CLEANUP ACTION PLAN
R.G. HALEY INTERNATIONAL CORPORATION SITE
BELLINGHAM, WASHINGTON

Prepared by

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LIST OF ABBREVIATIONS AND ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
Bgs	Below ground surface
BNSF	Burlington Northern/Santa Fe
CAP, Plan	Cleanup Action Plan
CAOs	Cleanup action objectives
CFR	Code of Federal Regulations
City	City of Bellingham
Cornwall Site	Cornwall Avenue Landfill site
cPAHs	carcinogenic PAHs
CSL	Cleanup Screening Level
CUL	Cleanup level
DNR	Washington State Department of Natural Resources
Ecology	Washington State Department of Ecology
EDR	Engineering Design Report
ENR	Enhanced natural recovery
ESA	Endangered Species Act
HIS	Indicator Hazardous Substances
LNAPL	Light non-aqueous phase liquid
MNR	Monitored natural recovery
MTCA	Model Toxics Control Act
NEPA	National Environmental Policy Act
ng/kg	nanograms per kilogram
PCP	Pentachlorophenol
Pilot Project	Bellingham Bay Demonstration Pilot Project
PLPs	Potentially Liable Persons
Port	Port of Bellingham
PQL	Practical quantitation limit
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI/FS	Remedial Investigation/Feasibility Study
SCO	Sediment Cleanup Objective
Site, Haley Site	R.G Haley International Corp site
SMS	Sediment Management Standards
SSI	Supplemental Sediment Investigation
SEPA	State Environmental Policy Act
TEQ	Toxic equivalent concentration
TPH	Total petroleum hydrocarbons
µg/kg	micrograms per kilogram
USACE	United States Army Corps of Engineers
WAC	Washington Administrative Code

1.0 INTRODUCTION

This document is the Washington State Department of Ecology's (Ecology) Cleanup Action Plan (CAP or Plan) for the R.G. Haley International Corp site (Site or Haley Site) in Bellingham Washington. The general location of the Site south[1] of the downtown business district is shown on Figure 1. The production and handling of pentachlorophenol-treated wood products occurred at the Site between approximately 1948 and 1985.

This CAP has been prepared pursuant to the requirements of the Model Toxics Control Act (MTCA) administered by Ecology under Chapter 173-340 of the Washington Administrative Code (WAC), and the requirements of the Sediment Management Standards (SMS) administered by Ecology under Chapter 173-204 WAC. The CAP is based on the February 2016 Final Remedial Investigation/Feasibility Study (RI/FS) (GeoEngineers 2016) and additional information collected since completion of the RI/FS—the Supplemental Sediment Investigation (SSI) (GeoEngineers 2018), attached as Appendix A.

1.1. General Facility Information

The following is a summary of general facility information for the Haley Site:

Site Name	R.G. Haley International Corp
Property Address	Cornwall Avenue N, Bellingham, Washington, 98227-1075
Cleanup Site ID	3928
Facility Site ID	2870
RI/FS Agreed Order No.	DE 2186
RI/FS Agreed Order Dates	April 5, 2005 (Original), October 15, 2010 (Amendment 1), August 14, 2013 (Amendment 2)
Parties to the Orders	Ecology, City of Bellingham
Current Property Owners	City of Bellingham, Washington State (managed by the Department of Natural Resources), Port of Bellingham

1.2. Purpose and Contents of the Cleanup Action Plan

The purpose of the CAP is to present Ecology's chosen cleanup action for the Site. The Plan includes the following elements required under WAC 173-340-380, plus a summary of site history and contamination:

- Cleanup levels and points of compliance for Indicator Hazardous Substances (IHS);
- Applicable state and federal laws for the proposed cleanup action that are known at this point in the process;

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

- A summary of the process used in the FS to select the preferred cleanup alternative, including a description of other cleanup alternatives evaluated in the FS;
- A general description of the selected cleanup action for the Site;
- A summary of the contamination that will remain at the Site after completing the cleanup action;
- Institutional controls required as part of the proposed cleanup action; and
- The anticipated cleanup action schedule.

Ecology has made a preliminary determination that a cleanup in conformance with the CAP will comply with the requirements for selection of a remedy under WAC 173-340-360. This Plan forms the basis for cleanup action design that will be conducted under a new Agreed Order between Ecology and the City of Bellingham (City), and cleanup action implementation that will be conducted under a subsequent Consent Decree between Ecology and one or more of the potentially liable persons (PLPs) for the Site.

1.3. Site Location and Definition

The R.G. Haley International Corp wood treatment facility was formerly located on the eastern shore of Bellingham Bay, at the foot of a steep bluff (Figure 1). The wood treatment facility operated on a shoreline parcel currently owned by the City (Haley property) and on adjacent State-owned upland located west of the Inner Harbor Line (Figure 2). Other properties adjoining the Haley property include the Nielson Brothers parcel to the north, a City-owned parcel to the south (Cornwall property), and an active Burlington Northern/Santa Fe (BNSF) rail line to the east (BNSF right-of-way) (Figure 2). A small Port of Bellingham (Port) parcel is located near the northwest corner of the Haley property; the Port parcel comprises part of the Pine Street Beach.

The RI/FS Agreed Order identified the Haley Site as being composed of the property where the former wood treatment facility operated, as approximately shown in Figure 1. RI data, however, indicated that Haley-related contamination extended over a larger area, southward onto the Cornwall property and westward into aquatic lands. A further, more complete, definition of the extent of the aquatic portion of the Haley Site was developed later, after the RI/FS was finalized, based on data from the SSI (Figure 2). Note that the aquatic Haley boundary shown on Figure 2 is approximate, based on extrapolation from and interpolation between available data points. The estimated extent of the upland portion of the Haley Site is based on existing RI data, although that data does not fully delineate the extent of all Site contaminants. The upland Site boundaries will be further evaluated in the future as a separate action.

The Site is subdivided into two units: an Upland Unit and a Marine Unit, separated by the ordinary high water mark (Figure 3). The Upland Unit includes the Haley property and a portion of the Cornwall property to the south. The Upland Unit also includes some State-owned land. The Marine Unit includes the City-, Port-, and State-owned portions of the Pine Street Beach and State-owned aquatic land.

The Haley Site overlaps the adjacent Cornwall Avenue Landfill cleanup Site (Cornwall Site), which is being cleaned up under a Consent Decree (Whatcom County Superior Court No. 14-2-02593-5). The two sites are differentiated as follows:

- Haley Site: Upland and in-water areas impacted by contaminant releases from former wood-treating operations. The footprint of wood treatment chemicals includes areas where wood waste was historically placed in tidelands prior to the existence of the Haley wood treatment facility. Where wood treatment chemicals are co-located with the wood waste, the Haley site includes the wood waste and chemicals potentially associated with degradation of the wood waste.
- Cornwall Site: The upland area containing the former municipal landfill and wood waste within the Cornwall property, plus adjacent in-water areas impacted by releases from the landfill and from the degradation of wood waste.

1.4. Site History and Description

Prior to development, the area comprising the Site consisted of tidelands and open water. Various kinds of fill material were placed at the Site creating land and moving the shoreline out into the bay. Historical land uses at or near the Site included railroad activities, lumber mill operations, wood treatment and storage, disposal of municipal waste at the Cornwall Avenue Landfill, and pulp and paper mill activities.

The BNSF railroad was constructed in about 1890. Various mill operations and mill support activities began in the late 1880s. Several over-water structures (wharves and piers) were built within and adjacent to the Site to support mill operations and coal transport related to nearby mining and marine shipping. Wood-treating operations were conducted at the Site from 1948 to 1985. During the 1950s and 1960s, the Cornwall site was used for disposal of municipal refuse, pulp waste, and medical waste. No buildings associated with these historical activities remain on the Haley or Cornwall properties.

The upland portion of the Site is currently fenced and vacant. A vertical sheet pile barrier is present along a portion of the shoreline. The shoreline is covered with armoring, sparse vegetation, gravel and debris. Numerous remnant timber pilings and debris associated with former overwater structures remain in the intertidal zone.

Various cleanup activities have occurred or are continuing to occur at the Site including the removal of seepage pit sludge in 1985, the installation of the sheet pile wall referenced above in 2002, the placement of an oil absorbent layer over part of the shoreline in a 2013 Interim Action, and the periodic removal of oil from wells at the Site beginning in 2000.

1.5. Adjacent MTCA Cleanup Sites

Twelve cleanup sites located in the general vicinity of the Haley Site are part of the Bellingham Bay Demonstration Pilot Project (Pilot Project). The Pilot Project is a coordinated effort by federal, tribal, state, and local governments to clean up contamination around Bellingham Bay. Two of these cleanup sites overlap with the Haley Site: the Cornwall Site to the south (discussed previously) and the Whatcom Waterway Site to the west (Figure 4).

Cleanup of the Cornwall Site is being led by the Port, with involvement by the City and Washington State Department of Natural Resources (DNR). IHSs at the Cornwall Site include landfill refuse and wood waste, manganese and ammonia in groundwater, methane and other volatile organic compounds (VOCs) in soil gas, and metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and phthalates in sediment. The Cornwall Site cleanup is currently in the design phase and will generally include construction of an upland low-permeability cap in Management Unit 1 (MU-1 in Figure 4), and a shoreline stabilization system and thin-layer sediment cap in Management Unit 2 (MU-2 in Figure 4). Additional remedial action will also likely be required in deeper water outside of MU-2; if needed, the remedial action in this broader area is anticipated to be monitored natural recovery (Ecology 2014).

The Whatcom Waterway cleanup is being led by the Port, with involvement by the City, DNR, and a private property owner. Mercury is the key IHS in sediment associated with the Whatcom Waterway Site. Whatcom Waterway cleanup actions that overlap with the Haley Site primarily consist of monitored natural recovery for offshore sediment (Units 6A, 6B, 6C and 9 in Figure 4; Anchor QEA 2015); a cap is planned in the western portions of Units 6B and 6C to limit erosion at the location of the Port's barge off-loading pier. The Whatcom Waterway cleanup is being conducted in two phases; the first phase was completed in 2016 and the second phase is scheduled to begin in 2020. The Whatcom Waterway Site/Haley Site overlap occurs within the area slated for the second phase of cleanup.

The Haley, Cornwall and Whatcom Waterway cleanups will be coordinated to assure compatibility. In general, the upland caps and nearshore sediment actions associated with the Haley and Cornwall sites will be designed to provide seamless coverage. In deeper subtidal waters, the overlapping cleanups for the Haley and Whatcom Waterway Sites are nearly identical, with monitored natural recovery selected as the remedy for both. This is also anticipated to be the remedy for the Cornwall Site if its boundary is extended beyond MU-2. Compatibility and coordination of the cleanups are discussed further in Sections 5.7 and 6.5.

2.0 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination in both the Haley Upland and Marine Units are described in the RI (GeoEngineers 2016). Haley-related contamination originated from the use and release of wood treatment chemicals, which consisted of a diesel-like carrier oil and the active ingredient pentachlorophenol (PCP). The primary contaminants associated with this source include diesel-range hydrocarbons and individual PAHs, including carcinogenic PAHs (cPAHs), PCP, and dioxins/furans. The diesel-like oil is referred to as light non-aqueous phase liquid (LNAPL) when encountered in the subsurface.

The Haley-related contaminants were released over time into surface soils across the upland portion of the Site. Oily fractions migrated down to the water table, where they collected and periodically discharged out into Bellingham Bay, or were retained in a "smear zone" at the water table. Infiltrating storm water also carried dissolved contaminants down to the water table, where they entered the groundwater body underlying the Site. Further dissolution of contaminants occurred within the smear zone, and the contaminated groundwater then discharged directly into Bellingham Bay. Sediment along the shoreline of the Haley facility also became contaminated from these release processes, and from soil erosion and transport in

surface water runoff. Long-shore transport and wave activity then spread the contaminated sediment northward along the shoreline and outward into the bay. Currently, contaminant movement is occurring primarily through surface water infiltration/groundwater transport, shoreline sediment transport, and soil erosion.

The distribution of contaminants in upland media (soil and groundwater) strongly coincides with the footprint of the oil smear zone and nearshore plume of LNAPL. This contamination falls within the boundaries of the Haley Upland Unit, and overlaps with the northern portion of Cornwall Unit MU-1.

In the Haley Marine Unit, the greatest number and concentration of Haley-related contaminants occur in the nearshore area (intertidal and shallow subtidal zones) immediately adjacent to the former Haley wood treatment facility. Outside of this nearshore area, the Haley Marine Unit extends into deeper subtidal waters (Figure 3). The boundary of the Marine Unit is defined by data collected during the SSI (Appendix A), and reflects the location where dioxin/furan concentrations decline to the regional background concentration based on geospatial modeling and best professional judgment. The other Haley bioaccumulative compounds associated with historical Haley-related activities (cPAHs and PCP) have a much smaller footprint, and therefore did not play a role in establishing the boundary of the Haley Marine Unit.

3.0 CLEANUP STANDARDS

Contaminants detected in soil, groundwater, and sediment were evaluated relative to a broad range of screening levels in the RI. The list of chemicals exceeding screening levels was further condensed to a group of IHSs, which were then used in cleanup needs. IHSs varied somewhat by medium, but collectively included total petroleum hydrocarbons (TPH), several individual PAHs, cPAHs (TEQ), PCP, and dioxins/furan (TEQ).

Cleanup standards for the IHSs were then proposed in the FS. Modifications to those standards are now set in this CAP. Cleanup standards consist of: (1) chemical concentrations in environmental media that are protective of human health and the environment, and (2) the locations where the cleanup levels must be met (point of compliance). Media-specific cleanup levels and points of compliance for soil, groundwater and sediment are presented in the following sections. Cleanup levels for soil, groundwater, and sediment IHSs are summarized in Table 1, along with the basis for each value. Table 1 also includes cleanup levels for air to address soil vapor that will be vented from beneath the planned upland cap.

3.1. Soil Cleanup Standards

Soil cleanup levels are based on the protection of human health (direct contact) and the protection of groundwater (Table 1).

Potential terrestrial ecological receptors' exposure to soil, and erosion of soil to sediment were considered in the development of soil cleanup levels; however, as discussed in the FS, these exposure pathways will be addressed by the upland remedy, which will include an engineered

cap and institutional controls that will prevent terrestrial ecological exposures and erosion of upland soil.

In summary, the soil cleanup levels and soil management practices established in this CAP address the following potential exposure pathways and receptors:

- Direct contact (humans and terrestrial species);
- Leaching to groundwater, which is discharging to sediment/surface water (humans and benthic/aquatic species); and
- Soil erosion and transport to sediment (humans and benthic/aquatic species).

The soil cleanup levels based on the protection of groundwater (Table 1) are lower than background concentrations associated with non-specific (diffuse) sources in some urban environments. For example, Ecology (2011) found that shallow soil in six Seattle neighborhoods had a background cPAH concentration of 390 micrograms per kilogram (µg/kg),[2] which exceeds the practical quantitation limit (PQL)-based soil cleanup levels (CUL; 7.6 µg/kg) selected for the Haley Site (Table 1). For this reason, the potential presence of urban background contamination will be considered when applying the PQL-based soil cleanup levels to the Haley Site. Empirical groundwater data also will be considered when applying these cleanup levels to the Site as described in MTCA (WAC 173-340-747(9)).

The standard point of compliance for soil based on the protection of groundwater is throughout the Site. For the protection of human health via direct contact, the standard point of compliance for soil is from ground surface to 15 feet below ground surface (bgs). See WAC 173-340-740(6)(d). Soil cleanup levels, however, will not be achieved at the standard point of compliance throughout the Site because the selected alternative for the Haley Site includes containment. MTCA recognizes that soil cleanup levels typically are not met at the standard point of compliance for cleanups involving containment, and that these cleanups still comply with cleanup standards under certain conditions (WAC 173-340-740(6)(f)). The cleanup action selected for the Haley Site meets these conditions.

In summary, the point of compliance for soil will be considered to have been met once the cleanup actions established in this CAP have been implemented.

3.2. Groundwater Cleanup Standards

Groundwater cleanup levels are based on the protection of marine surface water and sediment (Table 1). As discussed in Section 5.1.2 of the RI, Ecology has determined that groundwater beneath the Haley Site and other waterfront cleanup sites in Bellingham Bay is non-potable; therefore, use of groundwater as drinking water was not considered in the development of cleanup levels.

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[2] 90th percentile value for all urban soil samples collected during Ecology's study; cPAH concentrations in all samples ranged from 1.9 to 8,900 µg/kg.

In summary, the groundwater cleanup levels established in this CAP address the following exposure pathways and receptors:

- Discharge to sediment (humans and benthic/aquatic species); and
- Discharge to marine surface water (humans and aquatic species).

The standard point of compliance for groundwater under MTCA is throughout the site. MTCA allows use of a conditional point of compliance at sites where it can be demonstrated that it is not practicable to meet cleanup levels throughout the site within a reasonable restoration time frame, and that all practicable methods of treatment have been used in the cleanup (WAC 173-340-720(8)(c)). Ecology has determined that the cleanup action selected for the Haley Site meets the regulatory requirements for use of a conditional point of compliance for groundwater. At such sites, the conditional point of compliance must be located as close as technically possible to the source of contamination; analyses conducted during the FS indicate this is likely to be located at the point where groundwater flows into surface water. However, final location(s) will be established in the monitoring plan described in Section 6.6.

In summary, the point of compliance for groundwater will be conditional and located as close as practicable to the source of contamination.

The effects of in-situ soil treatment on groundwater quality are being evaluated by treatability testing. This information will be used during remedial design to further evaluate the groundwater pathway. This evaluation may lead to the future development of remediation levels for groundwater.

3.3. Sediment Cleanup Standards

Cleanup levels for sediment are selected from a range of numerical values. The SMS Sediment Cleanup Objective (SCO) is the low end of the range, below which no adverse effects or unacceptable risks are anticipated to human health or the environment; the Cleanup Screening Level (CSL) is the higher end of the range, above which adverse effects or unacceptable risks would be expected to human health and the environment.

Sediment cleanup levels for individual chemicals were chosen for protection of two primary exposure pathways – direct contact and bioaccumulation:

- For the direct contact pathway, the exposure scenarios involve benthic organisms living in sediment and people engaged in beach play, clamming, or net-fishing.
- For the bioaccumulation pathway, the exposure scenarios involve people and ecological receptors (higher trophic species) consuming seafood foraged from the Site.

The final cleanup levels for sediment are in Table 1. Additional details on cleanup level derivation are provided in the following paragraphs.

Sediment cleanup levels are initially established at the SCO and may be adjusted up to, but not higher than, the CSL. Sediment cleanup levels based on the protection of benthic organisms are set at the SCO for non-carcinogenic PAHs, benzo(a)anthracene and TPH. The

remaining three sediment IHSs (dioxins/furans, cPAHs, and PCP) are bioaccumulative compounds; typically, risk-based cleanup levels are far below levels that occur in nature or our ability to quantify them in environmental media. Under the SMS, background values or analytical practical quantitation limits can be considered for use as cleanup levels for ubiquitous bioaccumulative compounds. In the 2013 modifications to the SMS, natural background represents the SCO, whereas regional background (indicative of urban sources to a watershed) is equivalent to the CSL. Selection of CULs for bioaccumulative IHSs is discussed further below.

- Dioxins/furans and cPAHs: The sediment cleanup levels for these IHSs are set at the regional background concentrations established by Ecology in Bellingham Bay (15 nanograms per kilogram [ng/kg] and 86 µg/kg, respectively). These regional background values were selected as cleanup levels because they represent the prevailing sediment quality in areas of the eastern and inner portions of Bellingham Bay not influenced by specific contaminant sources or sites. As such, regional background concentrations represent the levels to which surface sediment will equilibrate (i.e., recontaminate to) over time following sediment cleanup. Although it is possible to attain lower sediment concentrations initially following cleanup, lower levels cannot be maintained due to the influence of ongoing, widespread contribution from aerial deposition, upland runoff or other processes transporting contaminants on a regional basis. The selection of regional background concentrations as sediment cleanup levels is feasible and can be achieved within a reasonable timeframe. In addition, use of regional background as cleanup levels for bioaccumulative compounds is consistent with the consent decree for the Cornwall site.
- PCP: Neither a natural or regional background value is available for PCP in Bellingham Bay. The sediment cleanup level is therefore set at the PQL of 100 µg/kg, which is higher than the lowest risk-based sediment criterion for this constituent.

In summary, the sediment cleanup levels established in this CAP address the following exposure pathways and receptors:

- Direct contact (humans and benthic species); and
- Bioaccumulation through seafood consumption (humans and higher trophic species).

For marine sediment, the point of compliance for the protection of benthic organisms is the biologically active zone (BAZ), which is considered the upper 12 centimeters (cm) of sediment in Bellingham Bay. This same point of compliance addresses protection of human and higher trophic species with respect to consumption of seafood gathered from subtidal areas. The point of compliance for the protection of human health from consumption of shellfish (specifically clams) collected from the intertidal zone is the upper 45 cm (1.5 feet).

Compliance with cleanup levels based on benthic toxicity are measured on a point-by-point basis whereas compliance with seafood-consumption-based cleanup levels is assessed on an area-weighted average basis. The area-weighted basis involves weighting individual sampling results to ensure that areas with more samples are not over-represented with respect to areas with fewer samples.

Post-construction compliance monitoring will include the Haley-related chemicals for which cleanup levels have been established, and other chemicals related to the adjacent (and overlapping) Whatcom Waterway and Cornwall Avenue Landfill MTCA sites. Compliance monitoring will also be conducted at these adjacent sites. Data collected in the overlap areas will be shared to allow all parties to evaluate whether cleanup levels pertaining to their sites are attained in the areas of overlap. In these areas, the opportunity exists to coordinate compliance monitoring programs to reduce duplication of effort.

3.4. Air Cleanup Standards

Air cleanup levels established in this CAP are based on the protection of human health (inhalation; Table 1). The standard point of compliance is ambient air throughout the Site.

Air cleanup levels were established for analytes that were detected in soil vapor samples obtained at the Site at concentrations greater than MTCA Method B sub-slab soil vapor screening levels (Ecology 2015). Ecology's sub-slab soil vapor screening levels are applicable to shallow soil vapor samples: that is, soil vapor samples obtained at depths between 0- to 15-feet bgs. The soil vapor samples at the Site were obtained at depths of 5 feet bgs.

Air cleanup levels were established for the following analytes:

- C5 to C8 Aliphatic Hydrocarbons
- C9 to C12 Aliphatic Hydrocarbons
- CC9 to C10 Aromatic Hydrocarbons
- Benzene
- Xylenes
- Naphthalene

4.0 AREAS REQUIRING CLEANUP

Areas requiring cleanup are defined by locations where chemical concentrations exceed cleanup levels as shown in Figure 3. The Upland Unit encompasses cleanup level exceedances in soil and groundwater. The Marine Unit encompasses the nearshore benthic toxicity exceedance area and the more widespread footprint of sediment that exceeds bioaccumulation-based cleanup levels.

Note that the outer boundary of the Marine Unit is the location where dioxin/furan concentrations decline to the regional background level. This dioxin/furan footprint encompasses cPAH contamination and the entire footprint of the PCP contamination (see Figures 14 and 15 in the SSI report, Appendix A). However, the extent and concentrations of cPAH contamination in surface sediment between the Marine Unit and the Bellingham Shipping Terminal are unknown and are not addressed in this CAP.

5.0 DESCRIPTION OF CLEANUP ACTION

This section summarizes the remedy selection process, as presented in the FS, and describes the selected cleanup action. It also describes modifications to the selected remedy that were made to account for new information and analyses available after the FS was published.

5.1. Cleanup Objectives

The general objective of the cleanup action is to eliminate, reduce, or otherwise control to the extent feasible and practicable, unacceptable risks to human health and the environment posed by hazardous substances in impacted media. The individual cleanup action objectives (CAOs) for the cleanup action at the Site are specific to certain contaminants, exposure pathways and receptors. CAOs guided the development and evaluation of the remedial alternatives in the FS.

The objectives for the Upland Unit cleanup are to eliminate, reduce or control to the extent feasible, risks from hazardous substances in soil, soil vapor and groundwater associated with the following potential exposure routes:

- People and ecological receptors being exposed to hazardous substances in soil and groundwater by direct contact;
- People being exposed to hazardous substances by inhalation of soil vapors;
- Transport of upland contaminated soil to marine sediment as a result of erosion; and
- Leaching of contaminants from soil to groundwater and subsequent transport in groundwater to sediment or surface water.

The objectives for the Marine Unit are to eliminate, reduce or control to the extent feasible, risks from hazardous substances in surface sediment associated with the following potential exposure routes:

- Aquatic organisms being exposed to hazardous substances in sediment within the biologically active zone (the upper 12 cm of sediment);
- People being exposed to hazardous substances in sediment by direct contact;
- People being exposed to Site-related bioaccumulative compounds by seafood ingestion; and
- Higher trophic level receptors (fish, aquatic-dependent birds and mammals) being exposed to contaminated benthic invertebrate prey via ingestion.

Other considerations for cleanup actions at the Haley Site include:

- The cleanup action should be compatible with cleanup actions currently planned at the adjacent Cornwall and Whatcom Waterway cleanup sites.

The design of the cleanup action should be cognizant of the City's plans to redevelop the Haley and Cornwall sites as a future public park. Conceptual park plans include vegetated open areas, access and use of shoreline and intertidal beach areas, enhanced/restored aquatic

habitat functions and limited park amenities. The City may design elements of the selected remedy to accommodate future end use as a park without compromising the functionality of the system.

5.2. Evaluation of Remedial Alternatives

The FS evaluated multiple cleanup alternatives for addressing contaminated media at the Site. The alternatives evaluation was divided into two parts: Upland Unit alternatives and Marine Unit alternatives. Following are the six alternatives evaluated for addressing Upland Unit contamination.

Alternative U1: Vertical shoreline barrier, passive LNAPL removal, upland cap

This alternative included LNAPL removal via skimming pumps, a low-permeability subsurface barrier wall at the shoreline to prevent LNAPL migration, and a low-permeability upland cap.

Alternative U2: Permeable reactive barrier, passive LPNAL removal, upland cap

This alternative is the same as U1, but replaced the low-permeability barrier wall with a flow-through groundwater treatment wall.

Alternative U3a: Nearshore in-situ soil solidification, upland cap

This alternative included in-situ solidification of soils containing potentially mobile LNAPL near the shoreline, and a low-permeability upland cap.

Alternative U3b: Expanded nearshore in-situ soil solidification, smear zone soil stabilization, and a low-permeability upland cap

This alternative expanded the area of soil solidification and added soil stabilization in the rest of the smear zone, and an upland cap.

Alternative U3c: Soil removal, nearshore in-situ soil solidification, smear zone soil stabilization, upland cap

This alternative added the excavation and removal of soil in the area with potentially mobile LNAPL, and kept the remainder of the expanded area of soil solidification and stabilization. This alternative also had the upland cap.

Alternative U4: Complete removal

This alternative removed all contaminated soil and disposed of it off-Site.

The following are the six alternatives evaluated for addressing contamination in the Marine Unit.

Alternative S1: Containment

This alternative included an amended sand cap over the intertidal and shallow subtidal area, with enhanced natural recovery (ENR) and monitored natural recovery (MNR) in deeper water.

Alternative S2: Partial removal of LNAPL-impacted sediment, and containment

This alternative has S1 elements, but modified the amended sand cap to include removal of the upper three feet of LNAPL-impacted sediment.

Alternative S3: Full removal of LNAPL-impacted sediment, and containment

This alternative modified S2 to include complete removal of the LNAPL-impacted sediment and use of a conventional sand cap.

Alternative S4: Partial removal of LNAPL-impacted and deeper intertidal sediment, and containment

This alternative modified S2 to include removing the upper 3 feet of sediment in the deeper intertidal zone (including the LNAPL-impacted sediment).

Alternative S5a: Full intertidal and shallow subtidal contaminated sediment removal, placement on upland part of Site

This alternative removed all sediment exceeding cleanup levels within the intertidal and shallow subtidal zone (to approximately -10 feet elevation NAVD88), and placed as much of it as possible on the upland part of the Site beneath the low-permeability cap.

Alternative S5b: Full intertidal and shallow subtidal contaminated sediment removal, disposal off-Site

This alternative is the same as S5a, except that excavated sediment is disposed of off-Site.

Each of the alternatives was then evaluated with respect to the criteria outlined in the MTCA Cleanup Regulation. This regulation sets forth the minimum requirements and procedures for selecting a cleanup action. A cleanup action must meet each of the minimum requirements specified in WAC 173-340-360(2), and other requirements, as outlined below.

Threshold Requirements

The cleanup action must:

- Protect human health and the environment;
- Comply with cleanup standards (*see* Section 3.0);
- Comply with applicable state and federal laws (*see* Sections 6.2 and 6.3); and
- Provide for compliance monitoring.

