guide: https://www.osha.gov/SLTC/emergencypreparedness/guides/cold.html
National Institute for Occupational Safety and Health (NIOSH):
http://www.cdc.gov/niosh/topics/coldstress/

Heat-related illnesses:
OSHA Occupational Heat Exposure: https://www.osha.gov/SLTC/heatstress/
National Institute for Occupational Safety and Health (NIOSH):
http://www.cdc.gov/niosh/topics/heatstress/

Corrosive Chemicals:
Brandeis University Department of Health and Safety:
http://www.brandeis.edu/ehs/labs/corrosives.html

Job Hazard Analysis:
OSHA Job Hazard Analysis: https://www.osha.gov/Publications/osha3071.html

Ladder safety:
American Ladder Institute: http://www.laddersafety.org/

Materials Handling and Storage:
OSHA document 2236: https://www.osha.gov/Publications/osha2236.pdf

Personal Protective Equipment:
EPA Emergency Response: http://www2.epa.gov/emergency-response/personal-protective-equipment

Additional Resources:

Environmental Services Directory for Washington State Toll-Free Hotlines:
http://www.esdwa.com/hotlines/

Health and Safety and Environmental Plan, Gravity Consulting LLC July 2009

Washington State Department of Labor and Industries General Small Business Checklists:
http://www.lni.wa.gov/Safety/Basics/SmallBusiness/General/default.asp

Washington State Department of Labor and Industries Safety and Health Core Rules:
http://www.lni.wa.gov/wisha/rules/corerules/PDFs/CoreRuleBookComplete.pdf

Appendix A: Job Hazard Analysis

A hazard is the potential for harm. In practical terms, a hazard often is associated with a condition or activity that, if left uncontrolled, can result in an injury or illness. A job hazard analysis is a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment. Ideally, after you identify uncontrolled hazards, you will take steps to eliminate or reduce them to an acceptable risk level.

To identify workplace hazards, answer the following questions:

- What can go wrong?
- What are the consequences?
- How could it arise?
- What are other contributing factors?
- How likely is it that the hazard will occur?

Good hazard scenarios describe:

- Where it is happening (environment),
- Who or what it is happening to (exposure),
- What precipitates the hazard (trigger),
- The outcome that would occur should it happen (consequence), and
- Any other contributing factors.

Hazard Control Measures

Information obtained from a job hazard analysis is useless unless hazard control measures recommended in the analysis are incorporated into the tasks. Managers should recognize that not all hazard controls are equal. Some are more effective than others at reducing the risk.

The order of precedence and effectiveness of hazard control is the following:

1. Engineering controls.
2. Administrative controls.
3. Personal protective equipment.

Engineering controls include the following:

- Elimination/minimization of the hazard -- Designing the facility, equipment, or process to remove the hazard, or substituting processes, equipment, materials, or other factors to lessen the hazard;
- Enclosure of the hazard using enclosed cabs, enclosures for noisy equipment, or other means;
- Isolation of the hazard with interlocks, machine guards, blast shields, welding curtains, or other means; and
- Removal or redirection of the hazard such as with local and exhaust ventilation.

Administrative controls include the following:

- Written operating procedures, work permits, and safe work practices;
- Exposure time limitations (used most commonly to control temperature extremes and ergonomic hazards);
- Monitoring the use of highly hazardous materials;
- Alarms, signs, and warnings;
- Buddy system; and
- Training.

Personal Protective Equipment -- such as respirators, hearing protection, protective clothing, safety glasses, and hardhats -- is acceptable as a control method in the following circumstances:

- When engineering controls are not feasible or do not totally eliminate the hazard;
- While engineering controls are being developed;
- When safe work practices do not provide sufficient additional protection; and
- During emergencies when engineering controls may not be feasible.

Use of one hazard control method over another higher in the control precedence may be appropriate for providing interim protection until the hazard is abated permanently. In reality, if the hazard cannot be eliminated entirely, the adopted control measures will likely be a combination of all three items instituted simultaneously.