Other Requirements

In addition, the cleanup action must:

- Use permanent solutions to the maximum extent practicable;
- Provide for a reasonable restoration time frame; and
- Consider public concerns.

WAC 173-340-360(3) describes the specific requirements and procedures for determining whether a cleanup action uses permanent solutions to the maximum

extent practicable. A permanent solution is defined as one where cleanup levels can be met without further action being required at the Site other than the disposal of residue from the treatment of hazardous substances. To determine whether a cleanup action uses permanent solutions to the maximum extent practicable, a disproportionate cost analysis (DCA) is conducted. This analysis compares the costs and benefits of the cleanup action alternatives and involves the consideration of several factors, including:

- Protectiveness;
- Permanent reduction of toxicity, mobility and volume;
- Cost;
- Long-term effectiveness;
- Short-term risk;
- Implementability; and
- Consideration of public concerns.

The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment.

WAC 173-340-360(4) describes the specific requirements and procedures for determining whether a cleanup action provides for a reasonable restoration time frame.

Cleanup Action Expectations

WAC 173-340-370 sets forth expectations for the development of cleanup action alternatives and the selection of cleanup actions. These expectations represent the types of cleanup actions Ecology considers likely results of the remedy selection process; however, Ecology recognizes that there may be some sites where cleanup actions conforming to these expectations are not appropriate.

The cleanup action for the Haley Site was selected in accordance with the MTCA requirements described above, and as described in detail in the final RI/FS report (GeoEngineers 2016). The remedy selection process included several steps:

- Identified and evaluated remedial technologies: Remedial technologies and process options potentially applicable to the cleanup of Haley contaminants and media were identified and screened as the basis for choosing those most appropriate for the Site. Screening criteria included relative cost, implementability, and effectiveness. Technologies not selected in this process were eliminated from further consideration.
- Assembled alternatives: Retained technologies were assembled to develop separate remedial alternatives for the Haley Upland and Marine Units. Six alternatives were developed for the Upland Unit and six alternatives were developed for the Marine Unit, as noted above.
- Evaluated alternatives: The alternatives were evaluated in accordance with procedures set forth in MTCA and SMS to determine the preferred alternatives for the upland and

marine units. All alternatives were determined to meet the threshold requirements (WAC 173-340-360(2)(a) and WAC 173-204-570(3)) and were carried forward to the DCA to identify the most permanent remedy in accordance with WAC 173-340-360. A separate DCA was performed for each of the units.

The DCA identified upland Alternative U3a ("Nearshore In-Situ Soil Solidification, Upland Cap") and sediment Alternative S3 ("Upper Intertidal Sediment Removal and Sand Cap") as having the highest degree of benefit per unit cost compared to all the remedial alternatives evaluated. Collectively, Alternatives U3a and S3 comprise the selected cleanup action for the Site.

It should be noted that the footprint of the selected cleanup alternative has been expanded over that shown in the final FS report. This modification involved only the Marine Unit and was based on new sediment data collected during the 2015-16 SSI, as described in Sections 1.3 and 2.0. The new data was the basis for the following changes:

First, the boundary of the area subject to MNR was clarified with respect to Haley contamination. The footprint of dioxins/furans encompasses that of other Haley-related bioaccumulative compounds, as described in the SSI report (Appendix A).

Second, the boundary of the area subject to capping and ENR was extended northward to the Pine Street Beach area (see Figure 5).

A new DCA is not necessary in this case to confirm that the selected remedy remains permanent to the maximum extent practicable. The reason is that the increase in cost due to the larger area of cleanup would be added equally to the first four alternatives, but would increase the cost of the fifth alternative—complete removal. The result would be no relative change in the cost/benefit ratios for the first four alternatives, and an increase in the cost/benefit ratio for the fifth alternative. Alternative S3 would therefore remain the cleanup action that is permanent to the maximum extent practicable.

5.3. Overview of the Selected Cleanup Action

The components of the selected cleanup action are discussed below and presented in Figures 5 and 6.

1. In-situ soil solidification will be performed within the area of potentially mobile LNAPL near the shoreline.
2. A low-permeability cap will be constructed throughout most of the Upland Unit, at locations where soil exceeds cleanup levels. The cap will need to be vented to prevent the buildup of soil gases. Drainage improvements also will be implemented along the eastern boundary of the Site and within the BNSF property to divert surface water infiltration.
3. LNAPL-impacted sediment in the intertidal zone immediately adjacent to the shoreline will be excavated. Sediment remaining at the base of the excavation will be capped with clean sand and armored as necessary to prevent erosion. The excavated sediment will be consolidated under the upland cap.

4. Outside of the sediment removal area, an armored sediment cap will be placed in remaining intertidal and shallow subtidal areas where surface sediment concentrations exceed cleanup levels. This includes areas immediately west of the former Haley wood treatment facility where sediment concentrations exceed benthic criteria, and locations further north (Pine Street Beach area) where bioaccumulative IHSs exceed cleanup levels.
5. Natural recovery methods will be used in areas where contaminants in surface sediment exceed cleanup levels but would be expected to achieve cleanup levels within 10 years as a result of ongoing natural deposition of clean sediment. This primarily consists of MNR over the expanded footprint of the marine unit. ENR, involving placement of a thin layer of clean sand to accelerate natural recovery, will be used between the proposed MNR area and the shallow subtidal sediment cap.

The most significant change to the selected remedy since publication of the FS is the expansion of MNR over a significantly larger area to address dioxin/furan concentrations in sediment, as noted previously in Section 5.2. In addition, nearshore sediment capping is expanded into the Pine Street Beach area to account for the presence of bioaccumulative IHSs.

Components of the selected cleanup action for the Haley Site are described in further detail in the following sections.

5.3.1. Upland Soil Solidification

In-situ soil solidification methods will be used to treat potentially mobile LNAPL and associated contaminated soil near the shoreline. Treatability testing is in progress to determine the stabilizing reagent specifications for the solidification process.

This component of the upland remedy will reduce LNAPL mobility and contaminant leaching to groundwater. The treated soil mass also will have a significantly reduced hydraulic conductivity, thereby causing groundwater to preferentially flow deeper through cleaner soil. This will enhance natural attenuation processes, resulting in reduced contaminant flux from the upland to bay.

5.3.2. Upland Low-Permeability Capping

A low-permeability, multi-layer cap will be constructed in the Upland Unit to address soil that exceeds cleanup levels. The cap will reduce stormwater infiltration and the risk of direct contact exposure. The cap layers will include (bottom to top) a separation layer, a gas-collection layer, a low-permeability geomembrane liner, a drainage layer, a separation geotextile and at least 2 feet of imported fill or topsoil that may be seeded or paved depending on Site redevelopment plans.

The upland cap will provide passive subsurface vapor collection and venting to mitigate the accumulation of volatile compounds from subsurface contamination or landfill gases from refuse associated with the Cornwall site. Stormwater also will be managed to minimize infiltration.

5.3.3. Intertidal Sediment Removal

LNAPL-impacted sediment will be excavated and removed from the upper intertidal zone (above 0.0 foot NAVD88). Contaminated sediment remaining below the excavated sediment will be capped (*see* below). The excavated sediment will be consolidated in the Upland Unit beneath the low-permeability cap. The excavated sediment will require the addition of amendments to enhance its structural properties prior to consolidation under the low-permeability upland cap. The treatability study evaluated potential needs and methods for conditioning the sediment. Large debris or other material unsuitable for placement under the upland cap will be disposed off-site.

5.3.4. Sediment Capping

Sediment exceeding cleanup levels in nearshore areas of the Marine Unit will be capped both within and outside of the sediment removal area. In areas not expected to recover naturally, the cap will be constructed in the intertidal and shallow subtidal zones, down to an elevation of approximately -10 feet NAVD88. The sediment cap will isolate underlying contaminants and be armored to withstand physical erosion processes. The sediment cap will range in thickness from approximately 2 to 5 feet, with an additional layer of armoring. The thickest cap sections will be located in the sediment removal area. Cap thickness and the nature of armoring materials will be further evaluated during remedial design and may vary from the FS-level concepts reflected in this CAP.

5.3.5. Natural Recovery

MNR and ENR will be utilized to address deeper subtidal areas where Site-related bioaccumulative compounds at the Site exceed cleanup levels. MNR will be utilized in subtidal areas where exceedances of bioaccumulative-based cleanup levels are expected to naturally recover within 10 years. The outer-most extent of the MNR area coincides with the location where concentrations of dioxins/furans are estimated to be at or below regional background for this contaminant group (Figures 3 and 5). ENR will be utilized where contaminant concentrations are not expected to naturally recover in a 10-year timeframe, but will achieve this goal by augmenting the natural recovery process. The ENR layer will consist of clean sand and will be located between the seaward edge of the shallow subtidal sediment cap and the MNR area.

Areas were selected for MNR and ENR using a sediment recovery model that incorporated several factors such as contaminant concentration, depositional rate, depth of the biologically active zone and restoration time frame. These and other factors will be further evaluated during remedial design and the extent of natural recovery technologies may be refined. The sediment recovery model will be updated and presented in the Engineering Design Report.

5.4. Institutional Controls

Institutional controls are included as a component of the remedy to ensure its long-term protectiveness. As noted in WAC 173-340-440(4), institutional controls are required where contamination is left in place or conditional points of compliance are used; both conditions apply to the Haley Site. These controls limit or prohibit activities that may interfere with or impair the integrity of a cleanup action, its maintenance or monitoring, or any other activity necessary to ensure protection of human and environmental health.

For the selected remedy, an environmental covenant (MTCA refers to this legal instrument as a "restrictive covenant") will be filed with Whatcom County for the property owned by the City and Port to ensure that all restrictions are implemented and the integrity of the remedies is maintained. Aquatic use restrictions for state-owned lands that are part of the Site may also be required (e.g., leases or easements for constructed cap areas). Any use restrictions affecting the Port Management Area will be coordinated with the Port of Bellingham and DNR. All restrictions will apply, regardless of transfer of property ownership, lease, or operation. Any conveyance of title, easement, lease, or other interest in the properties associated with the Site will require written notice to Ecology of such conveyances or changes. Ecology approval is also necessary for use of or activity at the site that is inconsistent with the environmental covenant. Any proposed activity that is inconsistent with the restrictive covenant and permanently modifies an activity or use restriction at the Site will require public notice and an opportunity for public comment.

Environmental covenants may include, but not be limited to:

- Restrictions on withdrawal of groundwater for use as drinking water or for irrigation;
- Identification and use of engineering controls to prevent contaminant release during any construction, maintenance or repair activity (or any intrusive activity) in the upland or along the shoreline;
- Limits on boat activities (e.g. size, speed or anchoring) to minimize disturbance in sediment cap or ENR areas.

The restrictions and other requirements associated with institutional controls will be described in the Institutional Control Plan (part of the Operations, Maintenance and Monitoring Plan described in Section 6.6) and the restrictive covenant will be recorded with the County and approved by Ecology. DNR will include any restrictions affecting state-owned property on maps and within their databases used to track ownership and use activities.

5.5. Types, Levels and Amounts of Hazardous Substances to Remain in Place

Contaminated media will remain at the Site at concentrations exceeding cleanup levels after construction of the selected remedy. Off-site treatment and/or disposal of contaminated media will be limited, and will be primarily associated with debris that cannot be practicably consolidated beneath the upland cap. It is estimated that approximately 187,000 cubic yards of contaminated upland soil will remain at the Site, contained by approximately 7.7 acres of low-permeability cap. This volume includes approximately 15,000 cubic yards of upland soil that will be treated by in-situ solidification. Approximately 8,000 cubic yards of marine sediment will be excavated from the near-shore intertidal zone and consolidated beneath the low permeability cap.

The selected remedy contains treatment and containment technologies that will limit contaminant mobility and cut off exposure pathways to reduce risks to people and ecological receptors. Soil containing the greatest contaminant concentrations (LNAPL plume area) will be treated by in-situ solidification. This action, combined with upland capping, will reduce LNAPL mobility and contaminant leaching to groundwater throughout the upland unit. The

most heavily impacted sediment will be removed from the marine unit and consolidated beneath the upland low permeability cap. The nearshore sediment cap will isolate contaminated sediment to reduce the risks to the benthic community.

5.6. Restoration Time Frame

Cleanup standards will be achieved for the Haley Site as follows:

- Haley Upland Unit – When construction is completed.
- Marine Unit, Sediment removal and capping portions – When construction is completed. Biological communities, specifically benthic invertebrates, will likely become re-established in sediment removal or capping areas within 3 years of completing construction. Restoration of eelgrass beds, where disturbed, may require a longer time frame.
- Marine Unit, ENR area - Surface sediment concentrations in the ENR area would be reduced when construction is completed, with final recovery within 10 years.
- Marine Unit, MNR area – Within 10 years.

5.7. Compatibility with Adjacent Cleanup Sites

Portions of the Haley Upland and Marine Units overlap with the Cornwall upland and marine units. In addition, the Haley Marine Unit overlaps with Whatcom Waterway sediment Units 6 and 9 (Figure 4). The selected alternative for the Haley site will be compatible with the Cornwall and Whatcom Waterway remedies in the areas of overlap. To be compatible, however, direct coordination of the engineering design work will be required.

The Haley and Cornwall cleanups utilize several common elements in the area of overlap that will be compatible and for which design will be coordinated and optimized. These elements include low-permeability caps, landfill/soil gas collection system, stormwater drainage improvements, sediment capping and erosion control (or “shoreline stabilization” in the case of Cornwall), and ENR. The Haley MNR area also would be compatible with future Cornwall cleanup actions, if required, outside of Cornwall unit MU-2; Cornwall actions in this area, if required, are anticipated to be MNR (Ecology 2014). The Haley MNR area is also totally encompassed by Whatcom Waterway units 6A, 6B, 6C and 9, which are also slated for MNR except for a portion of the barge dock area, which will be capped (Anchor QEA et al. 2015).

The conceptual profiles for the Haley and Cornwall upland caps differ somewhat; however, either conceptual design may be suitable for use in the overlap area. The nearshore sediment cap in the Haley marine unit also differs in profile and function from the Cornwall shoreline stabilization system. Coordination will be required to match grades and other design elements of the cleanup actions in these areas of overlap while assuring that the CAOs for both sites are met.

5.8. Coordination with Site Redevelopment

The City has completed a master plan for the Cornwall Beach Park (Anchor QEA 2014), a proposed 17-acre waterfront park that will be constructed in the upland and intertidal areas

of the Cornwall and Haley sites. The conceptual park master plan was developed with input from City departments, the Port, cleanup consultants involved with the Haley and Cornwall sites, and the public.

The park may include construction of on-site structures, access roads, parking lots and landscaping, the design of which will need to be integrated with the Haley upland cap. Design and construction of the Haley cleanup and future City park may or may not proceed concurrently, particularly since the park is unfunded and requires final design.

6.0 IMPLEMENTATION OF THE CLEANUP ACTION

The cleanup action will be implemented based on this final CAP. Implementation includes remedial design, permitting, preparation of plans and specifications, construction, and post-construction monitoring and maintenance.

6.1. Remedial Design

Design details will be established in an Engineering Design Report (EDR), that will be subject to Ecology review and approval. Once approved, the EDR will serve as the basis for developing permit applications, construction plans and specifications, and final compliance monitoring plans. The plans and specifications will be developed to guide construction of the cleanup action and to serve as the basis for bidding the work to contractors. Pre-design investigations or evaluations may be performed to support the design process, such as a geotechnical investigation or an assessment of coastal marine processes in the Site vicinity.

6.2. Applicable, Relevant and Appropriate Requirements (ARARs)

The primary law governing cleanup of the Haley site is the MTCA (Chapter 70.105D Revised Code of Washington [RCW]). According to MTCA's implementing regulations, cleanup actions must comply with all state and federal laws (WAC 173-340-710(1)) that have jurisdiction over the cleanup (i.e., are applicable) or that Ecology determines may apply to the cleanup (i.e., are relevant and appropriate). Collectively these laws, implementing regulations, standards, limitations or other requirements are referred to as Applicable or Relevant and Appropriate Requirements (ARARs). ARARs regulate specific components of the cleanup, including standards for cleanup of sediment, disposal of hazardous waste, and management of stormwater during construction. Other applicable laws and their implementing regulations include, but are not limited to:

- Washington Chemical Contaminants and Water Quality Act implemented by the Sediment Management Standards (Chapter 173-204 WAC).
- Washington Water Pollution Control Act implemented by Washington State Water Quality for Surface Waters (Chapter 173-201A WAC).
- Clean Water Act, with respect to water quality criteria for surface water (Bellingham Bay) and in-water work associated with dredging or sediment capping.

- Dredge and fill requirements under Code of Federal Regulations (CFR) 320-330 implementing Section 404 of the Clean Water Act and Washington State Hydraulic Code Rules under Chapter 220-110 WAC.
- Washington Hazardous Waste Management Act and Dangerous Waste Regulations, to the extent that any dangerous wastes are discovered during implementation of the cleanup action.
- Resource Conservation and Recovery Act (RCRA) and Subtitle C regulations, to the extent that any hazardous wastes are discovered during the cleanup action.
- Washington State Clean Air Act and air quality regulations (Chapter 173-400 WAC) for point source emissions.
- Shoreline Management Act, with respect to construction activities during the cleanup action.
- Endangered Species Act (ESA), due to listing of Puget Sound Chinook and the potential listing of Coastal/Puget Sound bull trout. Additional ARARs may be identified during the cleanup design and permitting process.

Construction projects are subject to environmental impact review under State Environmental Policy Act (SEPA), National Environmental Policy Act (NEPA) or both. For most projects in Washington, this review consists of a SEPA checklist, although an environmental impact statement is sometimes required. Ecology has completed a SEPA review for the Haley Site cleanup, and has made a Determination of Non-Significance (DNS). The NEPA review will be completed by the U.S. Army Corps of Engineers (USACE) through the Section 404 permit process.

Shoreline Master Plan requirements apply to projects located within 200 feet of the shoreline. In addition to any local compliance review, Ecology conducts site-specific review of cleanup actions conducted under MTCA, provided that those actions are consistent with the substantive requirements of the Shoreline Master Program.

6.3. Permits

Most of the requirements associated with ARARs are specified as regulatory permit conditions; however, cleanup actions conducted under a MTCA Order or Consent Decree are exempt from the procedural requirements of most state and local permits including the Washington State Clean Air Act, Solid and Hazardous Waste Management Act, Hydraulic Code Rules, Water Pollution Control Act, State Environmental Policy Act and local regulations. Regardless of the permit exemptions, all cleanup actions must meet the substantive requirements of the subject regulations/permits. Ecology will consult with lead agencies for the exempted permits and identify the substantive requirements during the design phase of the cleanup.

Permits administered by the State of Washington but granted authority under federal regulations—the Clean Water Act (CWA), National Pollutant Discharge Elimination System (NPDES), and treatment, storage or disposal of hazardous waste under the RCRA— must still be obtained, as do all federally required permits. Requirements governing cleanup of sediment under federal regulation will be addressed through the Joint Aquatic Resource Permit Application (JARPA). The JARPA coordinates information applicable to the USACE-

issued CWA Section 10 and Section 404 permits (Nationwide 38 or Individual 404 permit) and Ecology-issued CWA Section 401 Water Quality Certifications. A state-issued NPDES permit may be required for any on-Site water treatment or discharge of stormwater from the cleanup site during implementation of the remedy as well as a DNR Use Authorizations for State-Owned Aquatic Lands.

The federal permitting process includes review of issues relating to wetlands, Tribal treaty rights, threatened and endangered species, habitat impacts and other factors. The USACE will consult with natural resource trustees regarding potential project impacts on species and habitats protected under the ESA and related requirements. In addition, the State Historic Preservation Office will be consulted to determine the effects of the cleanup under Section 106 of the National Historic Preservation Act.

Ecology will be responsible for final approval for the cleanup action, following consultation with other federal, state and local regulators. The USACE will separately be responsible for approval of the project under Nationwide Permit 38 or Section 404 permit, following ESA consultation with the federal natural resource trustees, and also incorporating Ecology's 401 Water Quality Certification.

6.4. Other Pre-Construction Submittals

Other documents will need to be prepared prior to construction including bid documents, contractor submittals required by the specifications, those required by permitting agencies, and others yet to be specified. All of these need to be provided to Ecology for review and for project records; some may also need to be approved by Ecology. A determination of whether approval is needed will be made by Ecology when it is notified that a document is being prepared.

6.5. Coordination with Adjacent Cleanup Actions

Compatibility and coordination of the Haley and adjacent cleanup sites was discussed from a design perspective in earlier sections. This section focuses on coordination from an implementation perspective. Regardless of Haley and Cornwall being considered separate sites from an administrative perspective, it is likely they will be built concurrently and viewed as one site from a construction perspective. Less coordination will be required between the Haley and Whatcom Waterway sites because they primarily overlap in an area slated for MNR. A few key coordination issues for the Haley and Cornwall sites are summarized below.

- Certain Haley actions (e.g. upland soil solidification and nearshore sediment removal) should be completed before beginning capping actions in overlapping portions of Cornwall units MU-1 or MU-2.
- Haley sediment removal actions must occur before construction of the upland cap on Cornwall (and Haley) because the excavated sediment will be consolidated beneath the upland cap.
- Construction of the upland caps, including the associated landfill gas/soil gas collection and stormwater drainage systems, will need to provide seamless coverage and function across both sites.

- Construction equipment and techniques will likely be the same for certain components of both cleanups (e.g. ENR) and should be completed as one action to reduce construction costs. The same could apply to the Haley MNR area if it is determined in the future that MNR is required for Cornwall unit MU-3.

Construction actions at these overlapping cleanup sites will need to be carefully sequenced, and these plans should be specified in construction documents.

6.6. Compliance Monitoring and Operations and Maintenance

Three types of compliance monitoring are required under MTCA for site cleanup: protection, performance and confirmation. A long-term care and maintenance plan will also be required because contaminated materials will remain on-Site in perpetuity in accordance with the selected remedy.

Protection monitoring (also referred to as construction monitoring) will be conducted during construction to assure that permit requirements are met and human health and the environment are protected.

Performance monitoring (also referred to as post-construction monitoring) will be conducted at the end of the construction period to confirm that design specifications and cleanup standards have been achieved. This type of monitoring can be further divided into short-term and long-term phases. The short-term phase covers elements that can be checked-off immediately at the end of construction, whereas the long-term phase includes requirements that will not be met immediately.

Confirmation monitoring (also referred to as long-term monitoring) will be conducted to confirm that the remedy is continuing to be effective over time in areas/media that have attained cleanup standards.

The following specific MTCA monitoring plans will therefore be prepared for the Haley Site:

- Construction Protection and Short-Term Performance Monitoring Plan (CP/STPM plan). This combined plan will be part of construction documents, as the requirements in these plans will need to be implemented during and checked immediately after construction.
- Long-Term Performance and Confirmation Monitoring Plan (LTP/CM plan). This combined plan will be prepared for the post-construction period to track areas that do not meet cleanup standards immediately after construction, and to confirm that the cleanup continues to be effective in areas that do meet cleanup standards immediately after construction. This plan will be included in the document described in the following paragraph.

Long-term care and maintenance of the completed cleanup will be important to maintain its effectiveness in protecting human health and the environment. Consequently, an umbrella plan termed the Operations, Maintenance, and Monitoring Plan (OMMP) will be prepared to guide care and monitoring of the cleanup after the construction is complete. This document will include the LTC/CM plan referenced above, and will also include a consideration of contingency response measures. Because the Haley Site will likely be developed into a park

over time in conjunction with the adjoining Cornwall site, the OMMP may need to be revised periodically, or combined with a similar plan being prepared for the Cornwall site.

All of these plans and revisions to plans will be submitted to Ecology for review and approval, either as part of another deliverable or as stand-alone documents.

6.7. Schedule

It is hoped that design and permitting of the Haley cleanup can be completed over a period of approximately two years. However, the permitting timeframe can be unpredictable.

Construction of the Haley cleanup should begin shortly after permitting is completed, and will require phasing the upland and sediment activities, plus coordination with the Cornwall site cleanup. The schedule for in-water work will be limited to permit-specified fish windows to minimize effects to migrating juvenile salmonids and other aquatic species. Because of the phasing and coordination needs, and in-water work windows, construction is expected to take approximately two full calendar years. Post-construction monitoring will be performed for a duration and frequency to be identified during remedial design.

A final binding construction schedule and set of deliverables will be established in a Consent Decree between Ecology and one or more of the potential liable parties.

7.0 REFERENCES

Anchor QEA 2014, "Cornwall Beach Park Master Plan Report". Prepared for City of Bellingham, October 2014.

Anchor QEA 2015, "Final Engineering Design Report, Whatcom Waterway Cleanup in Phase 1 Site Areas," Prepared for Port of Bellingham, February 2015.

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Ecology 2015. CLARC Master Spreadsheet. July 2015.

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APPENDIX

Table 1

Summary of Cleanup Levels

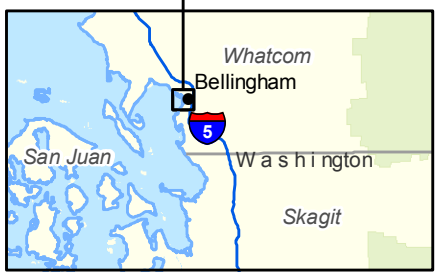
R.G. Haley Site

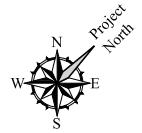
Bellingham, Washington

Indicator Hazardous Substance	Soil	Groundwater	Sediment		Air	Basis for Cleanup Level
			Organic Carbon (0.5% to 3.5%)	Organic Carbon (<0.5% or >3.5%)		
Dioxins/Furans						
Dioxin TEQ	13 ng/kg	32 pg/L	15 ng/kg dw	15 ng/kg dw	na	**Soil:** Human health - based on direct contact **GW:** Protection of surface water (bioaccumulative risks to people), adjusted up to the derived PQL **Sed:** Regional background (SMS CSL based on bioaccumulative risks to people and ecological receptors)
PAHs						
1-Methylnaphthalene	42 µg/kg	15 µg/L	na	na	na	**Soil:** Protection of groundwater - based on protection of sediment (benthic organism toxicity) **GW:** Protection of sediment based on benthic organism toxicity (using 2-methylnaphthalene as a surrogate).
2-Methylnaphthalene	41 µg/kg	15 µg/L	38 mg/kg oc	670 µg/kg dw	na	**Soil:** Protection of groundwater - based on protection of sediment (benthic organism toxicity) **GW:** Protection of sediment based on benthic organism toxicity **Sed:** Benthic organism toxicity (SMS SCO)
Acenaphthene	na	5.3 µg/L	16 mg/kg oc	500 µg/kg dw	na	**GW:** Protection of sediment based on benthic organism toxicity **Sed:** Benthic organism toxicity (SMS SCO)
Fluoranthene	na	na	160 mg/kg oc	1,700 µg/kg dw	na	**Sed:** Benthic organism toxicity (SMS SCO)
Naphthalene	na	na	99 mg/kg oc	2,100 µg/kg dw	0.074 µg/m^3	**Sed:** Benthic organism toxicity (SMS SCO) **Air:** Human health - inhalation
Phenanthrene	na	na	100 mg/kg oc	1,500 µg/kg dw	na	**Sed:** Benthic organism toxicity (SMS SCO)
Benzo(a)anthracene	na	0.01 µg/L	110 mg/kg oc	1,300 µg/kg dw	na	**GW:** Protection of surface water (bioaccumulative risks to people), adjusted up to the PQL **Sed:** Benthic organism toxicity (SMS SCO). Potential bioaccumulative risks addressed by the cPAH TEQ sediment cleanup level.
cPAH TEQ	7.6 µg/kg	0.02 µg/L	86 µg/kg dw	86 µg/kg dw	na	**Soil:** Protection of surface water (bioaccumulative risks to people), adjusted up to the derived PQL **GW:** Protection of surface water (based on bioaccumulative risks to people); adjusted up to the derived PQL **Sed:** Regional background (SMS CSL equivalent based on bioaccumulative risks to people and ecological receptors)
SVOCs						
Pentachlorophenol	6.3 µg/kg	0.04 µg/L	100 µg/kg dw	100 µg/kg dw	na	**Soil:** Protection of groundwater - based on protection of surface water (bioaccumulative risks to people), adjusted up to the PQL **GW:** Protection of surface water (bioaccumulative risks to people). **Sed:** PQL (SMS SCO equivalent addressing bioaccumulative risks to people and ecological receptors)
VOCs						
Benzene	na	na	na	na	0.32 µg/m^3	**Air:** Human health - inhalation
m- and p-Xylenes	na	na	na	na	46 µg/m^3	**Air:** Human health - inhalation
o-Xylene	na	na	na	na	46 µg/m^3	**Air:** Human health - inhalation
Petroleum Hydrocarbons						
TPH Sum	1,534 mg/kg	na	260 mg/kg dw	260 mg/kg dw	na	**Soil:** Human health - based on direct contact **Sed:** Benthic organism toxicity (site-specific SCO)
C5 to C8 Aliphatics	na	na	na	na	90,000 µg/m^3	**Air:** Human health - inhalation
C9 to C12 Aliphatics	na	na	na	na	4,700 µg/m^3	**Air:** Human health - inhalation
C9 to C10 Aromatics	na	na	na	na	6,000 µg/m^3	**Air:** Human health - inhalation

Notes:

cPAH = carcinogenic polycyclic aromatic hydrocarbon
CSL = cleanup screening level
dw - dry weight
GW = groundwater
mg/kg = milligram per kilogram
na = compound is not an indicator hazardous substance for this medium, therefore, no cleanup level is needed.
ng/kg = nanogram per kilogram
oc = organic carbon
PAH = polycyclic aromatic hydrocarbons
PQL = practical quantitation limit
SCO = sediment cleanup objective
SVOC = semivolatile organic compound
Sed = sediment
SMS = Sediment Management Standards
TEQ = toxic equivalent concentration
TPH = total petroleum hydrocarbons (sum of diesel- and lube oil-range)
µg/kg = microgram per kilogram
µg/L = microgram per liter
µg/m^3 = microgram per cubic meter
VOC = volatile organic compound





2,000 0 2,000

Feet

Reference: Whatcom County GIS, City of Bellingham GIS, Aerial from Esri, 2013.

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Projection: NAD 1983 UTM Zone 10N

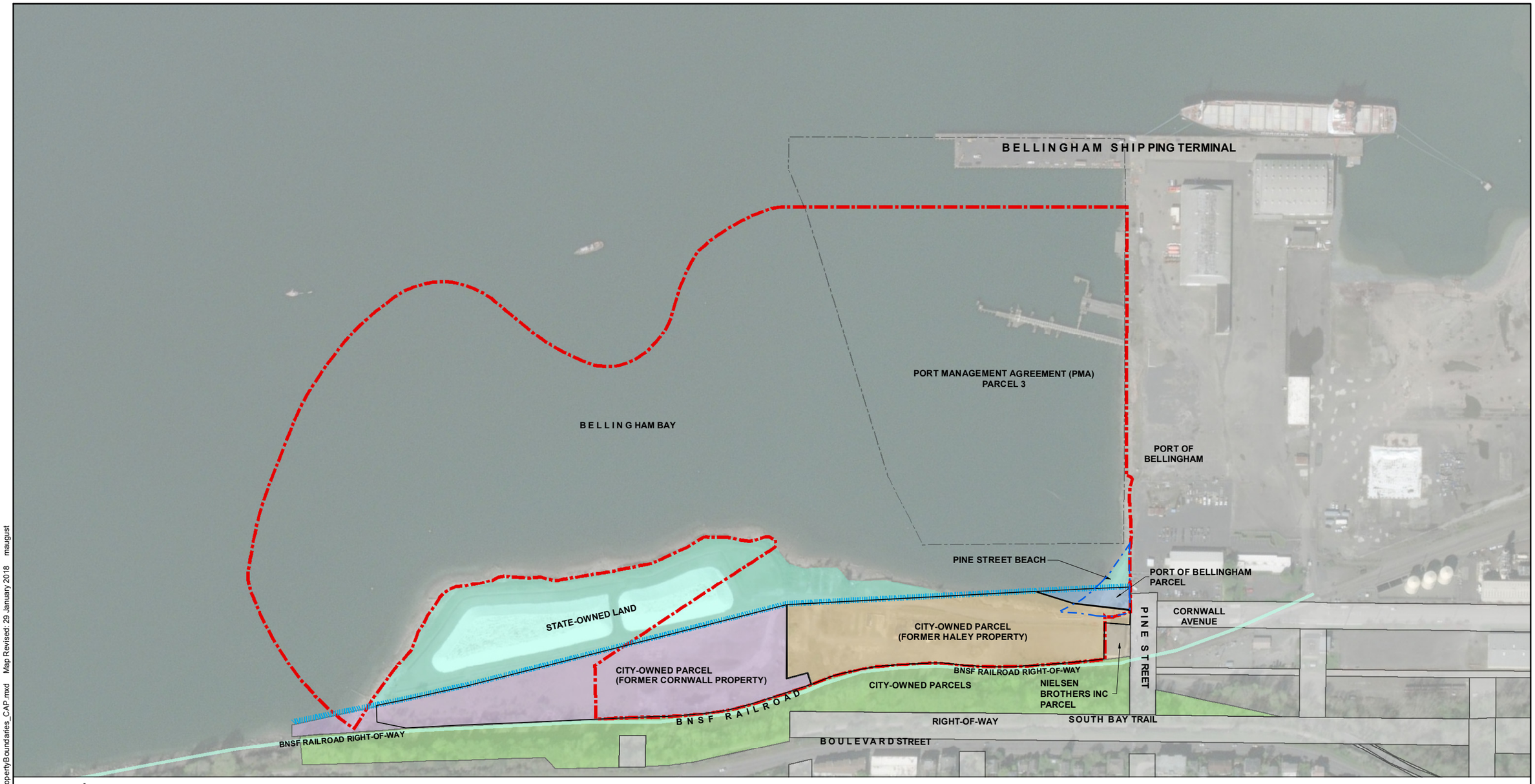
Vicinity Map

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 1

Path: P:\00356114\GIS\MXDs\Fig_1-1_VicinityMap.mxd Map Revised: 09 January 2018 maugust



True North
Project North
W N S E
0 100 200
Feet

Legend

- Haley Cleanup Area Boundary
- Inner Harbor Line

Reference: Aerial from Esri, 2013.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. The estimated extent of the upland portion of the Haley Site is based on existing RI data, although that data does not fully delineate the extent of all Site contaminants. The upland Site boundaries will be further evaluated in the future as a separate action.

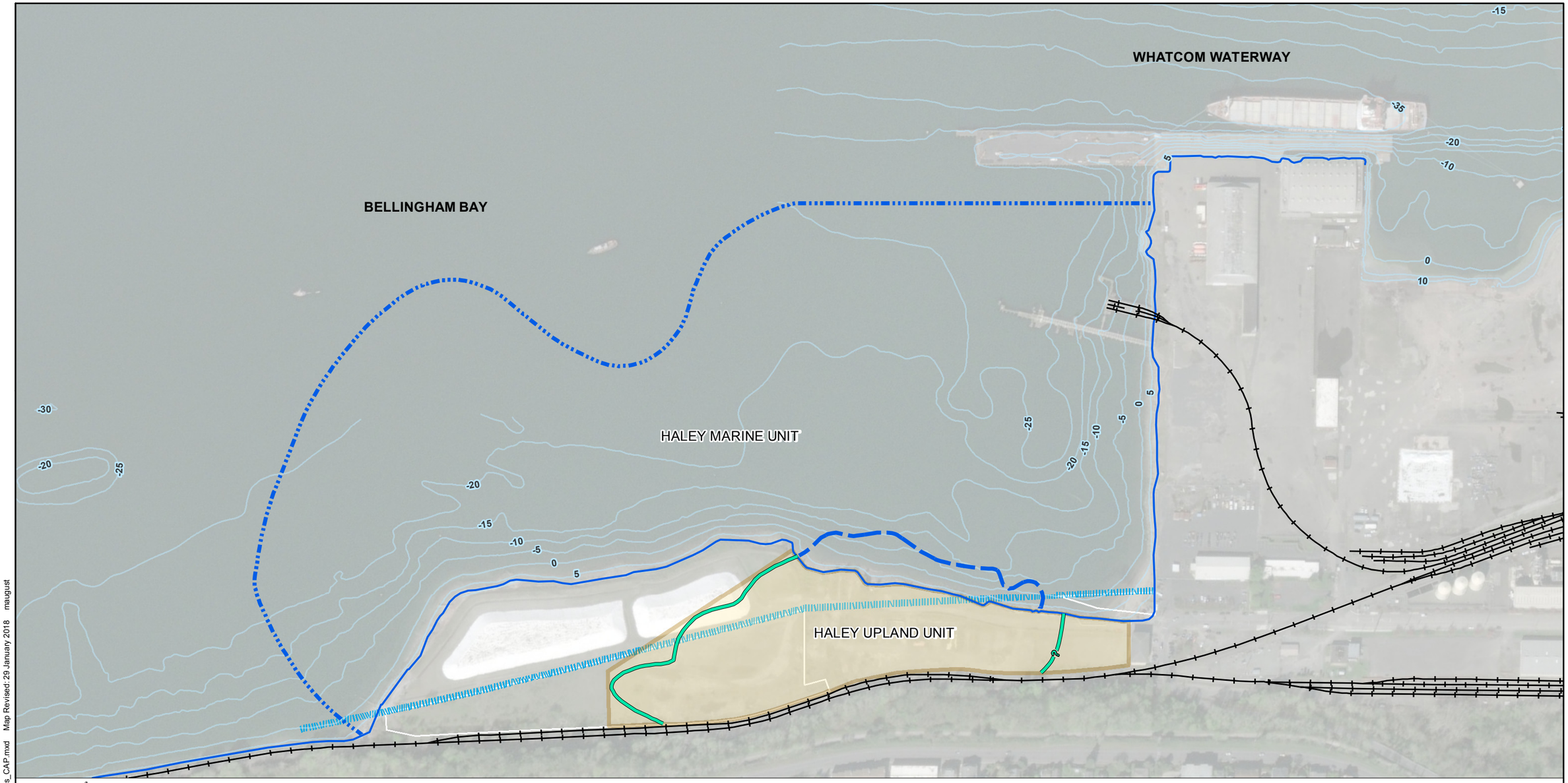
Haley Site and Property Ownership

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 2

Path: P:\0\0356114\GIS\MXDs\0356114406_Fig_02_PropertyBoundaries_CAP.mxd Map Revised: 29 January 2018 maugust



W True North S N E Project North

0 150 300

Feet

- Cleanup area exceeding soil and/or groundwater cleanup levels (to be confirmed during design).
- Cleanup area exceeeding sediment cleanup levels based on benthic toxicity.
- Cleanup area exceeding sediment bioaccumulation-based cleanup levels.
- BNSF Railroad
- Bathymetric Contour (5-ft interval)
- Inner Harbor Line

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

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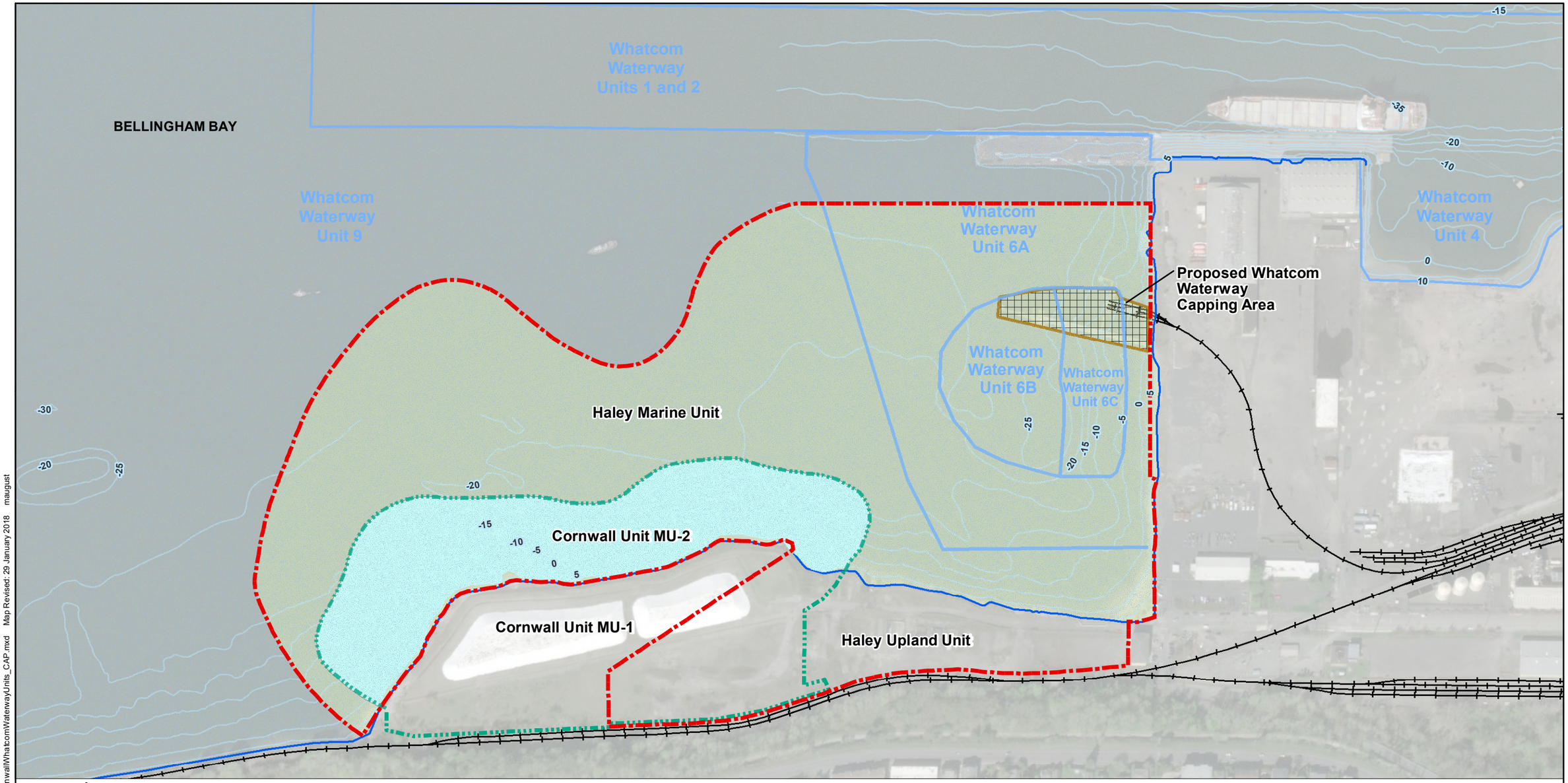
Haley Site Units

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 3

Path: P:\0\0356114\GIS\MXDs\0356114406_Fig03_SiteUnits_CAP.mxd Map Revised: 29 January 2018 maugust



W True North S N Project North E

0 150 300
Feet

Legend

- Haley Cleanup Area Boundary
- Boundary of Cornwall Units MU-1 and MU-2
- BNSF Railroad
- Current Shoreline
- Bathymetric Contour (5-ft interval)

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
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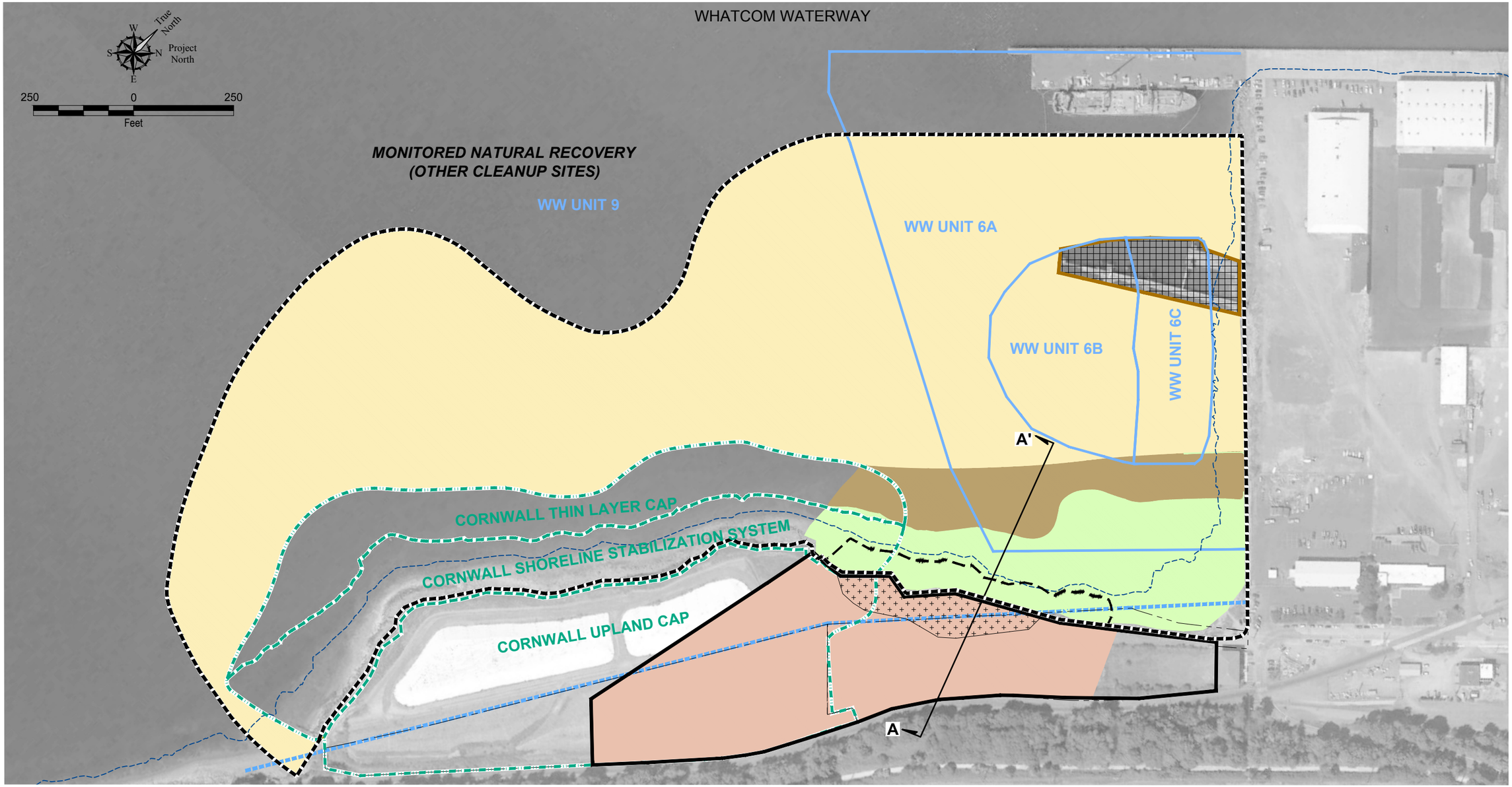
Haley, Cornwall and Whatcom Waterway Site Units

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 4

Path: P:\0035611\4\GIS\MXDs\0356111406_Fig4_HaleyCornwallWhatcomWaterwayUnits_CAP.mxd Map Revised: 29 January 2018 maugust



Notes

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

Reference: Base aerial photo from Google Earth Pro dated 7/24/2017.

Legend

A A' — Cross Section Location

Cornwall Cleanup Action Components

"WW Unit" Designation
(Whatcom Waterway Units Slated for MNR)

Inner Harbor Line

Lower Limit of Intertidal Zone
(-4ft NAVD88)

HALEY CLEANUP ACTION COMPONENTS

- Low-Permeability Upland Cap
- In-Situ Soil Solidification
- Sand Cap (2-Feet to 5-Feet Thick)
- Enhanced Natural Recovery
- Monitored Natural Recovery
- Extent of Sediment Removal
- Haley Upland Unit Boundary
- Haley Marine Unit Boundary
- Whatcom Waterway Capping and Armoring

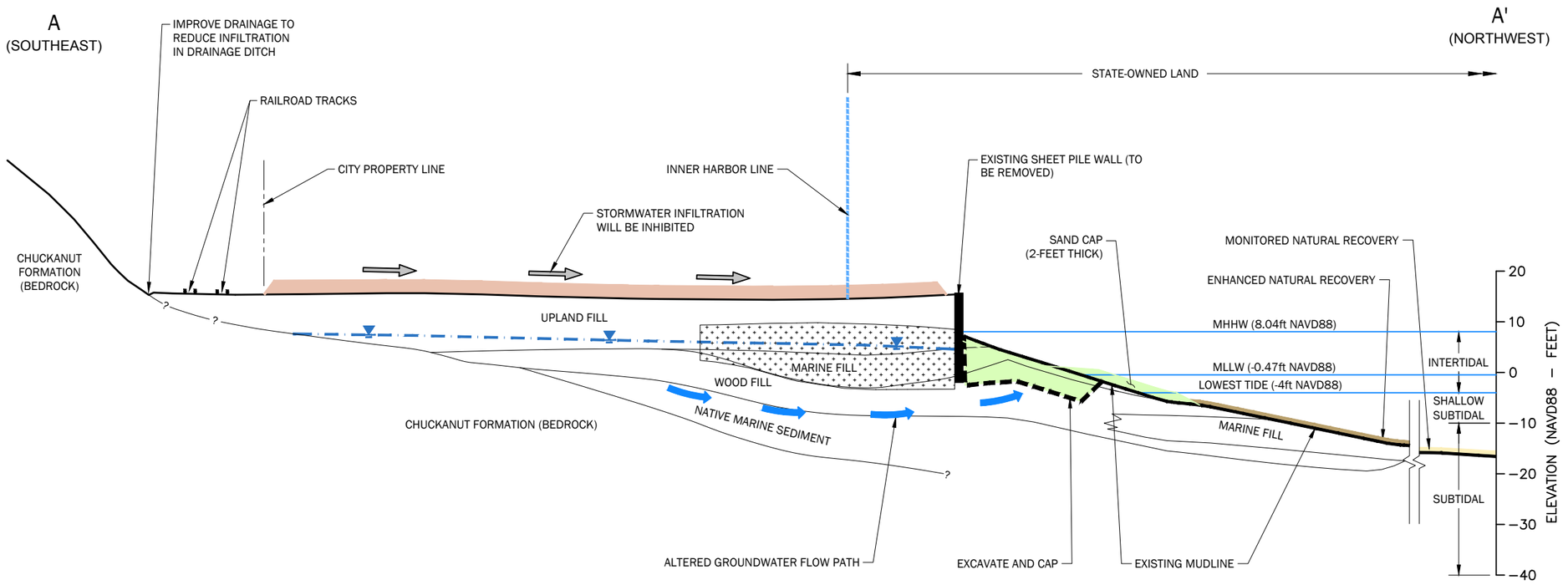
Cleanup Action Components

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 5

P:\0\0356114\06\CAD\Task 3009 CAP\Figure 5 Cleanup Action Components.dwg TAB:F05 Date Exported: 01/09/18 - 9:55 by hmara



Legend

- Low-Permeability Upland Cap
- In-Situ Soil Solidification
- Sand Cap (Ranges from 2 Feet to 5 Feet Thick)
- Enhanced Natural Recovery
- Monitored Natural Recovery

HORIZONTAL SCALE: 1"= 50'
VERTICAL SCALE: 1"= 25'
VERTICAL EXAGGERATION: 2X

50 0 50
FEET

Notes

1. Directions given on cross section line refer to Project North.
2. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
3. Details regarding the shoreline slope in the bank transition area, and post-cleanup upland grades and bathymetry will be determined during remedial design.
4. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document.

Selected Cleanup Action
Cross Section A-A'

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 6

P:\0\0356114\06\CAD\Task 3009 CAP\Figure Selected Cleanup Action Cross-Section AA.dwg TAB:oldBB New AA Date Exported: 02/16/17 - 9:42 by tmichaud

APPENDIX

Supplemental Sediment Investigation Report

R.G. Haley Site
Bellingham, Washington

for
City of Bellingham

January 10, 2018

GeoEngineers
Earth Science + Technology

Supplemental Sediment Investigation Report

R.G. Haley Site
Bellingham, Washington

for
City of Bellingham

January 10, 2018

GeoEngineers

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206.728.2674

Supplemental Sediment Investigation Report

R.G. Haley Site
Bellingham, Washington

File No. 0356-114-06

January 10, 2018

Prepared for:

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Licensed Geologist
STEPHEN C. WOODWARD
1/10/18

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APPENDICES

1.0 INTRODUCTION

Supplemental sediment investigations (SSIs) were conducted on behalf of the City of Bellingham (City) to address data gaps identified in the Remedial Investigation Report (RI) and Feasibility Study (FS) Report (GeoEngineers 2016a,b) for the marine unit of the R.G. Haley (Haley) Site (Figure 1). The marine unit includes intertidal and subtidal aquatic lands adjacent to the upland unit of the Site, where site-related contaminants exceed preliminary cleanup levels (PCULs) identified in the FS.

The investigations were performed to resolve the following data gaps in the marine unit:

- The northern and southern extent of nearshore sediment that exceeds chemical and biological criteria based on benthic toxicity, and
- The bayward extent of site-related dioxins/furans, carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and pentachlorophenol (PCP) that exceed PCULs-based bioaccumulation effects.

Three phases of sampling were conducted after completion of the RI sediment investigation in 2012 to address these data gaps at intertidal and subtidal locations. The scope and approach for each of these sampling events were documented in two work plans and a sampling and analysis plan (SAP) reviewed and approved by Washington State Department of Ecology (Ecology) (GeoEngineers 2013, 2015 and 2016c). In addition, surface sediment samples obtained and archived by the Port of Bellingham (Port) to support remedial design of the adjacent Cornwall Avenue Landfill site (Landau 2016) were submitted for analysis of dioxins/furans to augment the Haley RI data set.

1.1. Objectives

Components of the preferred sediment remedy as defined in the Haley FS (GeoEngineers 2016b) are illustrated in Figure 2. As indicated in the Haley RI/FS report (GeoEngineers 2016a,b), additional sediment data were needed to establish the limits of the marine unit (Site boundary) and refine components of the sediment remedy throughout an expanded Site that was yet to be determined. Data collected during the SSIs were intended to fulfill these, and the following, more specific objectives:

- Confirm or refine the lateral extent of nearshore sediment removal and capping actions needed to address all sediment that exceeds chemical and/or biological criteria protective of the benthic community as defined in the Sediment Management Standards (SMS).
- Characterize the vertical extent of contamination in the same nearshore areas to support future remedial design.
- Characterize the distribution of site-related bioaccumulative compounds outside of the benthic toxicity exceedance area.
- Propose a Site boundary and expanded areas for remedy components in the marine unit based on the information collected as part of the SSI in support of the Cleanup Action Plan (CAP).

Data and work products developed as part of the SSIs will support development of the CAP, which will present the selected remedy for the entire marine unit of the Haley Site.

1.2. Scope

The SSIs included the following activities:

- Collected and analyzed a total of seven intertidal surface (0 to 0.39 foot) sediment samples north and south of the benthic toxicity exceedance area identified in the FS (Figure 2). These samples included SSI-SS-01 through SSI-SS-03 to the south, and SSI-SS-04 through SSI-SS-07 to the north (Figure 3).
- Collected subsurface sediment samples from seven cores advanced to depths as great as 8 feet below mudline (bml) at approximately the same locations as the surface samples described above. The coring locations are identified as SSI-SC-01 through SSI-SC-07 (Figure 3). Initially analyzed the samples collected from the 0 to 2-foot and 2- to 4-foot depth intervals from each core and archived the remainder of the samples. Additional analyses were conducted at several locations from the 4- to 6-foot sample interval based on the initial results.
- Collected eight shallow (0- up to 2-feet bml) subsurface grab samples (COB-CC-C1, COB-CC-C2, PSB-SC-01 through PSB-SC-04) from the Pine Street Beach for analysis of bioaccumulative compounds. Two intervals (1- to 2- feet) at PSB-SC-01 and PSB-SC-04 were archived.
- Selected intertidal surface sediment samples for biological testing based on the initial chemical analytical results. Samples SSI-SS-03, SSI-SS-05 and SSI-SS-06 were submitted for this follow-up testing.
- Collected 11 subtidal surface (0 to 0.39 foot) sediment samples to evaluate the distribution of site-related bioaccumulative compounds in deeper water surrounding the nearshore benthic toxicity exceedance area. These samples are identified as SSI-SS-08 through SSI-SS-18 (Figure 3).
- Coordinated with the Port of Bellingham to analyze dioxins/furans in surface sediment samples collected for the Cornwall Avenue Landfill site. These samples are identified as CL-SG-1, CL-SG-3 and CL-SG-4 (Figure 3) and analytical results are incorporated in the summary tables of this (SSI) report.
- Validated and incorporated the SSI and Cornwall data into the Haley RI/FS database and submitted the data to Ecology's Environmental Information Management (EIM) system.

The sediment samples described above are summarized in Table 1. In general, the analytical program for these samples, which is summarized in Table 2, was structured to assess risks to the benthic community in nearshore samples, and bioaccumulative compounds throughout the Site.