Common Hazards and Descriptions

Hazards	Hazard Descriptions
Chemical (Toxic)	A chemical that exposes a person by absorption through the skin, inhalation, or through the bloodstream that causes illness, disease, or death. The amount of chemical exposure is critical in determining hazardous effects. Check Material Safety Data Sheets (MSDS), and/or OSHA 1910.1000 for chemical hazard information.
Chemical (Flammable)	A chemical that, when exposed to a heat ignition source, results in combustion. Typically, the lower a chemical's flash point and boiling point, the more flammable the chemical. Check MSDS for flammability information.
Chemical (Corrosive)	A chemical that, when it comes into contact with skin, metal, or other materials, damages the materials. Acids and bases are examples of corrosives.
Explosion (Chemical Reaction)	Self-explanatory.
Explosion (Over Pressurization)	Sudden and violent release of a large amount of gas/energy due to a significant pressure difference such as rupture in a boiler or compressed gas cylinder.
Electrical (Shock/Short Circuit)	Contact with exposed conductors or a device that is incorrectly or inadvertently grounded, such as when a metal ladder comes into contact with power lines. 60Hz alternating current (common house current) is very dangerous because it can stop the heart.
Electrical (Fire)	Use of electrical power that results in electrical overheating or arcing to the point of combustion or ignition of flammables, or electrical component damage.
Electrical (Static/ESD)	The moving or rubbing of wool, nylon, other synthetic fibers, and even flowing liquids can generate static electricity. This creates an excess or deficiency of electrons on the surface of material that discharges (spark) to the ground resulting in the ignition of flammables or damage to electronics or the body's nervous system.

Hazards	Hazard Descriptions
Electrical (Loss of Power)	Safety-critical equipment failure as a result of loss of power.
Ergonomics (Strain)	Damage of tissue due to over exertion (strains and sprains) or repetitive motion.
Ergonomics (Human Error)	A system design, procedure, or equipment that is error-provocative. (A switch goes up to turn something off).
Excavation (Collapse)	Soil collapse in a trench or excavation as a result of improper or inadequate shoring. Soil type is critical in determining the hazard likelihood.
Fall (Slip, Trip)	Conditions that result in falls (impacts) from height or traditional walking surfaces (such as slippery floors, poor housekeeping, uneven walking surfaces, exposed ledges, etc.)
Fire/Heat	Temperatures that can cause burns to the skin or damage to other organs. Fires require a heat source, fuel, and oxygen.
Mechanical/Vibration (Chaffing/Fatigue)	Vibration that can cause damage to nerve endings, or material fatigue that results in a safety-critical failure. (Examples are abraded slings and ropes, weakened hoses and belts.)
Mechanical Failure	Self-explanatory; typically occurs when devices exceed designed capacity or are inadequately maintained.
Mechanical	Skin, muscle, or body part exposed to crushing, caught-between, cutting, tearing, shearing items or equipment.
Noise	Noise levels (>85 dBA 8 hr TWA) that result in hearing damage or inability to communicate safety-critical information.
Radiation (Ionizing)	Alpha, Beta, Gamma, neutral particles, and X-rays that cause injury (tissue damage) by ionization of cellular components.
Radiation (Non-Ionizing)	Ultraviolet, visible light, infrared, and microwaves that cause injury to tissue by thermal or photochemical means.
Struck By (Mass Acceleration)	Accelerated mass that strikes the body causing injury or death. (Examples are falling objects and projectiles.)
Struck Against	Injury to a body part as a result of coming into contact of a surface in which action was initiated by the person. (An example is when a screwdriver slips.)
Temperature Extreme (Heat/Cold)	Temperatures that result in heat stress, exhaustion, or metabolic slow down such as hypothermia.
Visibility	Lack of lighting or obstructed vision that results in an error or other hazard.
Weather Phenomena (Snow/Rain/Wind/Ice)	Self-explanatory.

Sample Job Hazard Analysis Form

Project title:	**Project Location:**	**Analyst:**	**Date:**
Task #	**Task Description:**		
Hazard Type:	**Hazard Description:**		
Consequence:	**Hazard Controls:**		
Rational or Comments:			