2.0 SEDIMENT SAMPLING ACTIVITIES

To meet the SSI objectives, both surface and subsurface samples were collected from the marine unit. Two surface sediment composite[1] samples (COB-CC-C1 and COB-CC-C2) were collected on August 17, 2013 from the Pine Street Beach; surface grab and subsurface core samples from SSI-SS/SC-01 through SSI-SS/SC-07 and surface samples from SSI-SS-08 through SSI-SS-18 (Figure 3) were obtained between October 12 and 15, 2015 from throughout the Site. Surface (0- to 1-foot) and shallow subsurface (1- to

[1] The two 2013 samples were each composed of 0-to-1 foot sample intervals from three discrete locations from the Pine Street Beach. The sample material was collected by hand over an area 1-foot in diameter at each target location and then composited for analysis.

2-foot) grab samples (PSB-SC-01 through PSB-SC-04) were collected on February 18, 2016 from the Pine Street Beach and analyzed separately to confirm the 2013 composite sample results.

Surface sample depths were defined based on the receptors of concern. The sampling depth for evaluation of benthic community risks was the top 0.39 feet (12 centimeters [cm]) of sediment and is based on the biologically active zone established for Bellingham Bay; this depth interval was also used to evaluate risks to higher trophic level aquatic receptors and net-fishers where bioaccumulative compounds are the primary indicator hazardous substances (IHSs) in the marine unit. The sampling depth interval for evaluation of human health risks associated with recreational clamming or beach play in the intertidal zone was defined in the FS as 0 to 1.5 feet. For the purpose of the SSI, this depth was represented by the 0- to 2-foot interval. Deeper subsurface sediment in the intertidal zone were collected to a target depth of 8 feet bml (where possible) to evaluate nature and extent and to support future remedial design. This depth was selected based on the depth of contamination in nearby sediment core samples that were collected during prior phases of the RI.

Surface and subsurface sampling locations were co-located to the extent practicable. The majority of the SSI samples were collected from a shallow-draft vessel using a power grab (in the case of surface sediment) or a vibracore (in the case of subsurface sediment). Intertidal surface and shallow subsurface sediment samples SSI-SS-02, SSI-SS-04, PSB-SC-01 through PSB-SC-04, and the composite samples COB-CC-C1 and COB-CC-C2 were collected by hand during a low tide. All sample location information is reported relative to NAD83/98 as the horizontal reference and NAVD88 for the vertical reference.

Details regarding sampling and analytical procedures and rationale are provided in the work plans and SAP (GeoEngineers 2013, 2015 and 2016c). Field logs, including core logs, along with photographs taken during field activities are provided in Appendix A and B, respectively.

2.1. Deviations from the Sampling and Analysis Plan

Samples were collected and analyzed in general accordance with the approved work plans and SAP (GeoEngineers 2013, 2015 and 2016c) with the following exceptions:

- The core sample at SSI-SC-02 could not be collected due to the presence of large rock and debris at this location, despite multiple attempts.
- The penetration depth was less than 8 feet due to refusal at the following cores:
  - SSI-SC-01 (6 feet)
  - SSI-SC-04 (4 feet)
  - SSI-SC-06 (7 feet)
- The actual sampling location for SSI-SC-04 was offset from the target location by 7 meters (rather than 3 meters as identified in the work plan) due to multiple failed attempts at the target location because of the presence of large rock, concrete and debris.
- Due to the presence of boulders, large cobble and debris and general lack of fine-grained sediment (i.e., gravel or smaller), surface samples at SSI-SS-02 and SSI-SS-04 required hand-collection of sediment over an area approximately 5 feet in diameter to achieve the required sample volume.
- The surface sediment sample at SSI-SS-02 was analyzed for dioxins/furans to provide information at this location, since a core could not be collected.

- PCP was initially not detected in sample SSI-SS-09; however, the reported detection limit was elevated. Because data at this location were needed to confirm the bayward extent of PCP, the sample was reanalyzed by a different analytical method to achieve a lower detection limit.
- Minor deviations in test parameters for water temperature and salinity occurred during bioassay testing.

3.0 CHEMICAL AND BIOLOGICAL TESTING

The sampling and analytical testing program is summarized in Table 2. Chemical analyses were conducted by Ecology-certified laboratories. Analytical Resources Incorporated (ARI) in Tukwila, Washington analyzed the SMS suite of organic compounds and conventional parameters; dioxins/furans were analyzed by Frontier Analytical in El Dorado Hills, California. Ramboll Environ (Ramboll) conducted the bioassay testing. Samples were analyzed according to the work plans and SAP (GeoEngineers 2013, 2015 and 2016c) and followed the Puget Sound Estuary Program (PSEP; 1987, 1995 and 1997 with updates) protocol and Sediment Cleanup Users' Manual II (SCUM II) guidance (Ecology 2015).

3.1. Initial and Follow-up Analytical Testing

The analytical testing program was developed based on the study objectives (Section 1.1). Samples were analyzed for one or more of the following chemicals or chemical groups:

- SMS suite of semi-volatile organic compounds (SVOCs)
- Dioxins/furans
- cPAHs
- PCP
- Total petroleum hydrocarbons (TPH)
- Total organic carbon (TOC)
- Grain size
- Total solids

The analytical program for intertidal surface samples focused on evaluation of potential effects to the benthic invertebrate community by analyzing for the SMS suite of chemicals excluding metals, pesticides and polychlorinated biphenyls, which were not site IHSs. Subtidal surface samples were analyzed for bioaccumulative IHSs to support the evaluation of human and ecological health risks. Subsurface samples collected from the intertidal zone were analyzed for bioaccumulative and SMS chemicals for the evaluation of health risks and to support remedy design.

Chemical analyses occurred in two phases: initial testing according to the work plans or SAP, and follow-up testing based on the initial results where needed to further evaluate the lateral and/or vertical extent of IHSs. Analysis of archived samples was triggered by an exceedance of the RI screening levels based on the protection of the benthic invertebrate community or PCULs for bioaccumulative IHSs from the FS.

Surface sediment samples from SSI-SS-01 through SSI-SS-12 were initially analyzed and samples from SSI-SS-13 to SSI-SS-18 were archived. Based on the analytical results, SSI-SS-14, SSI-SS-15 and SSI-SS-16 were submitted for follow-up testing to more clearly establish the bayward extent of dioxins/furans. Additionally, SSI-SS-09 was analyzed for PCP to confirm the bayward extent of this IHS.

Subsurface samples from 0- to 2-feet and 2- to 4- feet bml were initially analyzed at locations SSI-SC-01 and SSI-SC-03 through SSI-SC-07. Based on initial results, archived samples from 4 to 6 feet bml at SSI-SC-05, SSI-SC-06 and SSI-SC-07 were tested for dioxins/furans and polycyclic aromatic hydrocarbons (PAHs). Other archived sample analyses included the 4 to 6 feet bml sample at SSI-SC-05 (for TPH) and the 4 to 6 feet bml sample at SSI-SC-06 (for PCP). Follow-up analysis of archived sediment samples was not necessary after initial analysis of discrete samples collected from 0-to-1 foot bml at PSB-SC-01 through PSB-SC-04, and the samples from 1 to 2 feet bml at PSB-SC-02 and PSB-SC-03.

All chemical data were validated according to the U.S. Environmental Protection Agency's (EPA's) Contract Laboratory Program National Functional Guidelines (EPA 2008, 2009 and 2011) prior to inclusion in the RI/FS database. A summary of the validation results is provided in Appendix C; validation details are provided in the attachments (C-1 and C-2).

3.2. Toxicity Testing

In accordance with the 2015 work plan, initial chemical results for the intertidal surface samples were evaluated to determine if bioassay testing would be required.

Bioassays included:

- 10-day adult amphipod (*Eohaustorius estuarius*) mortality test (acute toxicity),
- Sediment bivalve (*Mytilus galloprovincialis*) larval test (acute toxicity), and
- 20-day juvenile polychaete (*Neanthes arenaceodentata*) growth test (chronic toxicity).

Samples exceeding RI screening levels based on the protection of the benthic community were submitted for a suite of toxicity testing. Based on these criteria, SSI-SS-03 and SSI-SS-05 were submitted for toxicity testing. Although not exceeding screening levels, Ecology requested that sample SSI-SS-06 also be submitted for toxicity testing.

4.0 ANALYTICAL RESULTS

This section presents the analytical results organized according to the SSI objectives. Results related to delineation of the area of toxicity to the benthic community according to SMS regulation are presented first, followed by results that were used to establish the limit of SMS exceedances in subsurface sediment, and finally results used to determine the extent of bioaccumulative risks for people and higher-order aquatic receptors. Analytical results supporting the SMS benthic toxicity evaluation and subsurface extent of contamination are provided in Table 3; analytical results for bioaccumulative IHSs are presented in Table 4. Although not discussed in this report, summary statistics for the entire updated RI data set are provided in Appendix D to support the development of the CAP and remedial design.

4.1. SMS Chemicals

Benthic toxicity was initially evaluated by comparing chemical analytical results from the seven intertidal surface samples to the screening levels based on the promulgated SMS criteria or the equivalent Apparent Effects Thresholds (AETs; expressed on a dry-weight basis). The site-specific toxicity-based screening level for TPH was also used in this evaluation.

The results of the SMS chemical evaluation for intertidal surface sediment are shown in Figure 4; results are color-coded to indicate the greatest level of exceedance for each chemical group (low-molecular weight PAHs [LPAHs], high-molecular-weight PAHs [HPAHs], TPH, phenols, chlorinated benzenes, phthalates and miscellaneous organic compounds). Only two surface samples exceeded benthic criteria: SSI-SS-03 exceeded for TPH and 2,4-dimethylphenol, and SSI-SS-05 exceeded for LPAHs, PCP and one chlorinated benzene. Sample SSI-SS-03 was located within the Cornwall Avenue Landfill Management Unit 2 (MU-2); sample SSI-SS-05 was north of the Haley benthic exceedance area identified in the RI/FS. The detection limits for several chlorinated benzenes were slightly greater than benthic criteria when normalized to TOC (SSI-SS-01, SSI-SS-02, SSI-SS-04, SSI-SS-05 and SSI-SS-07); however, no exceedances occurred when evaluated on a dry-weight basis (the original basis of the detection limit).

Three different bioassays (two acute and one chronic) were conducted on each of the three surface sediment samples and one reference sediment sample. Bioassay testing protocol requires a reference sediment with grain size matching that of the samples to be tested to factor out sediment grain-size effects on bioassay organisms. Reference sediment was collected by Ramboll from CR22 in Carr Inlet. Grain size was estimated in the field using a wet-sieve analysis of the reference sample to determine a match with the laboratory grain size results for the three samples from the Haley Site; reference sample grain size was later confirmed by laboratory analyses following PSEP protocol. Grain size characteristics (based on laboratory results) of the reference sample relative to the Site samples are provided below.

SAMPLE AND REFERENCE GRAIN SIZE COMPARISON

Sample	Percent Fines (%)
CR22 (Reference)	31
SSI-SS-03_0-12	26
SSI-SS-05_0-12	19
SSI-SS-06_0-12	28

Bioassay results are summarized in Table 5 and are shown on Figure 5; individual test results are provided in Tables 6, 7 and 8. Ramboll's laboratory report is included as Appendix E. All results passed SMS biological effects criteria indicating that impacts to the benthic community from sediment contamination at the locations tested are unlikely. These results confirm the benthic toxicity exceedance area identified in the Haley RI/FS.

Subsurface data from intertidal sediment samples were also compared to benthic chemical criteria to support future remedial design. The results are presented in Figure 6; color coding by chemical group is the same as in Figure 4. No benthic criteria were exceeded in the shallowest (0- to 2-foot) interval in three of the six cores sampled (SSI-SC-01, SSI-SC-06 and SSI-SC-07); PAHs and TPH concentrations exceeded benthic criteria in the three other cores (SSI-SC-03, SSI-SC-04 and SSI-SC-05). All of the 2- to 4-foot core

intervals had exceedances of PAHs, except for the two cores collected in the Cornwall Avenue Landfill MU-2. SSI-SC-05_2-4 sample also exceeded the TPH criterion. The two northern-most cores (SSI-SC-06 and SSI-SC-07) were the only cores with benthic criteria exceedances in the 4- to 6- foot bml samples; PAHs were the chemicals exceeding their respective criteria. These data are sufficient to support remedy design in the nearshore area to address dioxins/furans.

4.1. Bioaccumulative Chemicals

Data collected as part of the SSIs are presented here to address the extent of dioxins/furans, cPAHs and PCP that was not resolved in the RI/FS. Table 5 presents all these bioaccumulative IHS results for surface and subsurface samples collected after the 2012 RI sediment investigation.

4.1.1. Dioxins/Furans

Dioxin/furan concentrations detected in the SSI surface sediment samples (Figure 7) ranged from 15.4 nanograms per kilogram (ng/kg) toxicity equivalent (TEQ) (SSI-SS-08) to 52.2 ng/kg TEQ (CL-SG-04). SSI-SS-08 was collected west of the Pine Street Beach and CL-SG-04 was collected in Cornwall Avenue Landfill MU-2. Although all surface samples exceeded the PCUL, the concentrations of dioxins/furans in subtidal surface sediment samples decreased in a southerly direction and approached the PCUL of 15 ng/kg TEQ in the most distal samples. Dioxin/furan concentrations in the SSI samples also decreased in a westerly direction toward Whatcom Waterway; the most distal samples in this direction (SSI-SS-14 and -15) contained dioxins/furans at concentrations less than two times the PCUL. These concentrations are likely within the range that will naturally recover. Dioxin/furan concentrations were less than the PCUL in samples previously collected by others from the Whatcom Waterway. The new SSI data, combined with previously existing data, provide a sufficient basis to estimate the area over which dioxin/furan concentrations exceed the PCUL.

Dioxin/furan concentrations in intertidal subsurface sediment samples (Figure 8) ranged from 2.9 ng/kg TEQ (SSI-SC-05_4-6) to 608 ng/kg TEQ (SSI-SC-06_2-4). Of the 23 subsurface samples analyzed from 12 locations, all but three exceeded the PCUL (PSB-02_0-1 and PSB-03_0-1 from Pine Street Beach, and SSI-SC-05_4-6 south of Pine Street Beach). The majority of the 2015/2016 subsurface sediment dioxin/furan concentrations were less than three times the PCUL. Samples collected from the upper intertidal area of the Pine Street Beach (PSB-SC-01 through PSB-SC-04, COB-CC-C1 and COB-CC-C2) had among the lowest dioxin/furan concentrations; the highest dioxin/furan concentrations, however, were detected in the lowest intertidal portion of Pine Street Beach (SSI-SC-06). Subsurface intertidal sediment data are sufficient to support expansion of the nearshore remedy to address dioxins/furans in the Pine Street Beach area.

4.1.2. Carcinogenic PAHs

The SSI surface sediment cPAH concentrations (Figure 9) ranged from 13 micrograms per kilogram (µg/kg) TEQ to 1,140 µg/kg TEQ, with only four of the 11 post-RI samples exceeding the PCUL of 86 µg/kg TEQ. Samples with concentrations exceeding the PCUL were located within the nearshore area adjacent to the upland unit; cPAHs in offshore surface sediment samples collected to the south were less than the PCUL of 86 µg/kg TEQ.

Exceedances of the PCUL in subsurface samples were more frequent. Subsurface cPAH TEQ concentrations (Figure 10) ranged from 4 µg/kg TEQ to 1,000 µg/kg TEQ with 14 of the 21 samples analyzed (from

10 locations) exceeding the PCUL. The Pine Street Beach shallow subsurface sediment samples (PSB-SC-01 through PSB-SC-04) represented the lowest concentrations (4.4 µg/kg TEQ to 38.3 µg/kg TEQ) and all were less than the PCUL. The highest concentration was detected at SSI-SC-05 in the 0- to 2-foot sample interval. Concentrations were also elevated in the 2- to 4-foot bml sample in several other cores (SSI-SC-05 through SSI-SC-07). All subsurface exceedances of cPAHs co-occurred with dioxins/furans exceedances of the PCUL.

The previously collected RI data in concert with the SSI data identify the bayward extent of cPAH concentrations exceeding the PCUL, except along the shoreline west of Pine Street Beach. Elevated concentrations of cPAHs are present in sediment in the Pine Street Beach area and further west along the shoreline (Figure 9). These areas coincide with the site of the former Sehome Dock and other historical features, including the Port's present-day barge dock associated with the Bellingham Shipping Terminal. The former Sehome Dock was a large over-water freight wharf that included rail and warehouse facilities operated by Bellingham Bay and British Columbia Railroad Company and other companies (Figures F-1 and F-2; Appendix F). Historic overwater features also existed along the present-day shoreline west of Pine Street Beach. These included the Pine Street Trestle and City Wharf (precursor to the Bellingham Shipping Terminal Figure F-3). Further development of the Bellingham Shipping Terminal occurred on filled land that produced the present-day upland between Pine Street Beach and Whatcom Waterway. A composite view of historical nearshore and over-water features is presented in Figure F-4. The outlines of these historical features are also shown in Figure 9 (and Figure 14). It is likely that the nearshore area from Pine Street Beach to Whatcom Waterway was impacted by these historical activities as well as the over-water structures that supported these activities since the late 1800s.

Sediment analytical data also suggest that PAHs along the shoreline west of Pine Street Beach originated from a non-Haley source (Appendix G). The PAH profile of Haley-related chemicals is reflected by analytical data from samples RI-1 through RI-5 (Figures G-1 through G-5), which were collected immediately adjacent to the former Haley facility in an area impacted by the release of wood treatment chemicals. The profile of PAHs in sediment west of Pine Street Beach (Port barge dock area) is reflected in samples 6B-01-SS, 6C-01-SS and 6C-02-SS (Figures G-6 through G-8). PAH profiles are similar within each of these areas, but differ between the areas. In general, lighter molecular weight PAHs (naphthalene through anthracene) are more prevalent in sediment adjacent to the Haley facility than west of Pine Street Beach. PAH ratios are commonly used to evaluate sources and the most common ratio is fluoranthene:pyrene (F/P). This ratio is commonly used because these PAHs are typically abundant, behave similarly in the environment and resist weathering. Differences in F/P ratios, therefore, are more apt to reflect different sources as opposed to the effects of environmental fate and transport. The F/P ratio in all samples adjacent to the former Haley facility are <1, as opposed to samples collected west of Pine Street Beach which are all >1. Another obvious difference is the relative abundance of dibenzo(a,h)anthracene compared to indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene in samples from the two areas. Dibenzo(a,h)anthracene is less abundant than the other two compounds in the Haley samples, and more abundant than the other compounds in samples west of Pine Street Beach.

PAHs in samples COB-SS-04 and COB-SS-05 appear to represent mixed sources (Figures G-9 and G-10). These samples were collected at the location of the subtidal cPAH hot spot near Pine Street Beach (Figure 14). These samples exhibit some similarity to the Haley samples based on the relative abundance of light molecular weight PAHs; however, the F/P ratio in these samples resembles sediment in the Port barge dock area. Another diagnostic ratio used to evaluate PAH sources is anthracene:phenanthrene. The anthracene:phenanthrene ratio is considerably lower in the subtidal Pine Street Beach samples than either the Haley or Port barge dock samples.

The elevated cPAH concentrations in the Pine Street Beach area fall within the footprint of dioxins that will be actively remediated as part of the Haley cleanup. The elevated cPAH concentrations near the Bellingham Shipping Terminal barge dock are within the footprint of the proposed cap and armoring that will be constructed as part of the Phase II Whatcom Waterway cleanup. Concentrations of cPAHs between these locations are within the range that may recover naturally, and fall within areas proposed for monitored natural recover (MNR) as part of the Whatcom Waterway and/or Haley cleanups.

4.1.3. Pentachlorophenol

PCP concentrations in SSI surface sediment samples (Figure 11) ranged from non-detect (85U µg/kg) to 580 µg/kg. Three of the eight sediment samples exceeded the PCUL of 100 µg/kg. All surface sediment sample exceedances occurred in the intertidal area and fell within the footprint of dioxin/furan and cPAH exceedances.

Concentrations of PCP in subsurface sediment samples ranged from 12 µg/kg to 250 µg/kg (Figure 12); only 4 of the 19 samples analyzed exceeded the PCUL. The Pine Street Beach samples represented the lowest concentrations (12 µg/kg to 33 µg/kg); all were below the PCUL. The highest concentration occurred at SSI-SC-06 in the 2-to-4 foot bml sample interval (250 µg/kg). All subsurface sediment sample exceedances occurred in the intertidal area and fell within the footprint of dioxin/furan and cPAH exceedances.

5.0 DISCUSSION

Data presented in this report provide the necessary information to refine the selected cleanup action for the Haley marine unit in the CAP. The nearshore SSI chemical and biological data confirm that the benthic toxicity exceedance area does not extend further north or south than shown in the RI/FS. As a result, the nearshore sediment removal and capping components of the preferred remedy are expected to fully address risks to the benthic community at the Haley Site.

The SSI data also adequately characterize the extent of site-related bioaccumulative compounds. The spatial distribution of dioxins/furans, cPAHs and PCP in surface sediment were interpolated using an inverse-distance weighted model (Figures 13, 14 and 15, respectively). For each constituent, the geographic information system (GIS)-based model displays data for four different concentration intervals. The upper limit of each interval is set at the following approximate concentrations: the PCUL, about 3.5 times the PCUL, about 8 times the PCUL, and greater than 8 times the PCUL.

GIS interpolation models are affected by the density of the data and the magnitude of the known concentrations. The models interpolate data far beyond the last meaningful control point when data are sparse. For this reason, the outer boundary of the interpolated data was manually selected based on a practical interpretation of the data. For instance, the southern 15 ng/kg dioxin/furan concentration boundary was selected closer to samples CL-SG-1, SSI-SS-12 and SSI-SS-16 than the GIS model would otherwise indicate. Dioxin/furan concentrations in these samples are 15.5, 16.9 and 15.5 ng/kg, respectively. These values only very slightly exceed the regional background value of 15 ng/kg. However, given the wide spacing in data points, the true location of the 15 ng/kg boundary line may in some locations vary several hundred feet landward or seaward from its interpolated position.

The dioxin/furan footprint in surface sediment encompasses the cPAH and PCP footprints when compared to their respective PCULs (Figures 13, 14 and 15), excluding an area of elevated cPAHs near the Bellingham

Shipping Terminal. As previously discussed, cPAHs along the shoreline west of Pine Street Beach are likely related to historical over-water and nearshore activities, including the present-day barge dock. This area will be addressed as part of the Whatcom Waterway cleanup. The distribution of dioxins/furans can therefore be used to establish the Haley Site boundary in the CAP.

The footprint of bioaccumulative compounds is considerably larger than the spatial extent of the preferred sediment remedy shown in the Haley FS. This was anticipated at the time the FS was prepared and can be readily addressed in the CAP by an expansion of existing components of the Haley remedy. The footprint of bioaccumulative compounds also overlaps with remedial action areas associated with the adjacent Whatcom Waterway and Cornwall Landfill cleanups. These details will be further evaluated in the CAP.

6.0 LIMITATIONS

We have prepared this report for the City of Bellingham (City) for the R.G. Haley Site as an addendum to the remedial investigation and feasibility study. The City may distribute copies of this report to regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices for environmental investigations in this area at the time this report was prepared.

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

7.0 REFERENCES

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TABLES

GeoEngineers

Table 1

Sample Locations

R.G. Haley Site
Bellingham, Washington

Sample Location[1]	Sample Identification	Date Sampled	Sample Coordinates[2] Washington State Planes (NAD83)		Water Surface Elevation (ft NAVD88)	Depth of Water Column (ft)	Mudline Elevation (ft NAVD88)	Sampling Method	Penetration Depth (ft below mudline)	Sample Interval (below mud line)		Elevation at Top of Sample (ft NAVD88)
			Easting	Northing						Top (ft)	Bottom (ft)	
SSI-SS-01	SSI-SS-01-0-12	10/15/2015	1239699.93	639393.98	4.31	9.50	-5.24	Power Grab	0.30	0	0.3	-5.24
	SSI-SS-DUP-03	10/15/2015	1239699.93	639393.98	4.31	9.50	-5.24			0	0.3	-5.24
SSI-SS-02	SSI-SS-02_0-12	10/15/2015	1239821.87	639346.08	3.51	0.00	3.51	Hand-collected	0.39	0	0.39	3.51
SSI-SS-03	SSI-SS-03_0-12	10/15/2015	1239771.03	639465.48	4.51	12.80	-8.29	Power Grab	0.69	0	0.39	-8.29
SSI-SS-04	SSI-SS-04_0-12	10/15/2015	1240507.51	639802.05	2.51	0.00	2.51	Hand-collected	0.39	0	0.39	2.51
SSI-SS-05	SSI-SS-05_0-12	10/12/2015	1240424.93	639823.96	2.91	7.80	-4.89	Power Grab	0.46	0	0.39	-4.89
SSI-SS-06	SSI-SS-06_0-12	10/12/2015	1240485.55	639964.27	3.21	8.70	-5.49	Power Grab	0.56	0	0.39	-5.49
SSI-SS-07	SSI-SS-07_0-12	10/12/2015	1240451.56	640149.78	3.71	7.40	-3.69	Power Grab	0.43	0	0.39	-3.69
SSI-SS-08	SSI-SS-08_0-12	10/12/2015	1240062.51	640265.96	4.51	26.50	-21.99	Power Grab	0.79	0	0.39	-21.99
SSI-SS-09	SSI-SS-09_0-12	10/12/2015	1239630.95	639725.00	4.61	21.50	-16.89	Power Grab	0.75	0	0.39	-16.89
SSI-SS-10	SSI-SS-10_0-12	10/12/2015	1239203.19	639263.41	5.31	28.80	-23.49	Power Grab	0.46	0	0.39	-23.49
SSI-SS-11	SSI-SS-11_0-12	10/12/2015	1238821.87	638767.28	7.41	30.10	-22.69	Power Grab	0.72	0	0.39	-22.69
SSI-SS-12	SSI-SS-12_0-12	10/12/2015	1238699.52	638349.08	4.51	29.60	-25.09	Power Grab	0.69	0	0.39	-25.09
SSI-SS-13	SSI-SS-13_0-12	10/12/2015	1239637.27	640607.96	7.01	33.30	-26.29	Power Grab	0.72	0	0.39	-26.29
	SSI-SS-DUP-01	10/12/2015	1239637.27	640607.96	7.01	33.30	-26.29			0	0.39	-26.29
SSI-SS-14	SSI-SS-14_0-12	10/13/2015	1239617.14	640203.43	6.01	27.40	-21.39	Power Grab	0.52	0	0.39	-21.39
SSI-SS-15	SSI-SS-15_0-12	10/13/2015	1239228.96	639802.28	5.71	29.40	-23.69	Power Grab	0.46	0	0.39	-23.69
SSI-SS-16	SSI-SS-16_0-12	10/13/2015	1238508.27	639067.91	4.81	30.40	-25.59	Power Grab	0.46	0	0.39	-25.59
SSI-SS-17	SSI-SS-17_0-12	10/13/2015	1239120.49	640318.04	4.51	32.30	-27.79	Power Grab	0.59	0	0.39	-27.79
SSI-SS-18	SSI-SS-18_0-12	10/13/2015	1238808.66	639768.38	3.61	28.10	-24.49	Power Grab	0.46	0	0.39	-24.49
	SSI-SS-DUP-02	10/13/2015	1238808.66	639768.38	3.61	28.10	-24.49			0	0.39	-24.49
SSI-SC-01	SSI-SC-01_0-2	10/14/2015	1239695.34	639367.68	4.51	10.40	-5.89	Vibracore	6.0	0	2.0	-5.89
	SSI-SC-DUP-01	10/14/2015								0	2.0	-5.89
	SSI-SC-01_2-4	10/14/2015								2	4.0	-7.89
	SSI-SC-01_4-6	10/14/2015								4	6.0	-9.89
SSI-SC-02[3]	Abandoned	Abandoned	1239814.39[3]	639375.35[3]	--	--	--	--	--	--	--	--
SSI-SC-03	SSI-SC-03_0-2	10/14/2015	1239788.45	639426.59	4.51	7.60	-3.09	Vibracore	8.0	0	2.0	-3.09
	SSI-SC-03_2-4	10/14/2015								2	4.0	-5.09
	SSI-SC-03_4-6	10/14/2015								4	6.0	-7.09
	SSI-SC-DUP-02	10/14/2015								4	6.0	-7.09
	SSI-SC-03_6-8	10/14/2015								6	8.0	-9.09

Sample Location[1]	Sample Identification	Date Sampled	Sample Coordinates[2] Washington State Planes (NAD83)		Water Surface Elevation (ft NAVD88)	Depth of Water Column (ft)	Mudline Elevation (ft NAVD88)	Sampling Method	Penetration Depth (ft below mudline)	Sample Interval (below mud line)		Elevation at Top of Sample (ft NAVD88)
			Easting	Northing						Top (ft)	Bottom (ft)	
SSI-SC-04	SSI-SC-04_0-2	10/15/2015	1240482.54	639785.46	7.31	6.90	0.41	Vibracore	4.0	0	2.0	0.41
	SSI-SC-DUP-03	10/15/2015								0	2.0	0.41
	SSI-SC-04_2-4	10/15/2015								2	4.0	-1.59
SSI-SC-05	SSI-SC-05_0-2	10/13/2015	1240432.94	639831.19	6.01	9.50	-3.49	Vibracore	8.0	0	2.0	-3.49
	SSI-SC-05_2-4	10/13/2015								2	4.0	-5.49
	SSI-SC-05_4-6	10/13/2015								4	6.0	-7.49
	SSI-SC-05_6-8	10/13/2015								6	8.0	-9.49
SSI-SC-06	SSI-SC-06_0-2	10/13/2015	1240514.26	639964.40	4.01	6.80	-2.79	Vibracore	7.0	0	2.0	-2.79
	SSI-SC-06_2-4	10/13/2015								2	4.0	-4.79
	SSI-SC-06_4-6	10/13/2015								4	6.0	-6.79
	SSI-SC-06_6-7	10/13/2015								6	7.0	-8.79
SSI-SC-07	SSI-SC-07_0-2	10/13/2015	1240430.59	640152.61	4.91	8.20	-3.29	Vibracore	8.0	0	2.0	-3.29
	SSI-SC-DUP-04	10/13/2015								0	2.0	-3.29
	SSI-SC-07_2-4	10/13/2015								2	4.0	-5.29
	SSI-SC-07_4-6	10/13/2015								4	6.0	-7.29
	SSI-SC-07_6-8	10/13/2015								6	8.0	-9.29
PSB-SC-01	PSB-SC-01-0-1	2/18/2016	1240606.78	639879.16	4.33	0.00	4.33	Hand-collected	2.0	0	1.0	4.33
	PSB-SC-01-1-2	2/18/2016								1	2.0	3.33
PSB-SC-02	PSB-SC-02-0-1	2/18/2016	1240583.96	639961.75	1.31	0.00	1.31	Hand-collected	2.0	0	1.0	1.31
	PSB-SC-02-1-2	2/18/2016								1	2.0	0.31
PSB-SC-03	PSB-SC-03-0-1	2/18/2016	1240637.16	639963.99	6.11	0.00	6.11	Hand-collected	2.0	0	1.0	6.11
	PSB-SC-03-1-2	2/18/2016								1	2.0	5.11
PSB-SC-04	PSB-SC-04-0-1	2/18/2016	1240607.72	640040.70	4.71	0.00	4.71	Hand-collected	2.0	0	1.0	4.71
	PSB-SC-04-1-2	2/18/2016								1	2.0	3.71
CL-SG-1	CL-SG-1_0-10	6/10/2015	1239046.85	638088.18	4.61	13.90	-9.29	Power Grab	NR	0	0.33	-9.29
CL-SG-3	CL-SG-3_0-10	6/10/2015	1239171.17	638823.80	4.11	21.00	-16.89	Power Grab	NR	0	0.33	-16.89
CL-SG-4	CL-SG-4_0-10	6/10/2015	1239423.47	639210.89	3.21	20.00	-16.79	Power Grab	NR	0	0.33	-16.79
COB-CC-C1[4]	COB-CC-C1_0-1	8/17/2013	1240608.64	639939.70	-0.78 to 8.45	0.00	-0.78 to 8.45	Hand-collected	1.0	0	1.0	-0.78 to 8.45
COB-CC-C2[4]	COB-CC-C2_0-1	8/17/2013	1240602.86	640011.43	-0.75 to 8.83	0.00	-0.75 to 8.83	Hand-collected	1.0	0	1.0	-0.75 to 8.83

Notes:

[1] Sediment sample locations shown on Figure 3.

[2] Obtained using a real time kinematic (RTK) - global positioning system (GPS) and/or hand-held Trimble GPS device.

[3] Sample location abandoned after multiple refusals. Coordinates are for proposed location.

[4] Composite samples, reporting Easting and Northings centroid and elevations range.

ft = feet

NR = not reported

Table 2

Summary of Analyses

R.G. Haley Site
Bellingham, Washington

Location Description	Sample Location	Sample Interval (depth below mud line in feet)	Sampling Method	Analysis								
				Dioxins/ Furans	Total Organic Carbon	Total Solids	Grain Size	SVOCs	cPAHs	Chlorophenols	TPH (Diesel- and Heavy Oil-Range)	Bioassay
				EPA Method 1613 Mod	Plumb 1981, Standard Method 5310B or SW846 Method 9060	PSEP 1986	PSEP 1986 or ASTM D-422 Mod	EPA 8270	EPA 8270 SIM low level	EPA 8041	NWTPH-Dx with acid/ silica gel cleanup	PSEP 1995[1]
Intertidal Sediment	SSI-SS-01	0-0.30	Power Grab	--	X	X	X	X	X	X	A	A
	SSI-SS-02	0-0.39	Hand-collected	X	X	X	X	X	X	X	X	A
	SSI-SS-03	0-0.39	Power Grab	--	X	X	X	X	X	X	X	X
	SSI-SS-04	0-0.39	Hand-collected	--	X	X	X	X	X	X	X	A
	SSI-SS-05	0-0.39	Power Grab	--	X	X	X	X	X	X	X	X
	SSI-SS-06	0-0.39	Power Grab	--	X	X	X	X	X	X	A	X
	SSI-SS-07	0-0.39	Power Grab	--	X	X	X	X	X	X	A	A
	SSI-SC-01	0-2	Vibracore	X	X	X	X	--	X	X[2]	A	
		2-4		X	X	X	X	--	X	X[2]	A	
		4-6		A	A	A	A	--	A	A	A	
	SSI-SC-03	0-2		X	X	X	X	--	X	X[2]	X	
		2-4		X	X	X	X	--	X	X[2]	X	
		4-6		A	A	A	A	--	A	A	A	
		6-8		A	A	A	A	--	A	A	A	
	SSI-SC-04	0-2		X	X	X	X	--	X	X[2]	X	
		2-4		X	X	X	X	--	X	X[2]	X	
	SSI-SC-05	0-2		X	X	X	X	--	X	X[2]	X	
		2-4		X	X	X	X	--	X	X[2]	X	
		4-6		X	X	X	X	--	X	A	X	
		6-8		A	A	A	A	--	A	A	A	
	SSI-SC-06	0-2		X	X	X	X	--	X	X[2]	A	
		2-4		X	X	X	X	--	X	X[2]	A	
		4-6		X	X	X	X	--	X	X[2]	A	
		6-7		A	A	A	A	--	A	A	A	
	SSI-SC-07	0-2		X	X	X	X	--	X	X[2]	A	
		2-4		X	X	X	X	--	X	X[2]	A	
		4-6		X	X	X	X	--	X	A	A	
		6-8		A	A	A	A	--	A	A	A	
	PSB-SC-01	0-1	Hand-collected	X[3]	X[3]	X[3]	X[3]	--	X	X[2]	--	
	PSB-SC-01	1-2	Hand-collected	A	A	A	A	--	A	A	--	
	PSB-SC-02	0-1	Hand-collected	X[3]	X[3]	X[3]	X[3]	--	X	X[2]	--	
	PSB-SC-02	1-2	Hand-collected	X[3]	X[3]	X[3]	X[3]	--	X	X[2]	--	
	PSB-SC-03	0-1	Hand-collected	X[3]	X[3]	X[3]	X[3]	--	X	X[2]	--	
	PSB-SC-03	1-2	Hand-collected	X[3]	X[3]	X[3]	X[3]	--	X	X[2]	--	
	PSB-SC-04	0-1	Hand-collected	X[3]	X[3]	X[3]	X[3]	--	X	X[2]	--	
	PSB-SC-04	1-2	Hand-collected	A	A	A	A	--	A	A	--	
	COB-CC-C1	0-1	Hand-collected	X	X	X	X	--	--	--	--	
	COB-CC-C2	0-1	Hand-collected	X	X	X	X	--	--	--	--	
Subtidal Sediment	SSI-SS-08	0-0.39	Power Grab	X	X	X	X	--	A	--	--	
	SSI-SS-09	0-0.39		X	X	X	X	--	X	X[2]	--	
	SSI-SS-10	0-0.39		X	X	X	X	--	X	--	--	
	SS-SSI-11	0-0.39		X	X	X	X	--	X	--	--	
	SSI-SS-12	0-0.39		X	X	X	X	--	X	--	--	
	SSI-SS-13	0-0.39		A	A	A	A	--	A	--	--	
	SSI-SS-14	0-0.39		X	X	X	X	--	A	--	--	
	SSI-SS-15	0-0.39		X	X	X	X	--	A	--	--	
	SSI-SS-16	0-0.39		X	X	X	X	--	A	--	--	
	SSI-SS-17	0-0.39		A	A	A	A	--	A	--	--	
	SSI-SS-18	0-0.39		A	A	A	A	--	A	--	--	
	CL-SG-1	0-0.33		X	--	--	--	--	--	--	--	
	CL-SG-3	0-0.33		X	--	--	--	--	--	--	--	
	CL-SG-4	0-0.33		X	--	--	--	--	--	--	--	

Notes:

[1]Benthic PAH toxicity evaluated with exposure to ultraviolet (UV) light according to the SCUM II 2015 Appendix C.

[2]Pentachlorophenol analysis only.

[3]Confirmation analysis to address the effect of compositing on previously collected intertidal sediment samples from 2013.

A = archive

cPAH = carcinogenic polycyclic aromatic hydrocarbons

EPA = Environmental Protection Agency

ft = feet

PAH = polycyclic aromatic hydrocarbons

PSEP = Puget Sound Estuary Program

SMS = Sediment Management Standards

SVOCs = semivolatile organic compounds

TPH = total petroleum hydrocarbons

X = chemical or chemical group was analyzed

-- = not analyzed for this group

Table 3

2013-2016 Sediment Analytical Results Compared to Screening Levels for Protection of Benthic Organisms

R.G Haley Site

Bellingham, Washington

			Sample Location	**PSB-01**	**PSB-02**	**PSB-02**	**PSB-03**	**PSB-03**	**PSB-04**	**SSI-SS-01**	**SSI-SC-01**	**SSI-SC-01**	**SSI-SS-02**
			Sample ID:	**PSB-SC-01-0-1**	**PSB-SC-02-0-1**	**PSB-SC-02-1-2**	**PSB-SC-03-0-1**	**PSB-SC-03-1-2**	**PSB-SC-04-0-1**	**SSI-SS-01_0-0.39**	**SSI-SC-01_0-2**	**SSI-SC-01_2-4**	**SSI-SS-02_0-0.39**
			Date Sampled:	**2/18/2016**	**2/18/2016**	**2/18/2016**	**2/18/2016**	**2/18/2016**	**2/18/2016**	**10/15/2015**	**10/14/2015**	**10/14/2015**	**10/15/2015**
			Depth Interval (ft bml):	**0-1 ft**	**0-1 ft**	**1-2 ft**	**0-1 ft**	**1-2 ft**	**0-1 ft**	**0-0.39 ft**	**0-2 ft**	**2-4 ft**	**0-0.39 ft**
			Elevation at Top of Sample (ft NADV88):	**4.3**	**1.3**	**0.3**	**6.1**	**5.1**	**4.7**	**-5.2**	**-5.9**	**-7.9**	**-0.5**
			Collected By	**GeoEngineers**									
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**										
Total Organic Carbon	Percent	0.5	3.5	**0.243**	**0.587**	**0.279**	**0.195**	**0.491**	**0.742**	**1.06**	**1.00**	**0.824 J**	**0.398**
Total Solids	Percent	NE	NE	**82.61**	**83.26**	**81.34**	**95.16**	**94.74**	**92.41**	**70.67**	**72.72**	**72.57**	**84.94**
LPAHs (OC-Normalized)													
Sum of LPAHs	mg/kg OC	370	780	–	–	–	–	–	–	**54**	**84**	**95**	**3.5**
2-Methylnaphthalene	mg/kg OC	38	64	–	–	–	–	–	–	**4.5**	**16**	**9.3**	4.8 U
Acenaphthene	mg/kg OC	16	57	–	–	–	–	–	–	**3.6**	**4.2**	**4.0**	4.8 U
Acenaphthylene	mg/kg OC	66	66	–	–	–	–	–	–	**3.6**	**5.0**	**4.4**	4.8 U
Anthracene	mg/kg OC	220	1,200	–	–	–	–	–	–	**6.4**	**12**	**13**	4.8 U
Fluorene	mg/kg OC	23	79	–	–	–	–	–	–	**4.2**	**6.8**	**7.8**	4.8 U
Naphthalene	mg/kg OC	99	170	–	–	–	–	–	–	**8**	**22**	**32**	4.8 U
Phenanthrene	mg/kg OC	100	480	–	–	–	–	–	–	**30**	**34**	**34**	**3.5**
LPAHs (Dry Weight)													
Sum of LPAHs	µg/kg	5,200	5,200	–	–	–	–	–	–	**570**	**840**	**780**	**14 J**
2-Methylnaphthalene	µg/kg	670	670	–	–	–	–	–	–	**48**	**160 J**	**77**	19 U
Acenaphthene	µg/kg	500	500	–	–	–	–	–	–	**38**	**42**	**33**	19 U
Acenaphthylene	µg/kg	1,300	1,300	–	–	–	–	–	–	**38**	**50 J**	**36**	19 U
Anthracene	µg/kg	960	960	–	–	–	–	–	–	**68**	**120**	**110**	19 U
Fluorene	µg/kg	540	540	–	–	–	–	–	–	**45**	**68**	**64**	19 U
Naphthalene	µg/kg	2,100	2,100	–	–	–	–	–	–	**80**	**220**	**260**	19 U
Phenanthrene	µg/kg	1,500	1,500	–	–	–	–	–	–	**300**	**340**	**280**	**14 J**
HPAHs (OC-Normalized)													
Sum of HPAHs	mg/kg OC	960	5,300	–	–	–	–	–	–	**120**	**210**	**220**	**29.6**
Benzo(a)anthracene	mg/kg OC	110	270	**3.2**	**1.7**	**9.3**	**3.4**	**0.8 J**	**1.1**	**10**	**16**	**18**	**2.8**
Benzo(a)pyrene	mg/kg OC	99	210	**3.5**	**1.5**	**10.0**	**2.9**	**0.5 J**	**1.0**	**14**	**22**	**22**	**3.5**
Benzofluoranthenes (Total)	mg/kg OC	230	450	**5.8**	**3.6**	**19.0**	**6.2**	**1.7**	**2.0**	**22**	**34**	**40**	**7**
Benzo(g,h,i)perylene	mg/kg OC	31	78	–	–	–	–	–	–	**8.2**	**13**	**10**	**3**
Chrysene	mg/kg OC	110	460	**3.8**	**3.1**	**14.0**	**4.4**	**1.1**	**1.6**	**13**	**20**	**21**	**4.3**
Dibenzo(a,h)anthracene	mg/kg OC	12	33	1.9 U	**0.8 J**	**2.0**	2.5 U	1.0 U	0.6 U	**2.4**	**3.2**	**2.7**	**1.3**
Fluoranthene	mg/kg OC	160	1,200	–	–	–	–	–	–	**21**	**41**	**45**	**4**
Indeno(1,2,3-c,d)pyrene	mg/kg OC	34	88	**2.3**	**1.2**	**5.4**	**2.5**	**0.7**	**0.8**	**7**	**11**	**10**	4.8 U
Pyrene	mg/kg OC	1,000	1,400	–	–	–	–	–	–	**25**	**53**	**55**	**4.3**

			Sample Location	**PSB-01**	**PSB-02**	**PSB-02**	**PSB-03**	**PSB-03**	**PSB-04**	**SSI-SS-01**	**SSI-SC-01**	**SSI-SC-01**	**SSI-SS-02**
			Sample ID:	**PSB-SC-01-0-1**	**PSB-SC-02-0-1**	**PSB-SC-02-1-2**	**PSB-SC-03-0-1**	**PSB-SC-03-1-2**	**PSB-SC-04-0-1**	**SSI-SS-01_0-0.39**	**SSI-SC-01_0-2**	**SSI-SC-01_2-4**	**SSI-SS-02_0-0.39**
			Date Sampled:	**2/18/2016**	**2/18/2016**	**2/18/2016**	**2/18/2016**	**2/18/2016**	**2/18/2016**	**10/15/2015**	**10/14/2015**	**10/14/2015**	**10/15/2015**
			Depth Interval (ft bml):	**0-1 ft**	**0-1 ft**	**1-2 ft**	**0-1 ft**	**1-2 ft**	**0-1 ft**	**0-0.39 ft**	**0-2 ft**	**2-4 ft**	**0-0.39 ft**
			Elevation at Top of Sample (ft NADV88):	**4.3**	**1.3**	**0.3**	**6.1**	**5.1**	**4.7**	**-5.2**	**-5.9**	**-7.9**	**-0.5**
			Collected By	**GeoEngineers**									
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**										
HPAHs (Dry Weight)													
Sum of HPAHs	µg/kg	12,000	17,000	–	–	–	–	–	–	1,300	2,100	1,800	**120**
Benzo(a)anthracene	µg/kg	1,300	1,600	**7.7**	9.8	**26**	**6.6**	**3.8 J**	7.9	110 J	160	150	**11 J**
Benzo(a)pyrene	µg/kg	1,600	1,600	**8.5**	9	**28**	**5.6**	**2.6 J**	7.3	150	220	180	**14 J**
Benzofluoranthenes (Total)	µg/kg	3,200	3,600	**14**	21	**53**	**12**	**8.4**	15	230 J	340	300	**28 J**
Benzo(g,h,i)perylene	µg/kg	670	720	–	–	–	–	–	–	87	130	100	**10 J**
Chrysene	µg/kg	1,400	2,800	**9.2**	18	**39**	**8.6**	**5.6**	12	140	200	170	**17 J**
Dibenzo(a,h)anthracene	µg/kg	230	230	4.7 U	4.5 J	**5.5**	4.8 U	4.9 U	4.8 U	25	32	22	**5.3**
Fluoranthene	µg/kg	1,700	2,500	–	–	–	–	–	–	220 J	410	370	**16 J**
Indeno(1,2,3-c,d)pyrene	µg/kg	600	690	**5.6**	7.1	**15**	**4.9**	**3.3**	5.8	74 J	110	83	19 U
Pyrene	µg/kg	2,600	3,300	–	–	–	–	–	–	260 J	530	450	**17 J**
Petroleum Hydrocarbons (Dry Weight)													
Diesel Fuel	mg/kg	260	260	–	–	–	–	–	–	–	–	–	**16**
Motor Oil	mg/kg	260	260	–	–	–	–	–	–	–	–	–	**140**
Petroleum Hydrocarbons (Total)	mg/kg	260	260	–	–	–	–	–	–	–	–	–	**156**
Chlorinated Hydrocarbons (OC-Normalized)													
1,2,4-Trichlorobenzene	mg/kg OC	0.81	1.8	–	–	–	–	–	–	1.8 U	–	–	4.8 U
1,2-Dichlorobenzene (o-Dichlorobenzene)	mg/kg OC	2.3	2.3	–	–	–	–	–	–	1.8 U	–	–	4.8 U
1,3-Dichlorobenzene (m-Dichlorobenzene)	mg/kg OC	NE	NE	–	–	–	–	–	–	1.8 U	–	–	4.8 U
1,4-Dichlorobenzene (p-Dichlorobenzene)	mg/kg OC	3.1	9	–	–	–	–	–	–	**3**	–	–	4.8 U
Hexachlorobenzene	mg/kg OC	0.38	2.3	–	–	–	–	–	–	0.44 U	–	–	1.2 U
Chlorinated Hydrocarbons (Dry Weight)													
1,2,4-Trichlorobenzene	µg/kg	31	51	–	–	–	–	–	–	19 U	–	–	19 U
1,2-Dichlorobenzene (o-Dichlorobenzene)	µg/kg	35	50	–	–	–	–	–	–	19 U	–	–	19 U
1,3-Dichlorobenzene (m-Dichlorobenzene)	µg/kg	NE	NE	–	–	–	–	–	–	19 U	–	–	19 U
1,4-Dichlorobenzene (p-Dichlorobenzene)	µg/kg	110	110	–	–	–	–	–	–	**30**	–	–	19 U
Hexachlorobenzene	µg/kg	22	70	–	–	–	–	–	–	4.7 U	–	–	4.7 U
Phthalates (OC-Normalized)													
Bis(2-Ethylhexyl) Phthalate	mg/kg OC	47	78	–	–	–	–	–	–	**13**	–	–	12 U
Butyl benzyl Phthalate	mg/kg OC	4.9	64	–	–	–	–	–	–	1.8 U	–	–	4.8 U
Dibutyl Phthalate	mg/kg OC	220	1,700	–	–	–	–	–	–	1.8 U	–	–	4.8 U
Diethyl Phthalate	mg/kg OC	61	110	–	–	–	–	–	–	**3.1**	–	–	**30**
Dimethyl Phthalate	mg/kg OC	53	53	–	–	–	–	–	–	1.8 U	–	–	4.8 U
Di-n-Octyl Phthalate	mg/kg OC	58	4,500	–	–	–	–	–	–	1.8 U	–	–	4.8 U
Phthalates (Dry Weight)													
Bis(2-Ethylhexyl) Phthalate	µg/kg	1,300	1,900	–	–	–	–	–	–	**140**	–	–	47 U
Butyl Benzyl Phthalate	µg/kg	63	900	–	–	–	–	–	–	19 U	–	–	19 U
Dibutyl Phthalate	µg/kg	1,400	1,400	–	–	–	–	–	–	19 U	–	–	19 U
Diethyl Phthalate	µg/kg	200	200	–	–	–	–	–	–	33 U	–	–	100 U
Dimethyl Phthalate	µg/kg	71	160	–	–	–	–	–	–	19 U	–	–	19 U
Di-n-Octyl Phthalate	µg/kg	6,200	6,200	–	–	–	–	–	–	19 U	–	–	19 U

			Sample Location	PSB-01	PSB-02	PSB-02	PSB-03	PSB-03	PSB-04	SSI-SS-01	SSI-SC-01	SSI-SC-01	SSI-SS-02
			Sample ID:	PSB-SC-01-0-1	PSB-SC-02-0-1	PSB-SC-02-1-2	PSB-SC-03-0-1	PSB-SC-03-1-2	PSB-SC-04-0-1	SSI-SS-01_0-0.39	SSI-SC-01_0-2	SSI-SC-01_2-4	SSI-SS-02_0-0.39
			Date Sampled:	2/18/2016	2/18/2016	2/18/2016	2/18/2016	2/18/2016	2/18/2016	10/15/2015	10/14/2015	10/14/2015	10/15/2015
			Depth Interval (ft bml):	0-1 ft	0-1 ft	1-2 ft	0-1 ft	1-2 ft	0-1 ft	0-0.39 ft	0-2 ft	2-4 ft	0-0.39 ft
			Elevation at Top of Sample (ft NADV88):	4.3	1.3	0.3	6.1	5.1	4.7	-5.2	-5.9	-7.9	-0.5
			Collected By	GeoEngineers									
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**										
Phenols (Dry Weight)													
2,4-Dimethylphenol	µg/kg	29	29	–	–	–	–	–	–	24 U	–	–	23 U
2-Methylphenol (o-Cresol)	µg/kg	63	63	–	–	–	–	–	–	19 U	–	–	19 U
4-Methylphenol (p-Cresol)	µg/kg	670	670	–	–	–	–	–	–	**64**	–	–	19 U
Pentachlorophenol	µg/kg	360	690	**18**	**12**	**26 NJ**	**19 NJ**	**20**	**33**	94 U	**52**	**160 NJ**	93 U
Phenol	µg/kg	420	1,200	–	–	–	–	–	–	**280 J**	–	–	19 U
Miscellaneous Extractables (OC-Normalized)													
Dibenzofuran	mg/kg OC	15	58	–	–	–	–	–	–	**4**	–	–	4.8 U
Hexachlorobutadiene	mg/kg OC	3.9	6.2	–	–	–	–	–	–	0.44 U	–	–	1.2 U
n-Nitrosodiphenylamine (as diphenylamine)	mg/kg OC	11	11	–	–	–	–	–	–	1.8 U	–	–	4.8 U
Miscellaneous Extractables (Dry Weight)													
Dibenzofuran	µg/kg	540	540	–	–	–	–	–	–	**42**	–	–	19 U
Hexachlorobutadiene	µg/kg	11	120	–	–	–	–	–	–	4.7 U	–	–	4.7 U
n-Nitrosodiphenylamine (as diphenylamine)	µg/kg	28	40	–	–	–	–	–	–	19 U	–	–	19 U
Benzoic Acid	µg/kg	650	650	–	–	–	–	–	–	190 U	–	–	190 U
Benzyl Alcohol	µg/kg	57	730	–	–	–	–	–	–	19 UJ	–	–	19 UJ
Conventionals													
Gravel	Percent	NE	NE	**34.0**	**42.8**	**43.8**	**51.5**	**50.9**	**60.5**	**26.0**	**14.0**	**16.7**	**63.2**
Very coarse sand	Percent	NE	NE	**13.5**	**11.8**	**11.4**	**8.1**	**9.2**	**11.1**	**4.1**	**6.1**	**6.3**	**12.8**
Coarse sand	Percent	NE	NE	**26.5**	**20.0**	**19.5**	**15.3**	**15.9**	**13.2**	**6.5**	**8.6**	**8.4**	**14.1**
Medium sand	Percent	NE	NE	**22.3**	**20.5**	**18.8**	**20.9**	**19.8**	**11.1**	**26.3**	**26.6**	**22.6**	**8.3**
Fine sand	Percent	NE	NE	**2.2**	**2.9**	**3.1**	**3.4**	**3.4**	**3.1**	**22.4**	**25.8**	**23.0**	**1.0**
Very fine sand	Percent	NE	NE	**0.4**	**0.2**	**0.3**	**0.1**	**0.2**	**0.2**	**4.5**	**8.5**	**8.2**	**0.2**
Coarse silt	Percent	NE	NE	1.0 U	1.9 U	3.1 U	0.6 U	0.5 U	1.0 U	**4.7**	**0.9**	**2.6**	0.4 U
Medium silt	Percent	NE	NE	1.0 U	1.9 U	3.1 U	0.6 U	0.5 U	1.0 U	**0.8**	**1.6**	**1.6**	0.4 U
Fine silt	Percent	NE	NE	1.0 U	1.9 U	3.1 U	0.6 U	0.5 U	1.0 U	**1.2**	**2.6**	**2.5**	0.4 U
Very fine silt	Percent	NE	NE	1.0 U	1.9 U	3.1 U	0.6 U	0.5 U	1.0 U	**0.7**	**1.3**	**1.8**	0.4 U
Coarse clay	Percent	NE	NE	1.0 U	1.9 U	3.1 U	0.6 U	0.5 U	1.0 U	**0.7**	**0.9**	**1.6**	0.4 U
Medium clay	Percent	NE	NE	1.0 U	1.9 U	3.1 U	0.6 U	0.5 U	1.0 U	**0.7**	**1.2**	**1.7**	0.4 U
Particle/Grain size, Phi Scale >10	Percent	NE	NE	1.0 U	1.9 U	3.1 U	0.6 U	0.5 U	1.0 U	**1.3**	**2.1**	**3.0**	0.4 U
Total Fines	Percent	NE	NE	**1.0**	**1.9**	**3.1**	**0.6**	**0.5**	**1.0**	**10.2**	**10.5**	**14.8**	**0.4**

Sample Location				SSI-SS-03	SSI-SC-03	SSI-SC-03	SSI-SS-04	SSI-SC-04	SSI-SC-04	SSI-SS-05	SSI-SC-05	SSI-SC-05	SSI-SC-05
Sample ID:				SSI-SS-03_0-0.39	SSI-SC-03_0-2	SSI-SC-03_2-4	SSI-SS-04-0_0.39	SSI-SC-04_0-2	SSI-SC-04_2-4	SSI-SS-05_0-0.39	SSI-SC-05_0-2	SSI-SC-05_2-4	SSI-SC-05_4-6
Date Sampled:				10/15/2015	10/14/2015	10/14/2015	10/15/2015	10/15/2015	10/15/2015	10/12/2015	10/13/2015	10/13/2015	10/13/2015
Depth Interval (ft bml):				0-0.39 ft	0-2 ft	2-4 ft	0-0.39 ft	0-2 ft	2-4 ft	0-0.39 ft	0-2 ft	2-4 ft	4-6 ft
Elevation at Top of Sample (ft NADV88):				-8.3	-3.1	-5.1	-0.5	0.4	-1.6	-4.9	-3.5	-5.5	-7.5
Collected By				GeoEngineers									
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**										
Total Organic Carbon	Percent	0.5	3.5	**2.98**	**1.27**	**2.96**	**0.111**	**1.38**	**2.76**	**1.05**	**17.9**	**8.71**	**2.17**
Total Solids	Percent	NE	NE	**55.42**	**61.34**	**51.27**	**79.30**	**84.28**	**78.75**	**66.29**	**58.74**	**48.74**	**49.37**
LPAHs (OC-Normalized)													
Sum of LPAHs	mg/kg OC	370	780	**110**	**190**	**26**	13	**170**	**220**	**240**	73	170	**16**
2-Methylnaphthalene	mg/kg OC	38	64	**10**	**14**	**2**	17 U	**6.2**	**12**	**54**	3.5	6.4	**1.6**
Acenaphthene	mg/kg OC	16	57	**3.7**	**9.4**	**1.2**	17 U	**19**	**28**	**10**	4.0	4.2	**0.74**
Acenaphthylene	mg/kg OC	66	66	**6**	**9.4**	**1.5**	17 U	**4.1**	**5.4**	**10**	2	6.3	**0.69**
Anthracene	mg/kg OC	220	1,200	**10**	**14**	**2.4**	17 U	**20**	**24**	**20**	6.7	10	**1.3**
Fluorene	mg/kg OC	23	79	**4.7**	**17**	**2.2**	17 U	**20**	**25**	**13**	6.1	11	**1.2**
Naphthalene	mg/kg OC	99	170	**37**	**87**	**11**	5	**55**	**69**	**110**	30	86	**6.5**
Phenanthrene	mg/kg OC	100	480	**50**	**56**	**7.8**	7.7	**54**	**69**	**74**	26	54	**5.5**
LPAHs (Dry Weight)													
Sum of LPAHs	µg/kg	5,200	5,200	3,400	2,400	770	**14 J**	2,400	6,100	2,500	**13,000**	**15,000**	350
2-Methylnaphthalene	µg/kg	670	670	300	180	59	19 U	86	340	570	**620**	**560**	35
Acenaphthene	µg/kg	500	500	110	120	36	19 U	260	780	110	**800**	**370**	16
Acenaphthylene	µg/kg	1,300	1,300	180	120	43	19 U	57	150	110	**360**	**550**	15
Anthracene	µg/kg	960	960	400	180	71	19 U	270	670	200	**1,200**	**1,000**	29
Fluorene	µg/kg	540	540	140	210	65	19 U	280	680	140	**1,100**	**980**	26
Naphthalene	µg/kg	2,100	2,100	1,100	1,100	320	**5.6 J**	760	1,900	1,200	**5,000**	**7,500**	140
Phenanthrene	µg/kg	1,500	1,500	1,500	710	230	**8.5 J**	740	1,900	780	**4,700**	**4,700**	120
HPAHs (OC-Normalized)													
Sum of HPAHs	mg/kg OC	960	5,300	**300**	**190**	**30**	40	**180**	**220**	**320**	82.5	115.5	**16**
Benzo(a)anthracene	mg/kg OC	110	270	**29**	**13**	**2.5**	17 U	**12**	**16**	**24**	5.1	5.5	**1**
Benzo(a)pyrene	mg/kg OC	99	210	**28**	**13**	**2.6**	17 U	**9.4**	**13**	**23**	4.1	6.0	**1.2**
Benzofluoranthenes (Total)	mg/kg OC	230	450	**50**	**18**	**4.1**	11	**15**	**20**	**45**	7.3	9.3	**1.7**
Benzo(g,h,i)perylene	mg/kg OC	31	78	**13**	**8.7**	**2.2**	17 U	**7**	**7**	**17**	2.3	4.2	**1.1**
Chrysene	mg/kg OC	110	460	**37**	**20**	**2.5**	6.8	**16**	**18**	**34**	6.1	6.4	**1.3**
Dibenzo(a,h)anthracene	mg/kg OC	12	33	**4**	**1.4**	**0.44**	2.6	**1**	**1.6**	**3.6**	0.61	0.62	**0.29**
Fluoranthene	mg/kg OC	160	1,200	**64**	**53**	**8.4**	9	**60**	**70**	**77**	29	41	**4.5**
Indeno(1,2,3-c,d)pyrene	mg/kg OC	34	88	**10**	**5.9**	**1.5**	17 U	**5.3**	**6.5**	**14**	2.1	3.3	**1**
Pyrene	mg/kg OC	1,000	1,400	**60**	**60**	**9.1**	11	**53**	**65**	**82**	26	39	**3.6**

			Sample Location	**SSI-SS-03**	**SSI-SC-03**	**SSI-SC-03**	**SSI-SS-04**	**SSI-SC-04**	**SSI-SC-04**	**SSI-SS-05**	**SSI-SC-05**	**SSI-SC-05**	**SSI-SC-05**
			Sample ID:	**SSI-SS-03_0-0.39**	**SSI-SC-03_0-2**	**SSI-SC-03_2-4**	**SSI-SS-04-0_0.39**	**SSI-SC-04_0-2**	**SSI-SC-04_2-4**	**SSI-SS-05_0-0.39**	**SSI-SC-05_0-2**	**SSI-SC-05_2-4**	**SSI-SC-05_4-6**
			Date Sampled:	**10/15/2015**	**10/14/2015**	**10/14/2015**	**10/15/2015**	**10/15/2015**	**10/15/2015**	**10/12/2015**	**10/13/2015**	**10/13/2015**	**10/13/2015**
			Depth Interval (ft bml):	**0-0.39 ft**	**0-2 ft**	**2-4 ft**	**0-0.39 ft**	**0-2 ft**	**2-4 ft**	**0-0.39 ft**	**0-2 ft**	**2-4 ft**	**4-6 ft**
			Elevation at Top of Sample (ft NADV88):	**-8.3**	**-3.1**	**-5.1**	**-0.5**	**0.4**	**-1.6**	**-4.9**	**-3.5**	**-5.5**	**-7.5**
			Collected By	**GeoEngineers**									
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**										
HPAHs (Dry Weight)													
Sum of HPAHs	µg/kg	12,000	17,000	8,900	2,400	990	**44**	2,400	6,100	3,400	**15,000**	**10,000**	340
Benzo(a)anthracene	µg/kg	1,300	1,600	870	160	75	19 U	160	440	250	**920**	**480**	22
Benzo(a)pyrene	µg/kg	1,600	1,600	840	160	77	19 U	130	360	240	**740**	**500**	25
Benzofluoranthenes (Total)	µg/kg	3,200	3,600	1,500	230	120	**12 J**	210	560	470	**1,300**	**810**	36
Benzo(g,h,i)perylene	µg/kg	670	720	380	110	64	19 U	96	200	180	**420**	**370**	23
Chrysene	µg/kg	1,400	2,800	1,100	200	74	**7.5 J**	220	510	360	**1,100**	**560**	28
Dibenzo(a,h)anthracene	µg/kg	230	230	120	18	13 J	**2.9 J**	20	45	38	**110**	**54**	6.3
Fluoranthene	µg/kg	1,700	2,500	1,900	670	250	**10 J**	800	2,000	810	**5,200**	**3,600**	98
Indeno(1,2,3-c,d)pyrene	µg/kg	600	690	400	75	45	19 U	73	180	150	**380**	**290**	22
Pyrene	µg/kg	2,600	3,300	1,800	760	270	**12 J**	730	1,800	860	**4,600**	**3,400**	79
Petroleum Hydrocarbons (Dry Weight)													
Diesel Fuel	mg/kg	260	260	**220**	**230**	**84**	6.1 U	**44 J**	**92**	**58**	**310**	**230**	**15**
Motor Oil	mg/kg	260	260	**430**	**370**	**140**	12 U	**68**	**140**	**120**	**550**	**340**	**24**
Petroleum Hydrocarbons (Total)	mg/kg	260	260	**650**	**600**	**224**	12 U	**112**	**232**	**178**	**860**	**570**	**39**
Chlorinated Hydrocarbons (OC-Normalized)													
1,2,4-Trichlorobenzene	mg/kg OC	0.81	1.8	0.64 U	–	–	17 U	–	–	1.8 U	–	–	–
1,2-Dichlorobenzene (o-Dichlorobenzene)	mg/kg OC	2.3	2.3	**0.44**	–	–	17 U	–	–	1.8 U	–	–	–
1,3-Dichlorobenzene (m-Dichlorobenzene)	mg/kg OC	NE	NE	0.64 U	–	–	17 U	–	–	1.8 U	–	–	–
1,4-Dichlorobenzene (p-Dichlorobenzene)	mg/kg OC	3.1	9	**3**	–	–	17 U	–	–	**3.5**	–	–	–
Hexachlorobenzene	mg/kg OC	0.38	2.3	0.16 U	–	–	4.2 U	–	–	0.46 U	–	–	–
Chlorinated Hydrocarbons (Dry Weight)													
1,2,4-Trichlorobenzene	µg/kg	31	51	19 U	–	–	19 U	–	–	19 U	–	–	–
1,2-Dichlorobenzene (o-Dichlorobenzene)	µg/kg	35	50	**13 J**	–	–	19 U	–	–	19 U	–	–	–
1,3-Dichlorobenzene (m-Dichlorobenzene)	µg/kg	NE	NE	19 U	–	–	19 U	–	–	19 U	–	–	–
1,4-Dichlorobenzene (p-Dichlorobenzene)	µg/kg	110	110	**100**	–	–	19 U	–	–	**37**	–	–	–
Hexachlorobenzene	µg/kg	22	70	4.8 U	–	–	4.7 U	–	–	4.8 U	–	–	–
Phthalates (OC-Normalized)													
Bis(2-Ethylhexyl) Phthalate	mg/kg OC	47	78	**4.4**	–	–	42 U	–	–	**14**	–	–	–
Butyl benzyl Phthalate	mg/kg OC	4.9	64	**2.4**	–	–	17 U	–	–	1.8 U	–	–	–
Dibutyl Phthalate	mg/kg OC	220	1,700	0.64 U	–	–	17 U	–	–	**1.1**	–	–	–
Diethyl Phthalate	mg/kg OC	61	110	**3**	–	–	**23**	–	–	**4.1**	–	–	–
Dimethyl Phthalate	mg/kg OC	53	53	0.64 U	–	–	17 U	–	–	**7**	–	–	–
Di-n-Octyl Phthalate	mg/kg OC	58	4,500	**0.6**	–	–	17 U	–	–	1.8 U	–	–	–
Phthalates (Dry Weight)													
Bis(2-Ethylhexyl) Phthalate	µg/kg	1,300	1,900	**130**	–	–	47 U	–	–	**150**	–	–	–
Butyl Benzyl Phthalate	µg/kg	63	900	**73**	–	–	19 U	–	–	19 U	–	–	–
Dibutyl Phthalate	µg/kg	1,400	1,400	19 U	–	–	19 U	–	–	**12 J**	–	–	–
Diethyl Phthalate	µg/kg	200	200	100 U	–	–	25 U	–	–	43 U	–	–	–
Dimethyl Phthalate	µg/kg	71	160	19 U	–	–	19 U	–	–	**70**	–	–	–
Di-n-Octyl Phthalate	µg/kg	6,200	6,200	**18 J**	–	–	19 U	–	–	19 U	–	–	–

			Sample Location	SSI-SS-03	SSI-SC-03	SSI-SC-03	SSI-SS-04	SSI-SC-04	SSI-SC-04	SSI-SS-05	SSI-SC-05	SSI-SC-05	SSI-SC-05
			Sample ID:	SSI-SS-03_0-0.39	SSI-SC-03_0-2	SSI-SC-03_2-4	SSI-SS-04-0_0.39	SSI-SC-04_0-2	SSI-SC-04_2-4	SSI-SS-05_0-0.39	SSI-SC-05_0-2	SSI-SC-05_2-4	SSI-SC-05_4-6
			Date Sampled:	10/15/2015	10/14/2015	10/14/2015	10/15/2015	10/15/2015	10/15/2015	10/12/2015	10/13/2015	10/13/2015	10/13/2015
			Depth Interval (ft bml):	0-0.39 ft	0-2 ft	2-4 ft	0-0.39 ft	0-2 ft	2-4 ft	0-0.39 ft	0-2 ft	2-4 ft	4-6 ft
			Elevation at Top of Sample (ft NADV88):	-8.3	-3.1	-5.1	-0.5	0.4	-1.6	-4.9	-3.5	-5.5	-7.5
			Collected By	GeoEngineers									
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**										
Phenols (Dry Weight)													
2,4-Dimethylphenol	µg/kg	29	29	**47**	–	–	24 U	–	–	**19 J**	–	–	–
2-Methylphenol (o-Cresol)	µg/kg	63	63	**47**	–	–	19 U	–	–	**26**	–	–	–
4-Methylphenol (p-Cresol)	µg/kg	670	670	**430**	–	–	19 U	–	–	**270**	–	–	–
Pentachlorophenol	µg/kg	360	690	**170**	**150 NJ**	**46 NJ**	94 U	**23 NJ**	**54**	**580**	**140**	**59 NJ**	–
Phenol	µg/kg	420	1,200	**410 J**	–	–	19 U	–	–	**120**	–	–	–
Miscellaneous Extractables (OC-Normalized)													
Dibenzofuran	mg/kg OC	15	58	**5.4**	–	–	17 U	–	–	**14**	–	–	–
Hexachlorobutadiene	mg/kg OC	3.9	6.2	0.16 U	–	–	4.2 U	–	–	0.46 U	–	–	–
n-Nitrosodiphenylamine (as diphenylamine)	mg/kg OC	11	11	0.64 U	–	–	17 U	–	–	1.8 U	–	–	–
Miscellaneous Extractables (Dry Weight)													
Dibenzofuran	µg/kg	540	540	**160**	–	–	19 U	–	–	**150**	–	–	–
Hexachlorobutadiene	µg/kg	11	120	4.8 U	–	–	4.7 U	–	–	4.8 U	–	–	–
n-Nitrosodiphenylamine (as diphenylamine)	µg/kg	28	40	19 U	–	–	19 U	–	–	19 U	–	–	–
Benzoic Acid	µg/kg	650	650	**500**	–	–	190 U	–	–	**350**	–	–	–
Benzyl Alcohol	µg/kg	57	730	**50 J**	–	–	19 UJ	–	–	**78 J**	–	–	–
Conventionals													
Gravel	Percent	NE	NE	**3.4**	**11.7**	**9.9**	**17.4**	**25.1**	**39.9**	**4.6**	**7.0**	**3.9**	**0.5**
Very coarse sand	Percent	NE	NE	**5.7**	**7.1**	**7.2**	**5.5**	**7.3**	**5.8**	**4.1**	**5.9**	**6.4**	**0.9**
Coarse sand	Percent	NE	NE	**5.2**	**7.0**	**8.4**	**28.0**	**13.8**	**11.1**	**7.3**	**7.0**	**7.5**	**0.7**
Medium sand	Percent	NE	NE	**11.5**	**13.2**	**17.4**	**43.0**	**25.7**	**18.2**	**23.1**	**15.2**	**8.2**	**0.5**
Fine sand	Percent	NE	NE	**26.8**	**28.4**	**32.7**	**4.7**	**10.4**	**9.5**	**28.8**	**19.6**	**8.7**	**0.8**
Very fine sand	Percent	NE	NE	**21.8**	**18.1**	**16.5**	**0.5**	**3.8**	**5.8**	**13.2**	**11.2**	**9.0**	**5.0**
Coarse silt	Percent	NE	NE	**0.6**	**2.5**	**0.8**	1.0 U	**6.2**	**1.9**	**5.0**	**9.8**	**6.8**	**20.0**
Medium silt	Percent	NE	NE	**3.1**	**1.8**	**1.0**	1.0 U	**1.6**	**2.1**	**1.7**	**4.0**	**10.5**	**15.3**
Fine silt	Percent	NE	NE	**4.4**	**1.8**	**1.2**	1.0 U	**1.5**	**1.8**	**3.0**	**3.6**	**8.6**	**12.7**
Very fine silt	Percent	NE	NE	**4.4**	**1.9**	**1.1**	1.0 U	**1.2**	**1.6**	**2.1**	**4.0**	**8.1**	**10.9**
Coarse clay	Percent	NE	NE	**3.9**	**1.7**	**0.9**	1.0 U	**1.0**	**0.8**	**1.6**	**3.1**	**5.1**	**7.7**
Medium clay	Percent	NE	NE	**2.5**	**1.5**	**0.9**	1.0 U	**0.8**	**0.7**	**1.6**	**3.3**	**5.3**	**6.9**
Particle/Grain size, Phi Scale >10	Percent	NE	NE	**6.7**	**3.2**	**1.9**	1.0 U	**1.5**	**0.9**	**3.7**	**6.4**	**12.0**	**17.9**
Total Fines	Percent	NE	NE	**25.6**	**14.5**	**7.8**	**1.0**	**13.7**	**9.8**	**18.8**	**34.2**	**56.3**	**91.5**

			Sample Location	SSI-SS-06	SSI-SC-06	SSI-SC-06	SSI-SC-06	SSI-SS-07	SSI-SC-07	SSI-SC-07	SSI-SC-07	SSI-SS-08	SSI-SS-09
			Sample ID:	SSI-SS-06_0-0.39	SSI-SC-06_0-2	SSI-SC-06_2-4	SSI-SC-06_4-6	SSI-SS-07_0-0.39	SSI-SC-07_0-2	SSI-SC-07_2-4	SSI-SC-07_4-6	SSI-SS-08_0-0.39	SSI-SS-09_0-0.39
			Date Sampled:	10/12/2015	10/13/2015	10/13/2015	10/13/2015	10/12/2015	10/13/2015	10/13/2015	10/13/2015	10/12/2015	10/12/2015
			Depth Interval (ft bml):	0-0.39 ft	0-2 ft	2-4 ft	4-6 ft	0-0.39 ft	0-2 ft	2-4 ft	4-6 ft	0-0.39 ft	0-0.39 ft
			Elevation at Top of Sample (ft NADV88):	-5.5	-2.8	-4.8	-6.8	-3.7	-3.3	-5.3	-7.3	-22.0	-16.9
			Collected By	GeoEngineers									
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**										
Total Organic Carbon	Percent	0.5	3.5	**3.10**	**1.18**	**4.35**	**7.44**	**0.955**	**0.904**	**27.7**	**33.8**	**2.64**	**3.15**
Total Solids	Percent	NE	NE	**61.17**	**71.54**	**53.86**	**62.62**	**73.89**	**73.69**	**28.56**	**37.67**	**31.75**	**37.43**
LPAHs (OC-Normalized)													
Sum of LPAHs	mg/kg OC	370	780	**200**	**200**	320	90	**27**	**58**	83	56	–	–
2-Methylnaphthalene	mg/kg OC	38	64	**21**	**20**	25	7.0	**3.4**	**3.0**	0.43	0.77	–	–
Acenaphthene	mg/kg OC	16	57	**7.7**	**14**	20	5.8	**1.7**	**4.5**	13	8.0	–	–
Acenaphthylene	mg/kg OC	66	66	**8.1**	**7.8**	10	4.3	**1.3**	**2.4**	0.27	0.28	–	–
Anthracene	mg/kg OC	220	1,200	**12**	**20**	20	5.6	**2.4**	**8.0**	10	9.0	–	–
Fluorene	mg/kg OC	23	79	**8.4**	**19**	30	7.9	**2.3**	**6.5**	22	10	–	–
Naphthalene	mg/kg OC	99	170	**74**	**72**	140	43	**12**	**18**	1.7	3.8	–	–
Phenanthrene	mg/kg OC	100	480	**52**	**73**	83	30	**8**	**19**	35	23	–	–
LPAHs (Dry Weight)													
Sum of LPAHs	µg/kg	5,200	5,200	5,000	2,400	**14,000**	**6,700**	260 J	520	**23,000**	**19,000**	–	–
2-Methylnaphthalene	µg/kg	670	670	640	200	**1,100**	**500**	32	27	**120**	**260**	–	–
Acenaphthene	µg/kg	500	500	240	170	**1,000**	**430**	16 J	41	**3,600**	**2,700**	–	–
Acenaphthylene	µg/kg	1,300	1,300	250	92	**600**	**320**	12 J	22	**76**	**95**	–	–
Anthracene	µg/kg	960	960	360	240	**1,000**	**420**	23	70	**3,000**	**3,000**	–	–
Fluorene	µg/kg	540	540	260	230	**1,300**	**590**	22	59	**6,100**	**4,000**	–	–
Naphthalene	µg/kg	2,100	2,100	2,300	850	**6,300**	**3,200**	110	160	**470**	**1,300**	–	–
Phenanthrene	µg/kg	1,500	1,500	1,600	860	**3,600**	**2,000**	76	170	**9,600**	**7,900**	–	–
HPAHs (OC-Normalized)													
Sum of HPAHs	mg/kg OC	960	5,300	**170**	**270**	260	72	**43**	**116**	51.1	60	–	–
Benzo(a)anthracene	mg/kg OC	110	270	**12**	**19**	16	4.2	**3.2**	**7.6**	4.3	4.1	–	**1.7**
Benzo(a)pyrene	mg/kg OC	99	210	**10**	**19**	13	3.0	**2.7**	**8.7**	1.2	1.2	–	**1.4**
Benzofluoranthenes (Total)	mg/kg OC	230	450	**20**	**32**	20	6.2	**6.2**	**19**	3.0	3.0	–	**3.1**
Benzo(g,h,i)perylene	mg/kg OC	31	78	**7.1**	**14**	9.0	2.3	**2**	**5.1**	0.27	0.33	–	–
Chrysene	mg/kg OC	110	460	**16**	**24**	20	5.8	**4.8**	**11**	5.4	4.7	–	**2.4**
Dibenzo(a,h)anthracene	mg/kg OC	12	33	**1.5**	**2.8**	1.7	0.35	**0.42**	**1.3**	0.17	0.12	–	**0.3**
Fluoranthene	mg/kg OC	160	1,200	**45**	**81**	94	26	**9**	**29**	24	28	–	–
Indeno(1,2,3-c,d)pyrene	mg/kg OC	34	88	**6.1**	**10**	6.7	1.5	**1.5**	**4**	0.3	0.33	–	**0.92**
Pyrene	mg/kg OC	1,000	1,400	**48**	**72**	76	23	**13**	**30**	13	18	–	–

Sample Location				SSI-SS-06	SSI-SC-06	SSI-SC-06	SSI-SC-06	SSI-SS-07	SSI-SC-07	SSI-SC-07	SSI-SC-07	SSI-SS-08	SSI-SS-09
Sample ID:				SSI-SS-06_0-0.39	SSI-SC-06_0-2	SSI-SC-06_2-4	SSI-SC-06_4-6	SSI-SS-07_0-0.39	SSI-SC-07_0-2	SSI-SC-07_2-4	SSI-SC-07_4-6	SSI-SS-08_0-0.39	SSI-SS-09_0-0.39
Date Sampled:				10/12/2015	10/13/2015	10/13/2015	10/13/2015	10/12/2015	10/13/2015	10/13/2015	10/13/2015	10/12/2015	10/12/2015
Depth Interval (ft bml):				0-0.39 ft	0-2 ft	2-4 ft	4-6 ft	0-0.39 ft	0-2 ft	2-4 ft	4-6 ft	0-0.39 ft	0-0.39 ft
Elevation at Top of Sample (ft NADV88):				-5.5	-2.8	-4.8	-6.8	-3.7	-3.3	-5.3	-7.3	-22.0	-16.9
Collected By				GeoEngineers									
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**										
HPAHs (Dry Weight)													
Sum of HPAHs	µg/kg	12,000	17,000	5,200	3,200	**11,000**	**5,300**	410	1,100	**14,000**	**20,000**	–	–
Benzo(a)anthracene	µg/kg	1,300	1,600	370	220	**680**	**310**	31	69	**1,200**	**1,400**	–	55 J
Benzo(a)pyrene	µg/kg	1,600	1,600	320	230	**550**	**220**	26	79	**320**	**390**	–	44 J
Benzofluoranthenes (Total)	µg/kg	3,200	3,600	610	380	**1,000**	**460**	59	170	**820**	**1,000**	–	98 J
Benzo(g,h,i)perylene	µg/kg	670	720	220	160	**400**	**170**	19	46	**74**	**110**	–	–
Chrysene	µg/kg	1,400	2,800	490	280	**900**	**430**	46	99	**1,500**	**1,600**	–	76 J
Dibenzo(a,h)anthracene	µg/kg	230	230	47	33	**76**	**26**	4.0 J	12 J	**47**	**39**	–	10 J
Fluoranthene	µg/kg	1,700	2,500	1,400	950	**4,100**	**1,900**	90	260	**6,600**	**9,400**	–	–
Indeno(1,2,3-c,d)pyrene	µg/kg	600	690	190	120	**290**	**110**	14 J	40	**90**	**110**	–	29 J
Pyrene	µg/kg	2,600	3,300	1,500	850	**3,300**	**1,700**	120	270	**3,500**	**6,100**	–	–
Petroleum Hydrocarbons (Dry Weight)													
Diesel Fuel	mg/kg	260	260	–	–	–	–	–	–	–	–	–	–
Motor Oil	mg/kg	260	260	–	–	–	–	–	–	–	–	–	–
Petroleum Hydrocarbons (Total)	mg/kg	260	260	–	–	–	–	–	–	–	–	–	–
Chlorinated Hydrocarbons (OC-Normalized)													
1,2,4-Trichlorobenzene	mg/kg OC	0.81	1.8	0.61 U	–	–	–	2 U	–	–	–	–	–
1,2-Dichlorobenzene (o-Dichlorobenzene)	mg/kg OC	2.3	2.3	0.61 U	–	–	–	2 U	–	–	–	–	–
1,3-Dichlorobenzene (m-Dichlorobenzene)	mg/kg OC	NE	NE	0.61 U	–	–	–	2 U	–	–	–	–	–
1,4-Dichlorobenzene (p-Dichlorobenzene)	mg/kg OC	3.1	9	**1.2**	–	–	–	2 U	–	–	–	–	–
Hexachlorobenzene	mg/kg OC	0.38	2.3	**0.11**	–	–	–	0.5 U	–	–	–	–	–
Chlorinated Hydrocarbons (Dry Weight)													
1,2,4-Trichlorobenzene	µg/kg	31	51	19 U	–	–	–	19 U	–	–	–	–	–
1,2-Dichlorobenzene (o-Dichlorobenzene)	µg/kg	35	50	19 U	–	–	–	19 U	–	–	–	–	–
1,3-Dichlorobenzene (m-Dichlorobenzene)	µg/kg	NE	NE	19 U	–	–	–	19 U	–	–	–	–	–
1,4-Dichlorobenzene (p-Dichlorobenzene)	µg/kg	110	110	**37**	–	–	–	19 U	–	–	–	–	–
Hexachlorobenzene	µg/kg	22	70	**3.4 J**	–	–	–	4.8 U	–	–	–	–	–
Phthalates (OC-Normalized)													
Bis(2-Ethylhexyl) Phthalate	mg/kg OC	47	78	**7.4**	–	–	–	**10**	–	–	–	–	–
Butyl benzyl Phthalate	mg/kg OC	4.9	64	0.61 U	–	–	–	2 U	–	–	–	–	–
Dibutyl Phthalate	mg/kg OC	220	1,700	0.61 U	–	–	–	2 U	–	–	–	–	–
Diethyl Phthalate	mg/kg OC	61	110	**1**	–	–	–	**3.4**	–	–	–	–	–
Dimethyl Phthalate	mg/kg OC	53	53	0.61 U	–	–	–	**28**	–	–	–	–	–
Di-n-Octyl Phthalate	mg/kg OC	58	4,500	0.61 U	–	–	–	2 U	–	–	–	–	–
Phthalates (Dry Weight)													
Bis(2-Ethylhexyl) Phthalate	µg/kg	1,300	1,900	**230**	–	–	–	**96**	–	–	–	–	–
Butyl Benzyl Phthalate	µg/kg	63	900	19 U	–	–	–	19 U	–	–	–	–	–
Dibutyl Phthalate	µg/kg	1,400	1,400	19 U	–	–	–	19 U	–	–	–	–	–
Diethyl Phthalate	µg/kg	200	200	30 U	–	–	–	32 U	–	–	–	–	–
Dimethyl Phthalate	µg/kg	71	160	19 U	–	–	–	**270**	–	–	–	–	–
Di-n-Octyl Phthalate	µg/kg	6,200	6,200	19 U	–	–	–	19 U	–	–	–	–	–

			Sample Location	SSI-SS-06	SSI-SC-06	SSI-SC-06	SSI-SC-06	SSI-SS-07	SSI-SC-07	SSI-SC-07	SSI-SC-07	SSI-SS-08	SSI-SS-09
			Sample ID:	SSI-SS-06_0-0.39	SSI-SC-06_0-2	SSI-SC-06_2-4	SSI-SC-06_4-6	SSI-SS-07_0-0.39	SSI-SC-07_0-2	SSI-SC-07_2-4	SSI-SC-07_4-6	SSI-SS-08_0-0.39	SSI-SS-09_0-0.39
			Date Sampled:	10/12/2015	10/13/2015	10/13/2015	10/13/2015	10/12/2015	10/13/2015	10/13/2015	10/13/2015	10/12/2015	10/12/2015
			Depth Interval (ft bml):	0-0.39 ft	0-2 ft	2-4 ft	4-6 ft	0-0.39 ft	0-2 ft	2-4 ft	4-6 ft	0-0.39 ft	0-0.39 ft
			Elevation at Top of Sample (ft NADV88):	-5.5	-2.8	-4.8	-6.8	-3.7	-3.3	-5.3	-7.3	-22.0	-16.9
			Collected By	GeoEngineers									
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**										
Phenols (Dry Weight)													
2,4-Dimethylphenol	µg/kg	29	29	**19 J**	–	–	–	24 U	–	–	–	–	–
2-Methylphenol (o-Cresol)	µg/kg	63	63	**24**	–	–	–	19 U	–	–	–	–	–
4-Methylphenol (p-Cresol)	µg/kg	670	670	**450**	–	–	–	**42**	–	–	–	–	–
Pentachlorophenol	µg/kg	360	690	**360**	**150**	**250**	**52**	95 U	**18**	**60**	–	–	85 U
Phenol	µg/kg	420	1,200	**170**	–	–	–	**170**	–	–	–	–	–
Miscellaneous Extractables (OC-Normalized)													
Dibenzofuran	mg/kg OC	15	58	**10**	–	–	–	**2.4**	–	–	–	–	–
Hexachlorobutadiene	mg/kg OC	3.9	6.2	0.15 U	–	–	–	0.5 U	–	–	–	–	–
n-Nitrosodiphenylamine (as diphenylamine)	mg/kg OC	11	11	0.61 U	–	–	–	2 U	–	–	–	–	–
Miscellaneous Extractables (Dry Weight)													
Dibenzofuran	µg/kg	540	540	**300**	–	–	–	**23**	–	–	–	–	–
Hexachlorobutadiene	µg/kg	11	120	4.8 U	–	–	–	4.8 U	–	–	–	–	–
n-Nitrosodiphenylamine (as diphenylamine)	µg/kg	28	40	19 U	–	–	–	19 U	–	–	–	–	–
Benzoic Acid	µg/kg	650	650	**390**	–	–	–	**110 J**	–	–	–	–	–
Benzyl Alcohol	µg/kg	57	730	**37 J**	–	–	–	19 U	–	–	–	–	–
Conventionals													
Gravel	Percent	NE	NE	**1.0**	**1.6**	**4.7**	**0.5**	**4.4**	**3.3**	**72.0**	**36.2**	**0.6**	**0.5**
Very coarse sand	Percent	NE	NE	**1.1**	**2.4**	**4.1**	**1.4**	**2.7**	**1.0**	**3.5**	**5.5**	**3.6**	**1.0**
Coarse sand	Percent	NE	NE	**2.0**	**4.0**	**5.3**	**2.2**	**2.5**	**1.5**	**3.8**	**6.2**	**2.9**	**1.5**
Medium sand	Percent	NE	NE	**3.8**	**8.8**	**6.1**	**3.6**	**21.1**	**8.8**	**4.4**	**6.9**	**1.6**	**1.3**
Fine sand	Percent	NE	NE	**20.5**	**22.9**	**6.4**	**11.4**	**37.5**	**28.2**	**3.6**	**5.9**	**1.5**	**1.2**
Very fine sand	Percent	NE	NE	**43.6**	**23.4**	**10.0**	**26.6**	**19.8**	**32.3**	**4.4**	**12.0**	**2.4**	**1.2**
Coarse silt	Percent	NE	NE	**12.7**	**10.5**	**11.9**	**16.5**	**3.7**	**11.5**	8.3 U	**9.9**	**4.0**	**2.7**
Medium silt	Percent	NE	NE	**3.1**	**6.1**	**11.3**	**9.8**	**1.5**	**3.3**	8.3 U	**4.3**	**31.0**	**22.9**
Fine silt	Percent	NE	NE	**3.2**	**4.6**	**9.7**	**6.1**	**2.0**	**2.0**	8.3 U	**2.5**	**22.6**	**28.1**
Very fine silt	Percent	NE	NE	**1.9**	**3.8**	**7.3**	**5.6**	**1.0**	**1.8**	8.3 U	**2.5**	**6.3**	**10.1**
Coarse clay	Percent	NE	NE	**1.6**	**2.9**	**6.7**	**5.1**	**0.8**	**1.6**	8.3 U	**1.8**	**4.9**	**6.5**
Medium clay	Percent	NE	NE	**1.4**	**2.7**	**5.6**	**3.3**	**0.9**	**1.4**	8.3 U	**1.5**	**5.1**	**7.9**
Particle/Grain size, Phi Scale >10	Percent	NE	NE	**4.2**	**6.3**	**11.1**	**7.9**	**2.0**	**3.3**	8.3 U	**4.8**	**13.7**	**15.1**
Total Fines	Percent	NE	NE	**28.0**	**37.0**	**63.5**	**54.2**	**12.0**	**24.9**	**8.3**	**27.3**	**87.6**	**93.4**

			Sample Location	**SSI-SS-10**	**SSI-SS-11**	**SSI-SS-12**	**SSI-SS-14**	**SSI-SS-15**	**SSI-SS-16**	**CL-SG-1**	**CL-SG-3**	**CL-SG-4**
			Sample ID:	**SSI-SS-10_0-0.39**	**SSI-SS-11_0-0.39**	**SSI-SS-12_0-0.39**	**SSI-SS-14_0-0.39**	**SSI-SS-15_0-0.39**	**SSI-SS-16_0-0.39**	**CL-SG-1**	**CL-SG-3**	**CL-SG-4**
			Date Sampled:	**10/12/2015**	**10/12/2015**	**10/12/2015**	**10/13/2015**	**10/13/2015**	**10/13/2015**	**6/10/2015**	**6/10/2015**	**6/10/2015**
			Depth Interval (ft bml):	**0-0.39 ft**	**0-0.39 ft**	**0-0.39 ft**	**0-0.39 ft**	**0-0.39 ft**	**0-0.39 ft**	**0-0.33 ft**	**0-0.33 ft**	**0-0.33 ft**
			Elevation at Top of Sample (ft NADV88):	**-23.5**	**-22.7**	**-25.1**	**-21.4**	**-23.7**	**-25.6**	**-9.3**	**-16.9**	**-16.8**
			Collected By	**GeoEngineers**						**Landau**		
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**									
Total Organic Carbon	Percent	0.5	3.5	**3.09**	**1.84**	**2.12**	**2.46**	**2.00**	**2.05**	--	--	--
Total Solids	Percent	NE	NE	**29.13**	**40.90**	**42.77**	**32.27**	**42.12**	**30.63**	**41.69**	--	--
LPAHs (OC-Normalized)												
Sum of LPAHs	mg/kg OC	370	780	–	–	–	–	–	–	–	–	–
2-Methylnaphthalene	mg/kg OC	38	64	–	–	–	–	–	–	–	–	–
Acenaphthene	mg/kg OC	16	57	–	–	–	–	–	–	–	–	–
Acenaphthylene	mg/kg OC	66	66	–	–	–	–	–	–	–	–	–
Anthracene	mg/kg OC	220	1,200	–	–	–	–	–	–	–	–	–
Fluorene	mg/kg OC	23	79	–	–	–	–	–	–	–	–	–
Naphthalene	mg/kg OC	99	170	–	–	–	–	–	–	–	–	–
Phenanthrene	mg/kg OC	100	480	–	–	–	–	–	–	–	–	–
LPAHs (Dry Weight)												
Sum of LPAHs	µg/kg	5,200	5,200	–	–	–	–	–	–	–	–	–
2-Methylnaphthalene	µg/kg	670	670	–	–	–	–	–	–	–	–	–
Acenaphthene	µg/kg	500	500	–	–	–	–	–	–	–	–	–
Acenaphthylene	µg/kg	1,300	1,300	–	–	–	–	–	–	–	–	–
Anthracene	µg/kg	960	960	–	–	–	–	–	–	–	–	–
Fluorene	µg/kg	540	540	–	–	–	–	–	–	–	–	–
Naphthalene	µg/kg	2,100	2,100	–	–	–	–	–	–	–	–	–
Phenanthrene	µg/kg	1,500	1,500	–	–	–	–	–	–	–	–	–
HPAHs (OC-Normalized)												
Sum of HPAHs	mg/kg OC	960	5,300	–	–	–	–	–	–	–	–	–
Benzo(a)anthracene	mg/kg OC	110	270	**0.94**	**2**	**1.5**	–	–	–	–	–	–
Benzo(a)pyrene	mg/kg OC	99	210	**0.91**	**1.9**	**1.5**	–	–	–	–	–	–
Benzofluoranthenes (Total)	mg/kg OC	230	450	**2.1**	**4**	**3.1**	–	–	–	–	–	–
Benzo(g,h,i)perylene	mg/kg OC	31	78	–	–	–	–	–	–	–	–	–
Chrysene	mg/kg OC	110	460	**1.5**	**2.9**	**2.1**	–	–	–	–	–	–
Dibenzo(a,h)anthracene	mg/kg OC	12	33	0.45 U	**0.41**	**0.39**	–	–	–	–	–	–
Fluoranthene	mg/kg OC	160	1,200	–	–	–	–	–	–	–	–	–
Indeno(1,2,3-c,d)pyrene	mg/kg OC	34	88	**0.58**	**1.3**	**0.99**	–	–	–	–	–	–
Pyrene	mg/kg OC	1,000	1,400	–	–	–	–	–	–	–	–	–

			Sample Location	SSI-SS-10	SSI-SS-11	SSI-SS-12	SSI-SS-14	SSI-SS-15	SSI-SS-16	CL-SG-1	CL-SG-3	CL-SG-4
			Sample ID:	SSI-SS-10_0-0.39	SSI-SS-11_0-0.39	SSI-SS-12_0-0.39	SSI-SS-14_0-0.39	SSI-SS-15_0-0.39	SSI-SS-16_0-0.39	CL-SG-1	CL-SG-3	CL-SG-4
			Date Sampled:	10/12/2015	10/12/2015	10/12/2015	10/13/2015	10/13/2015	10/13/2015	6/10/2015	6/10/2015	6/10/2015
			Depth Interval (ft bml):	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.33 ft	0-0.33 ft	0-0.33 ft
			Elevation at Top of Sample (ft NADV88):	-23.5	-22.7	-25.1	-21.4	-23.7	-25.6	-9.3	-16.9	-16.8
			Collected By	GeoEngineers						Landau		
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**									
HPAHs (Dry Weight)												
Sum of HPAHs	µg/kg	12,000	17,000	–	–	–	–	–	–	–	–	–
Benzo(a)anthracene	µg/kg	1,300	1,600	29	37	32	–	–	–	–	–	–
Benzo(a)pyrene	µg/kg	1,600	1,600	28	35	31	–	–	–	–	–	–
Benzofluoranthenes (Total)	µg/kg	3,200	3,600	64	74	66	–	–	–	–	–	–
Benzo(g,h,i)perylene	µg/kg	670	720	–	–	–	–	–	–	–	–	–
Chrysene	µg/kg	1,400	2,800	45	53	44	–	–	–	–	–	–
Dibenzo(a,h)anthracene	µg/kg	230	230	14 U	7.5 J	8.2 J	–	–	–	–	–	–
Fluoranthene	µg/kg	1,700	2,500	–	–	–	–	–	–	–	–	–
Indeno(1,2,3-c,d)pyrene	µg/kg	600	690	18	24	21	–	–	–	–	–	–
Pyrene	µg/kg	2,600	3,300	–	–	–	–	–	–	–	–	–
Petroleum Hydrocarbons (Dry Weight)												
Diesel Fuel	mg/kg	260	260	–	–	–	–	–	–	–	–	–
Motor Oil	mg/kg	260	260	–	–	–	–	–	–	–	–	–
Petroleum Hydrocarbons (Total)	mg/kg	260	260	–	–	–	–	–	–	–	–	–
Chlorinated Hydrocarbons (OC-Normalized)												
1,2,4-Trichlorobenzene	mg/kg OC	0.81	1.8	–	–	–	–	–	–	–	–	–
1,2-Dichlorobenzene (o-Dichlorobenzene)	mg/kg OC	2.3	2.3	–	–	–	–	–	–	–	–	–
1,3-Dichlorobenzene (m-Dichlorobenzene)	mg/kg OC	NE	NE	–	–	–	–	–	–	–	–	–
1,4-Dichlorobenzene (p-Dichlorobenzene)	mg/kg OC	3.1	9	–	–	–	–	–	–	–	–	–
Hexachlorobenzene	mg/kg OC	0.38	2.3	–	–	–	–	–	–	–	–	–
Chlorinated Hydrocarbons (Dry Weight)												
1,2,4-Trichlorobenzene	µg/kg	31	51	–	–	–	–	–	–	–	–	–
1,2-Dichlorobenzene (o-Dichlorobenzene)	µg/kg	35	50	–	–	–	–	–	–	–	–	–
1,3-Dichlorobenzene (m-Dichlorobenzene)	µg/kg	NE	NE	–	–	–	–	–	–	–	–	–
1,4-Dichlorobenzene (p-Dichlorobenzene)	µg/kg	110	110	–	–	–	–	–	–	–	–	–
Hexachlorobenzene	µg/kg	22	70	–	–	–	–	–	–	–	–	–
Phthalates (OC-Normalized)												
Bis(2-Ethylhexyl) Phthalate	mg/kg OC	47	78	–	–	–	–	–	–	–	–	–
Butyl benzyl Phthalate	mg/kg OC	4.9	64	–	–	–	–	–	–	–	–	–
Dibutyl Phthalate	mg/kg OC	220	1,700	–	–	–	–	–	–	–	–	–
Diethyl Phthalate	mg/kg OC	61	110	–	–	–	–	–	–	–	–	–
Dimethyl Phthalate	mg/kg OC	53	53	–	–	–	–	–	–	–	–	–
Di-n-Octyl Phthalate	mg/kg OC	58	4,500	–	–	–	–	–	–	–	–	–
Phthalates (Dry Weight)												
Bis(2-Ethylhexyl) Phthalate	µg/kg	1,300	1,900	–	–	–	–	–	–	–	–	–
Butyl Benzyl Phthalate	µg/kg	63	900	–	–	–	–	–	–	–	–	–
Dibutyl Phthalate	µg/kg	1,400	1,400	–	–	–	–	–	–	–	–	–
Diethyl Phthalate	µg/kg	200	200	–	–	–	–	–	–	–	–	–
Dimethyl Phthalate	µg/kg	71	160	–	–	–	–	–	–	–	–	–
Di-n-Octyl Phthalate	µg/kg	6,200	6,200	–	–	–	–	–	–	–	–	–

			Sample Location	SSI-SS-10	SSI-SS-11	SSI-SS-12	SSI-SS-14	SSI-SS-15	SSI-SS-16	CL-SG-1	CL-SG-3	CL-SG-4
			Sample ID:	SSI-SS-10_0-0.39	SSI-SS-11_0-0.39	SSI-SS-12_0-0.39	SSI-SS-14_0-0.39	SSI-SS-15_0-0.39	SSI-SS-16_0-0.39	CL-SG-1	CL-SG-3	CL-SG-4
			Date Sampled:	10/12/2015	10/12/2015	10/12/2015	10/13/2015	10/13/2015	10/13/2015	6/10/2015	6/10/2015	6/10/2015
			Depth Interval (ft bml):	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.33 ft	0-0.33 ft	0-0.33 ft
			Elevation at Top of Sample (ft NADV88):	-23.5	-22.7	-25.1	-21.4	-23.7	-25.6	-9.3	-16.9	-16.8
			Collected By	GeoEngineers						Landau		
Parameter	**Unit(s)**	**SCO/LAET[1]**	**CSL/2LAET[1]**									
Phenols (Dry Weight)												
2,4-Dimethylphenol	µg/kg	29	29	–	–	–	–	–	–	–	–	–
2-Methylphenol (o-Cresol)	µg/kg	63	63	–	–	–	–	–	–	–	–	–
4-Methylphenol (p-Cresol)	µg/kg	670	670	–	–	–	–	–	–	–	–	–
Pentachlorophenol	µg/kg	360	690	–	–	–	–	–	–	–	–	–
Phenol	µg/kg	420	1,200	–	–	–	–	–	–	–	–	–
Miscellaneous Extractables (OC-Normalized)												
Dibenzofuran	mg/kg OC	15	58	–	–	–	–	–	–	–	–	–
Hexachlorobutadiene	mg/kg OC	3.9	6.2	–	–	–	–	–	–	–	–	–
n-Nitrosodiphenylamine (as diphenylamine)	mg/kg OC	11	11	–	–	–	–	–	–	–	–	–
Miscellaneous Extractables (Dry Weight)												
Dibenzofuran	µg/kg	540	540	–	–	–	–	–	–	=	=	=
Hexachlorobutadiene	µg/kg	11	120	–	–	–	–	–	–	=	=	=
n-Nitrosodiphenylamine (as diphenylamine)	µg/kg	28	40	–	–	–	–	–	–	=	=	=
Benzoic Acid	µg/kg	650	650	–	–	–	–	–	–	=	=	=
Benzyl Alcohol	µg/kg	57	730	–	–	–	–	–	–	=	=	=
Conventionals												
Gravel	Percent	NE	NE	**0.7**	**1.1**	**1.2**	**0.4**	**1.7**	**0.6**	**4.5**	**0.4**	--
Very coarse sand	Percent	NE	NE	**4.8**	**1.5**	**0.4**	**2.9**	**0.7**	**0.3**	**5.1**	**1.0**	--
Coarse sand	Percent	NE	NE	**3.5**	**1.6**	**1.4**	**3.0**	**1.3**	**1.8**	**5.7**	**1.8**	--
Medium sand	Percent	NE	NE	**1.5**	**1.2**	**1.0**	**1.4**	**0.8**	**1.4**	**5.7**	**1.5**	--
Fine sand	Percent	NE	NE	**1.1**	**0.8**	**0.9**	**1.0**	**0.7**	**1.0**	**12.6**	**1.2**	--
Very fine sand	Percent	NE	NE	**0.9**	**0.8**	**0.9**	**1.1**	**0.9**	**1.0**	**16.7**	**1.6**	--
Coarse silt	Percent	NE	NE	**1.9**	**2.9**	**1.5**	**4.8**	**10.8**	**4.9**	**3.5**	**2.6**	--
Medium silt	Percent	NE	NE	**34.8**	**27.1**	**28.2**	**44.4**	**14.9**	**41.7**	**6.8**	**10.3**	--
Fine silt	Percent	NE	NE	**19.4**	**26.8**	**26.8**	**15.8**	**26.9**	**20.1**	**8.6**	**21.0**	--
Very fine silt	Percent	NE	NE	**7.9**	**9.1**	**10.1**	**5.8**	**11.0**	**6.6**	**7.9**	**16.5**	--
Coarse clay	Percent	NE	NE	**4.8**	**5.7**	**6.2**	**3.5**	**8.6**	**4.0**	**6.8**	**12.6**	--
Medium clay	Percent	NE	NE	**5.5**	**6.8**	**7.1**	**4.6**	**6.2**	**4.0**	**5.5**	**10.4**	--
Particle/Grain size, Phi Scale >10	Percent	NE	NE	**13.4**	**14.5**	**14.3**	**11.4**	**15.6**	**12.5**	**10.5**	**19.0**	--
Total Fines	Percent	NE	NE	**87.5**	**92.9**	**94.2**	**90.1**	**94.0**	**93.7**	**49.8**	**92.4**	--

Notes:

[1] The screening levels provided are the Sediment Management Standards (SMS) Sediment Cleanup Objectives (SCO) and Cleanup Screening Levels (CSL) and the Lowest Apparent Effects Threshold (LAET) and 2nd Lowest Apparent Effects Threshold (2LAET) values except for petroleum hydrocarbons. SMS criteria have not been established for petroleum hydrocarbons; the screening level is based on bioassay tests and chemical analyses performed as part of the RG Haley remedial investigation (GeoEngineers 2016). LAET and 2LAET values are provided for comparison to dry weight concentrations for LPAHs, HPAHs, chlorinated organics, phthalates, and miscellaneous extractables when the total organic carbon content for a specific sample is outside of the range (0.5 percent to 3.5 percent) recommended for TOC normalization.

[2] Preliminary cleanup levels (PCULs) are those identified in the Feasibility Study and are provided for reference.

Total organic carbon (TOC) concentration is less than 0.5 percent or greater than 3.5 percent.

Do not evaluate screening level exceedances on this basis.

Value is greater than SCO or LAET.

Value is greater than CSL or 2LAET.

Detection limit is greater than screening level.

Bold indicates that the analyte was detected.

bml = below mudline

mg/kg = milligrams per kilogram

mg/kg OC = milligrams per kilogram organic carbon

ng/kg = nanograms per kilogram

µg/kg = micrograms per kilogram

J = Estimated value

U = Not detected at or above identified detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

NJ = The analyte has been “tentatively identified” and the associated numerical value is the estimated concentration in the sample.

-- = Sample was not submitted for the identified chemical analysis

NE = A criterion has not been established for the identified analyte

SMS = Sediment Management Standards

SCO = SMS Sediment Cleanup Objective (Chapter 173-204-320)

CSL = SMS Cleanup Screening Level (Chapter 173-204-520)

LAET = Lowest Apparent Effects Threshold (LAET). The LAET (expressed on a dry-weight basis) is analogous to the SMS SCO value for samples and is used as the sediment screening level where the sample-specific total organic carbon concentration is less than 0.5 percent or greater than 3.5 percent.

2LAET = Second Lowest Apparent Effects Threshold (2LAET). The 2LAET (expressed on a dry-weight basis) is analogous to the SMS CSL value and is used as the screening level for samples where the total organic carbon concentration is less than 0.5 percent or greater than 3.5 percent.

LPAH = Low molecular weight polycyclic aromatic hydrocarbons (PAHs)

HPAH = High molecular weight polycyclic aromatic hydrocarbons (PAHs)

Total LPAH is the sum of detected concentrations of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene and anthracene.

Total HPAH is the sum of detected concentrations of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b+j+k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3-c-d)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene.

The totals for LPAH and HPAH are the sum of all detected results. If no individual LPAHs or HPAHs were detected, the highest detection limit value is reported as the total.

Table 4

2013-2016 Sediment Analytical Results Compared to Bioaccumulative Screening Levels for Protection of Human Health, Fish and Wildlife

R.G Haley Site

Bellingham, Washington

Sample Location			PSB-01	PSB-02	PSB-02	PSB-03	PSB-03	PSB-04	SSI-SS-01	SSI-SC-01	SSI-SC-01	SSI-SS-02	SSI-SS-03
Sample ID:			PSB-SC-01-0-1	PSB-SC-02-0-1	PSB-SC-02-1-2	PSB-SC-03-0-1	PSB-SC-03-1-2	PSB-SC-04-0-1	SSI-SS-01_0-0.39	SSI-SC-01_0-2	SSI-SC-01_2-4	SSI-SS-02_0-0.39	SSI-SS-03_0-0.39
Date Sampled:			2/18/2016	2/18/2016	2/18/2016	2/18/2016	2/18/2016	2/18/2016	10/15/2015	10/14/2015	10/14/2015	10/15/2015	10/15/2015
Depth Interval (ft bml):			0-1 ft	0-1 ft	1-2 ft	0-1 ft	1-2 ft	0-1 ft	0-0.39 ft	0-2 ft	2-4 ft	0-0.39 ft	0-0.39 ft
Elevation at Top of Sample (ft NADV88):			4.3	1.3	0.3	6.1	5.1	4.7	-5.2	-5.9	-7.9	-0.5	-8.3
Collected By			GeoEngineers										
Parameter	**Unit(s)**	**PCULs[1]**											
Dioxin/Furans													
2,3,7,8-TCDD	ng/kg	NE	**0.449 J**	**0.254 J**	**0.374 J**	**0.249 J**	**0.930 J**	**2.11**	–	**3.19**	**3.38**	**0.652 J**	–
2,3,7,8-TCDF	ng/kg	NE	**0.496 J**	**0.348 J**	**0.370 J**	**0.281 J**	**0.919 J**	**0.598 J**	–	**5.02**	**4.80**	**0.921 J**	–
1,2,3,7,8-PeCDD	ng/kg	NE	**2.06 J**	**1.51 J**	**4.71 J**	**0.947 J**	**2.53 J**	**4.11 J**	–	**12.7**	**13.9**	**2.60 J**	–
1,2,3,7,8-PeCDF	ng/kg	NE	**1.28 J**	**0.954 J**	**1.51 J**	**0.592 J**	**3.22 J**	**1.35 J**	–	**6.68**	**6.21**	**1.26 J**	–
2,3,4,7,8-PeCDF	ng/kg	NE	**2.07 J**	**1.89 J**	**1.70 J**	**1.19 J**	**3.11 J**	**2.60 J**	–	**5.96**	**5.56**	**1.24 J**	–
1,2,3,4,7,8-HxCDD	ng/kg	NE	**5.74**	**3.38 J**	**6.92**	**2.22 J**	**6.92**	**7.33**	–	**20.8**	**29.2**	**6.49**	–
1,2,3,4,7,8-HxCDF	ng/kg	NE	**11.7**	**5.16**	**5.17**	**3.25 J**	**21.1**	**7.85**	–	**35.5**	**28.5**	**5.37**	–
1,2,3,6,7,8-HxCDD	ng/kg	NE	**35.1**	**15.0**	**48.9**	**11.1**	**64.3**	**23.1**	–	**126**	**91.6**	**17.8**	–
1,2,3,6,7,8-HxCDF	ng/kg	NE	**3.74 J**	**1.75 J**	**2.33 J**	**1.25 J**	**5.62**	**2.97 J**	–	**10.5**	**9.87**	**2.21 J**	–
1,2,3,7,8,9-HxCDD	ng/kg	NE	**9.99**	**5.01**	**9.76**	**4.29 J**	**13.0**	**12.2**	–	**43.4**	**45.6**	**9.40**	–
1,2,3,7,8,9-HxCDF	ng/kg	NE	**3.63 J**	**1.96 J**	**3.12 J**	**1.98 J**	**7.86**	**2.71 J**	–	**9.45**	**9.17**	**1.77 J**	–
2,3,4,6,7,8-HxCDF	ng/kg	NE	**5.62**	**2.67 J**	**3.43 J**	**2.02 J**	**10.2**	**4.80 J**	–	**17.4**	**15.7**	**3.74 J**	–
1,2,3,4,6,7,8-HpCDD	ng/kg	NE	**1,260**	**386**	**539**	**334**	**2,410**	**625**	–	**6,000 J**	**2,220**	**429**	–
1,2,3,4,6,7,8-HpCDF	ng/kg	NE	**185**	**65.9**	**76.1**	**64.5**	**368**	**105**	–	**578 J**	**256**	**38.6**	–
1,2,3,4,7,8,9-HpCDF	ng/kg	NE	**13.2**	**4.44 J**	**5.39**	**4.15 J**	**21.7**	**6.67**	–	**29.2 J**	**15.9**	**2.95 J**	–
OCDD	ng/kg	NE	**23,500**	**4,330**	**4,090**	**3,880**	**38,600**	**5,630**	–	**68,000 J**	**20,100**	**4,310**	–
OCDF	ng/kg	NE	**826**	**265**	**276**	**298**	**1,750**	**333**	–	**3,050 J**	**642**	**92.5**	–
Total Dioxin/Furan TEQ (ND=0.5DL) - Human/Mammal	ng/kg	15	**32.6 J**	**11.8 J**	**21.2 J**	**9.49 J**	**57.6 J**	**22.4 J**	–	**132 J**	**73.7**	**14.5 J**	–
cPAH (Dry Weight)													
Total cPAH TEQ (ND=0.5RL)	µg/kg	86	**11.6**	**13.4 J**	**38.3**	**8.28**	**4.45 J**	**10.5**	**195 J**	**286**	**237**	**19.6 J**	**1,140**
Phenols (Dry Weight)													
Pentachlorophenol	µg/kg	100	**18**	**12**	**26 NJ**	**19 NJ**	**20**	**33**	94 U	**52**	**160 NJ**	93 U	**170**

Sample Location			SSI-SC-03	SSI-SC-03	SSI-SS-04	SSI-SC-04	SSI-SC-04	SSI-SS-05	SSI-SC-05	SSI-SC-05	SSI-SC-05	SSI-SS-06
Sample ID:			SSI-SC-03_0-2	SSI-SC-03_2-4	SSI-SS-04-0_12	SSI-SC-04_0-2	SSI-SC-04_2-4	SSI-SS-05_0-0.39	SSI-SC-05_0-2	SSI-SC-05_2-4	SSI-SC-05_4-6	SSI-SS-06_0-0.39
Date Sampled:			10/14/2015	10/14/2015	10/15/2015	10/15/2015	10/15/2015	10/12/2015	10/13/2015	10/13/2015	10/13/2015	10/12/2015
Depth Interval (ft bml):			0-2 ft	2-4 ft	0-0.39 ft	0-2 ft	2-4 ft	0-0.39 ft	0-2 ft	2-4 ft	4-6 ft	0-0.39 ft
Elevation at Top of Sample (ft NADV88):			-3.1	-5.1	-0.5	0.4	-1.6	-4.9	-3.5	-5.5	-7.5	-5.5
Collected By			GeoEngineers									
Parameter	**Unit(s)**	**PCULs[1]**										
Dioxin/Furans												
2,3,7,8-TCDD	ng/kg	NE	**2.23**	**1.33**	–	**0.748 J**	**0.821 J**	–	**5.16**	**1.60**	0.145 U	–
2,3,7,8-TCDF	ng/kg	NE	**4.37**	**2.19**	–	**1.80**	**2.76**	–	**12.3**	**8.50**	**0.536 J**	–
1,2,3,7,8-PeCDD	ng/kg	NE	**10.5**	**4.96**	–	**3.91 J**	**2.96 J**	–	**25.0**	**6.16**	**0.492 J**	–
1,2,3,7,8-PeCDF	ng/kg	NE	**4.22 J**	**2.18 J**	–	**3.69 J**	**2.79 J**	–	**15.5**	**6.18**	**0.469 J**	–
2,3,4,7,8-PeCDF	ng/kg	NE	**3.56 J**	**1.91 J**	–	**3.96 J**	**2.32 J**	–	**13.9**	**4.38 J**	**0.920 J**	–
1,2,3,4,7,8-HxCDD	ng/kg	NE	**20.2**	**9.83**	–	**8.64**	**5.49**	–	**56.2**	**13.7**	**1.08 J**	–
1,2,3,4,7,8-HxCDF	ng/kg	NE	**14.7**	**8.75**	–	**22.7**	**17.6**	–	**74.4**	**22.0**	**1.37 J**	–
1,2,3,6,7,8-HxCDD	ng/kg	NE	**55.6**	**31.9**	–	**47.1**	**32.5**	–	**231**	**61.6**	**3.61 J**	–
1,2,3,6,7,8-HxCDF	ng/kg	NE	**6.09**	**3.66 J**	–	**7.74**	**5.90**	–	**28.4**	**9.34**	**0.711 J**	–
1,2,3,7,8,9-HxCDD	ng/kg	NE	**28.3**	**15.4**	–	**18.4**	**11.6**	–	**83.6**	**23.7**	**1.72 J**	–
1,2,3,7,8,9-HxCDF	ng/kg	NE	**4.17 J**	**2.58 J**	–	**6.73**	**4.90 J**	–	**23.0**	**6.14**	**0.606 J**	–
2,3,4,6,7,8-HxCDF	ng/kg	NE	**9.58**	**6.97**	–	**13.9**	**11.6**	–	**49.5**	**14.5**	**1.29 J**	–
1,2,3,4,6,7,8-HpCDD	ng/kg	NE	**1,160**	**858**	–	**1,070**	**738**	–	**5,190**	**1,260**	**62.6**	–
1,2,3,4,6,7,8-HpCDF	ng/kg	NE	**160.0**	**93.0**	–	**280.0**	**249**	–	**1,120**	**287**	**12.6**	–
1,2,3,4,7,8,9-HpCDF	ng/kg	NE	**9.53**	**5.00**	–	**17.5**	**15.7**	–	**62.5**	**16.7**	**1.07 J**	–
OCDD	ng/kg	NE	**10,400**	**7,390**	–	**9,040**	**5,770**	–	**42,400**	**10,300**	**482**	–
OCDF	ng/kg	NE	**443**	**241**	–	**976**	**885**	–	**4,210**	**918**	**39.8**	–
Total Dioxin/Furan TEQ (ND=0.5DL) - Human/Mammal	ng/kg	15	**44.8 J**	**26.9 J**	–	**35.3 J**	**25.8 J**	–	**168**	**44.2 J**	**2.87 J**	–
cPAH (Dry Weight)												
Total cPAH TEQ (ND=0.5RL)	µg/kg	86	**210**	**103**	**13 J**	**179**	**488**	**334**	**1,022**	**669**	**34**	**447**
Phenols (Dry Weight)												
Pentachlorophenol	µg/kg	100	**150 NJ**	**46 NJ**	94 U	**23 NJ**	**54**	**580**	**140**	**59 NJ**	–	**360**

Sample Location			SSI-SC-06	SSI-SC-06	SSI-SC-06	SSI-SS-07	SSI-SC-07	SSI-SC-07	SSI-SC-07	SSI-SS-08	SSI-SS-09	SSI-SS-10	SSI-SS-11
Sample ID:			SSI-SC-06_0-2	SSI-SC-06_2-4	SSI-SC-06_4-6	SSI-SS-07_0-0.39	SSI-SC-07_0-2	SSI-SC-07_2-4	SSI-SC-07_4-6	SSI-SS-08_0-0.39	SSI-SS-09_0-0.39	SSI-SS-10_0-0.39	SSI-SS-11_0-0.39
Date Sampled:			10/13/2015	10/13/2015	10/13/2015	10/12/2015	10/13/2015	10/13/2015	10/13/2015	10/12/2015	10/12/2015	10/12/2015	10/12/2015
Depth Interval (ft bml):			0-2 ft	2-4 ft	4-6 ft	0-0.39 ft	0-2 ft	2-4 ft	4-6 ft	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.39 ft
Elevation at Top of Sample (ft NADV88):			-2.8	-4.8	-6.8	-3.7	-3.3	-5.3	-7.3	-22.0	-16.9	-23.5	-22.7
Collected By			GeoEngineers										
Parameter	**Unit(s)**	**PCULs[1]**											
Dioxin/Furans													
2,3,7,8-TCDD	ng/kg	NE	**11.7**	**8.37**	**2.28**	–	**0.726 J**	**0.759 J**	**1.24**	**0.587 J**	–	**0.744 J**	**1.02**
2,3,7,8-TCDF	ng/kg	NE	**16.6**	**15.6**	**9.97**	–	**4.80**	**6.49**	**11.5**	**4.12**	–	**9.57**	**17.6**
1,2,3,7,8-PeCDD	ng/kg	NE	**66.8**	**61.7**	**8.12**	–	**3.08 J**	**3.54 J**	**6.90**	**2.17 J**	–	**3.38 J**	**4.46 J**
1,2,3,7,8-PeCDF	ng/kg	NE	**36.5**	**12.7**	**5.92**	–	**4.75 J**	**9.90**	**16.3**	**1.50 J**	–	**1.92 J**	**2.38 J**
2,3,4,7,8-PeCDF	ng/kg	NE	**40.3**	**13.2**	**6.22**	–	**3.66 J**	**8.64**	**10.8**	**2.02 J**	–	**1.53 J**	**2.57 J**
1,2,3,4,7,8-HxCDD	ng/kg	NE	**159**	**144**	**13.2**	–	**6.44**	**6.32**	**13.2**	**5.47**	–	**10.3**	**16.6**
1,2,3,4,7,8-HxCDF	ng/kg	NE	**184**	**140.0**	**17.9**	–	**16.8**	**36.9**	**61.4**	**7.08**	–	**6.12**	**5.92**
1,2,3,6,7,8-HxCDD	ng/kg	NE	**504**	**847**	**73.6**	–	**37.6**	**56.1**	**108**	**20.1**	–	**23.9**	**31.0**
1,2,3,6,7,8-HxCDF	ng/kg	NE	74.9 U	**62.6**	**10.9**	–	**5.36 J**	**9.56**	**20.1**	**2.54 J**	–	**2.66 J**	2.89 U
1,2,3,7,8,9-HxCDD	ng/kg	NE	**244**	**256**	**24.7**	–	**12.4**	**14.5**	**29.8**	**8.03**	–	**12.3**	**18.3**
1,2,3,7,8,9-HxCDF	ng/kg	NE	**60.6**	**14.4**	**3.78 J**	–	**4.71 J**	**9.40**	**17.1**	**2.53 J**	–	**2.18 J**	**1.94 J**
2,3,4,6,7,8-HxCDF	ng/kg	NE	**120.0**	**140.0**	**19.3**	–	**8.32**	**12.8**	**23.4**	**3.81 J**	–	**4.21 J**	**3.99 J**
1,2,3,4,6,7,8-HpCDD	ng/kg	NE	**12,100**	**22,600**	**1,200**	–	**755**	**1,230**	**2,050**	**471**	–	**442**	**436**
1,2,3,4,6,7,8-HpCDF	ng/kg	NE	**3,310**	**8,310**	**532**	–	**140.0**	**213**	**400.0**	**61.6**	–	**64.0**	**68.2**
1,2,3,4,7,8,9-HpCDF	ng/kg	NE	**170.0**	**307**	**31.8**	–	**7.81**	**12.2**	**28.7**	**4.58 J**	–	**4.23 J**	**4.53 J**
OCDD	ng/kg	NE	**80,600 J**	**163,000 J**	**7,370**	–	**6,390**	**13,700**	**21,300**	**3,900**	–	**3,720**	**3,050**
OCDF	ng/kg	NE	**11,000**	**33,800**	**1,670**	–	**329**	**466**	**1070**	**204**	–	**227**	**248**
Total Dioxin/Furan TEQ (ND=0.5DL) - Human/Mammal	ng/kg	15	**411 J**	**608 J**	**50.1 J**	–	**25.7 J**	**41.2 J**	**71.8**	**15.4 J**	–	**18.1 J**	**22.2 J**
cPAH (Dry Weight)													
Total cPAH TEQ (ND=0.5RL)	µg/kg	86	**308**	**764**	**315**	**37.3 J**	**109**	**551**	**661**	–	**64 J**	**40.3**	**49.8 J**
Phenols (Dry Weight)													
Pentachlorophenol	µg/kg	100	**150**	**250**	**52**	95 U	**18**	**60**	–	–	85 U	–	–

Sample Location			SSI-SS-12	SSI-SS-14	SSI-SS-15	SSI-SS-16	CL-SG-1	CL-SG-3	CL-SG-4	COB-CC-C1	COB-CC-C2
Sample ID:			SSI-SS-12_0-0.39	SSI-SS-14_0-0.39	SSI-SS-15_0-0.39	SSI-SS-16_0-0.39	CL-SG-1	CL-SG-3	CL-SG-4	COB-CC-C1	COB-CC-C2
Date Sampled:			10/12/2015	10/13/2015	10/13/2015	10/13/2015	6/10/2015	6/10/2015	6/10/2015	8/17/2013	8/17/2013
Depth Interval (ft bml):			0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.39 ft	0-0.33 ft	0-0.33 ft	0-0.33 ft	0-1 ft	0-1 ft
Elevation at Top of Sample (ft NADV88):			-25.1	-21.4	-23.7	-25.6	-9.3	-16.9	-16.8	composite sample	composite sample
Collected By			GeoEngineers				Landau			GeoEngineers	
Parameter	**Unit(s)**	**PCULs[1]**									
Dioxin/Furans											
2,3,7,8-TCDD	ng/kg	NE	**0.965 J**	**1.02**	**0.946 J**	**0.759 J**	1.81 U	1.10 U	2.28 U	**1.83**	**1.83**
2,3,7,8-TCDF	ng/kg	NE	**12.3**	**13.9**	**10.5**	**13.4**	**8.48**	**13.0**	**16.2**	**1.00**	**1.16**
1,2,3,7,8-PeCDD	ng/kg	NE	**3.78 J**	**5.80**	**3.54 J**	**3.66 J**	**4.09**	**5.50**	**12.1**	**6.41**	**7.26**
1,2,3,7,8-PeCDF	ng/kg	NE	**1.70 J**	**3.33 J**	**2.90 J**	**2.12 J**	**1.84**	**2.26**	**4.51**	**2.18**	**2.49**
2,3,4,7,8-PeCDF	ng/kg	NE	**1.66 J**	**4.33 J**	**3.49 J**	**1.66 J**	**1.91**	**2.73**	**5.82**	**1.91**	**2.68**
1,2,3,4,7,8-HxCDD	ng/kg	NE	**11.8**	**13.9**	**12.1**	**11.6**	**5.60**	**11.9**	**19.7**	**12.4**	**12.6**
1,2,3,4,7,8-HxCDF	ng/kg	NE	**4.21 J**	**12.5**	**8.25**	**4.90 J**	**4.36 J**	**7.66**	**17.8**	**8.44**	**14.9**
1,2,3,6,7,8-HxCDD	ng/kg	NE	**21.6**	**33.5**	**26.1**	**20.3**	**19.4**	**30.8**	**59.8**	**28.2**	**43.4**
1,2,3,6,7,8-HxCDF	ng/kg	NE	**2.48 J**	**5.15**	**3.82 J**	**2.30 J**	2.09 U	**3.32**	**7.00**	**3.29**	**5.53**
1,2,3,7,8,9-HxCDD	ng/kg	NE	**13.0**	**18.0**	**13.4**	**11.5**	**8.40**	**16.8**	**29.3**	**12.9**	**19.2**
1,2,3,7,8,9-HxCDF	ng/kg	NE	**1.44 J**	**4.33 J**	**2.88 J**	**1.73 J**	**1.58**	**2.79**	**6.38**	**3.24**	**4.92**
2,3,4,6,7,8-HxCDF	ng/kg	NE	**2.83 J**	**6.92**	**5.18**	**3.42 J**	1.59 UJ	2.59 U	**9.62**	**5.42**	**8.75**
1,2,3,4,6,7,8-HpCDD	ng/kg	NE	**337**	**565**	**422**	**255**	**341**	**660**	**1,420**	**675**	**1,060**
1,2,3,4,6,7,8-HpCDF	ng/kg	NE	**45.2**	**104**	**79.4**	**43.9**	**58.2**	**103**	**189**	**110**	**225**
1,2,3,4,7,8,9-HpCDF	ng/kg	NE	**3.29 J**	**8.53**	**6.45**	**3.91 J**	4.04 U	**6.59**	**12.2**	**7.24**	**14.2**
OCDD	ng/kg	NE	**2,330**	**4,720**	**3,480**	**1,780**	**2,730**	**5,700 J**	**13,600 J**	**5,780 J**	**9,380 J**
OCDF	ng/kg	NE	**158**	**355**	**267**	**148**	**170**	**440**	**735**	**410**	**924**
Total Dioxin/Furan TEQ (ND=0.5DL) - Human/Mammal	ng/kg	15	**16.9 J**	**27.3 J**	**20.0 J**	**15.5 J**	**15.5 J**	**25.2 J**	**52.2 J**	**26.1 J**	**37.1 J**
cPAH (Dry Weight)											
Total cPAH TEQ (ND=0.5RL)	µg/kg	86	**44.2 J**	–	–	–	–	–	–	–	–
Phenols (Dry Weight)											
Pentachlorophenol	µg/kg	100	–	–	–	–	–	–	–	–	–

Notes:

[1] SMS criteria have not been promulgated for dioxins/furans, carcinogenic PAHs and pentachlorophenol. Regional background values are used as preliminary cleanup levels for dioxins/furans and carcinogenic PAHs; the preliminary cleanup level for pentachlorophenol is based on the practical quantitation limit.

Value is greater than the preliminary cleanup level.

Bold indicates that the analyte was detected.

bml = below mudline

mg/kg = milligrams per kilogram

mg/kg OC = milligrams per kilogram organic carbon

ng/kg = nanograms per kilogram

µg/kg = micrograms per kilogram

J = Estimated value

U = Not detected at or above identified detection limit

UJ = Compound analyzed, but not detected above estimated detection limit

NJ = The analyte has been "tentatively identified" and the associated numerical value is the estimated concentration in the sample.

-- = Sample was not submitted for the identified chemical analysis

NE = A criterion has not been established for the identified analyte

PCUL = Preliminary cleanup level

SMS = Sediment Management Standards

SCO = SMS Sediment Cleanup Objective (Chapter 173-204-320)

CSL = SMS Cleanup Screening Level (Chapter 173-204-520)

LAET = Lowest Apparent Effects Threshold (LAET). The LAET (expressed on a dry-weight basis) is analogous to the SMS SCO value for samples and is used as the sediment screening level where the sample-specific total organic carbon concentration is less than 0.5 percent or greater than 3.5 percent.

2LAET = Second Lowest Apparent Effects Threshold (2LAET). The 2LAET (expressed on a dry-weight basis) is analogous to the SMS CSL value and is used as the screening level for samples where the total organic carbon concentration is less than 0.5 percent or greater than 3.5 percent.

LPAH = Low molecular weight polycyclic aromatic hydrocarbons (PAHs)

HPAH = High molecular weight polycyclic aromatic hydrocarbons (PAHs)

Total LPAH is the sum of detected concentrations of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene and anthracene.

Total HPAH is the sum of detected concentrations of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b+j+k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3-c-d)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene.

The totals for LPAH and HPAH are the sum of all detected results. If no individual LPAHs or HPAHs were detected, the highest detection limit value is reported as the total.

Table 5

Sediment Bioassay Summary Results

R.G. Haley Site

Bellingham, Washington

Sample ID	SCO Pass/Fail			CSL Pass/Fail		
	Larval Toxicity Test (*Mytilus galloprovincialis*)[1]	Juvenile Polychaete 20-Day Toxicity Test (*Neanthes arenaceodentata*)[2]	Amphipod 10-Day Toxicity Test (*Eohaustorius estuarius*)[3]	Larval Toxicity Test (*Mytilus galloprovincialis*)[4]	Juvenile Polychaete 20-Day Toxicity Test (*Neanthes arenaceodentata*)[5]	Amphipod 10-Day Acute Toxicity Test (*Eohaustorius estuarius*)[6]
SSI-SS-03	Pass	Pass	Pass	Pass	Pass	Pass
SSI-SS-05	Pass	Pass	Pass	Pass	Pass	Pass
SSI-SS-06	Pass	Pass	Pass	Pass	Pass	Pass

Notes:

[1] SCO failure - if the mean number of normal survivors in the test sediment is significantly less (1-tailed t-test at $P \leq 0.10$) than the mean number of normal survivors in the reference sediment and less than 85 percent of the number of normal survivors in the reference sediment.

[2] SCO failure - if the mean growth rate in the test sediment is significantly lower (1-tailed t-test at $P \leq 0.05$) than that in the reference sediment and less than 70 percent of the mean reference sediment response.

[3] SCO failure - if the test sediment mean amphipod mortality is significantly higher (1-tailed t-test at $P < 0.05$) than the reference sediment mean amphipod mortality and the absolute mortality is greater than 25 percent.

[4] CSL failure - (single-test criterion) if the mean number of normal survivors in the test sediment is significantly less (1-tailed t-test at $P \leq 0.10$) than the mean number of normal survivors in the reference sediment and less than 70 percent of the mean number of normal survivors in the reference sediment.

[5] CSL failure - (single-test criterion) if the mean individual growth rate in the test sediment is significantly lower (1-tailed t-test at $P \leq 0.05$) than that in the reference sediment and less than 50 percent of the mean reference sediment response.

[6] CSL failure - (single-test criterion) if the test sediment mean amphipod mortality is significantly higher (1-tailed t-test at $P \leq 0.05$) than the reference sediment mean amphipod mortality and the absolute difference is greater than 30 percent.

SCO = Sediment Cleanup Objectives Chapter 173-204 Washington Administrative Code (WAC)

CSL = Cleanup Screening Level

Table 6

Bioassay Results for the Amphipod *Eohaustorius estuarius* Test

R.G. Haley Site
Bellingham, Washington

Treatment	Replicate	Initial Number	Number Surviving	Percent Survival	Mean Percent		Standard Deviation
					Survival	Mortality	
Control	1	20	20	100	100	0	0
	2	20	20	100			
	3	20	20	100			
	4	20	20	100			
	5	20	20	100			
Reference (CR22)	1	20	19	95	95	5	3.5
	2	20	19	95			
	3	20	18	90			
	4	20	20	100			
	5	20	19	95			
SSI-SS-03_0-12	1	20	20	100	99	1	2.2
	2	20	20	100			
	3	20	20	100			
	4	20	19	95			
	5	20	20	100			
SSI-SS-05_0-12	1	20	20	100	99	1	2.2
	2	20	19	95			
	3	20	20	100			
	4	20	20	100			
	5	20	20	100			
SSI-SS-06_0-12	1	20	19	95	99	1	2.2
	2	20	20	100			
	3	20	20	100			
	4	20	20	100			
	5	20	20	100			

Notes:

Please refer to laboratory report in Appendix D for additional details.

Table 7

Bioassay Results for the Polychaete *Neanthes arenaceodentata* Test

R.G. Haley Site
Bellingham, Washington

Treatment	Replicate	Initial Number	Number Surviving	Percent Survival	Individual Growth (mg/individual/day)					
					Dry Weight	Mean	Standard Deviation	Ash-free Dry Weight	Mean	Standard Deviaton
Control	1	5	5	100	0.785	0.902	0.1	0.485	0.577	0.083
	2	5	5	100	0.853			0.626		
	3	5	5	100	0.859			0.489		
	4	5	5	100	1.002			0.64		
	5	5	5	100	1.012			0.646		
Reference (CR22)	1	5	5	100	0.884	0.694	0.108	0.714	0.527	0.11
	2	5	5	100	0.621			0.496		
	3	5	5	100	0.67			0.517		
	4	5	5	100	0.63			0.483		
	5	5	5	100	0.665			0.427		
SSI-SS-03_0-12	1	5	5	100	0.698	0.843	0.116	0.585	0.687	0.115
	2	5	5	100	0.909			0.703		
	3	5	5	100	0.86			0.688		
	4	5	5	100	0.989			0.87		
	5	5	5	100	0.761			0.592		
SSI-SS-05_0-12	1	5	5	100	0.751	0.774	0.101	0.653	0.631	0.09
	2	5	5	100	0.803			0.648		
	3	5	5	100	0.808			0.662		
	4	5	5	100	0.89			0.715		
	5	5	5	100	0.617			0.477		
SSI-SS-06_0-12	1	5	5	100	0.668	0.679	0.064	0.569	0.567	0.044
	2	5	5	100	0.626			0.537		
	3	5	5	100	0.738			0.61		
	4	5	5	100	0.751			0.61		
	5	5	5	100	0.61			0.511		

Notes:

Please refer to laboratory report in Appendix D for additional details.

mg = milligrams

Table 8

Bioassay Results for the Bivalve Larvae *Mytilus galloprovincialis* Test

R.G. Haley Site

Bellingham, Washington

Treatment	Replicate	Number Normal	Number Abnormal	Mean Number Normal (N)	Standard Deviation	Control Normal Survival N_C/I	Reference Normal Survival Relative to Control N_R/N_C	Performance Standard
Control	1	270	4	273.2	19.2	97.6		>70%; meets criterion
	2	242	6					
	3	291	5					
	4	277	6					
	5	286	8					
Reference (CR22)	1	206	4	238.8	32		87.4	>65%; meets criterion
	2	256	6					
	3	266	2					
	4	264	5					
	5	202	3					
SSI-SS-03_0-12	1	219	3	229.2	32.8			
	2	234	5					
	3	183	3					
	4	274	1					
	5	236	2					
SSI-SS-05_0-12	1	226	2	244.6	20.7			
	2	253	3					
	3	233	1					
	4	234	2					
	5	277	2					
SSI-SS-06_0-12	1	246	0	254	24.5			
	2	226	2					
	3	288	5					
	4	241	3					
	5	269	1					

Notes:

I = Mean initial count (stocking density); 280 individuals

N_C = Mean Control Normal

N_R = Mean Reference Normal

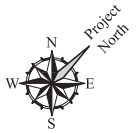
Please refer to laboratory report in Appendix D for additional details

FIGURES

GeoEngineers

Legend

Haley Site per Agreed Order, Exhibit 1



2,000 0 2,000

Feet

Reference: Whatcom County GIS, City of Bellingham GIS, Aerial from Esri, 2013.

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
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Projection: NAD 1983 UTM Zone 10N

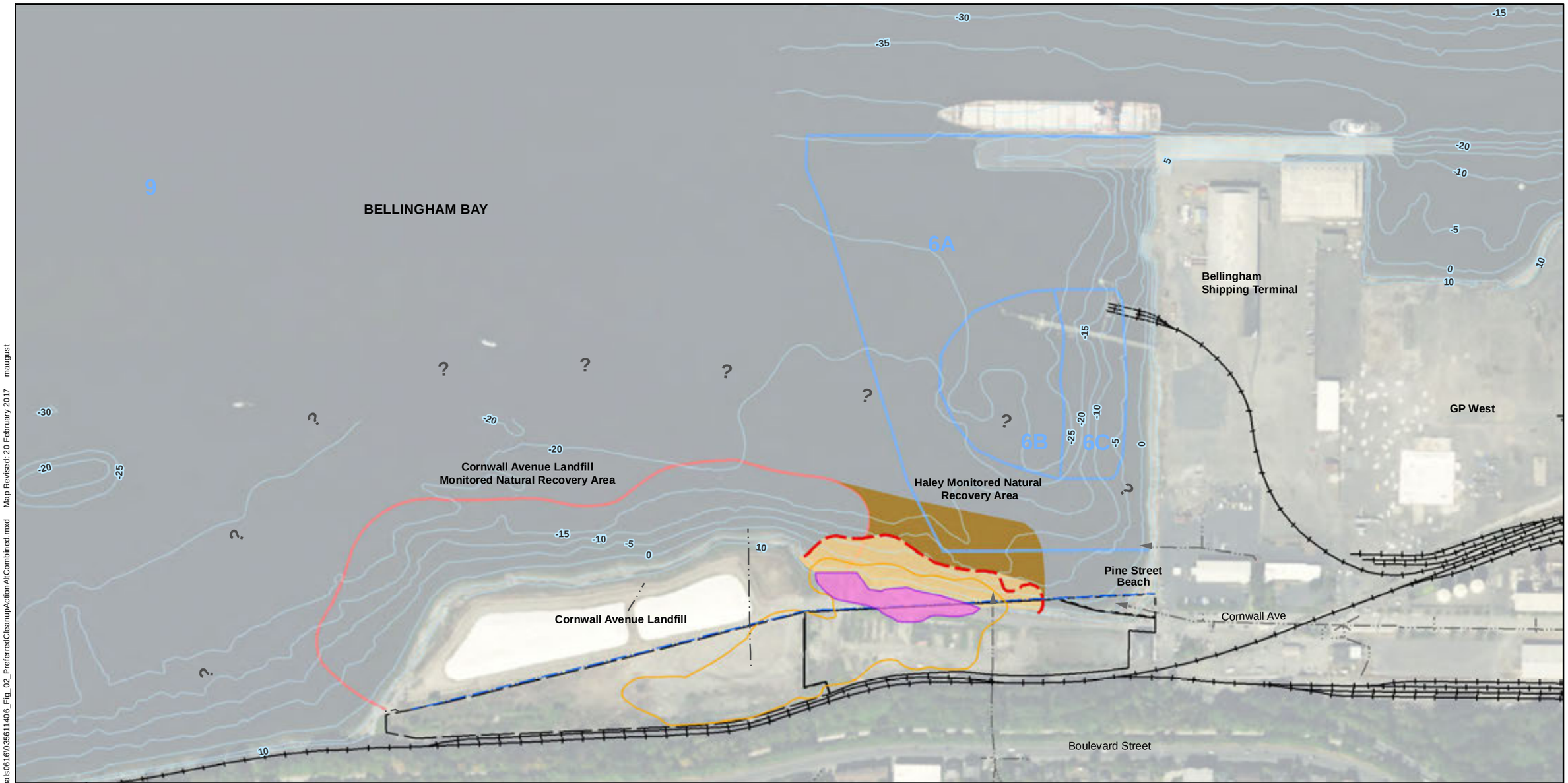
Vicinity Map

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 1

Path: \\seal\projects\0035611\4\GIS\MXDs\SupplementalSedimentInvestigation\0035611406_F1_VicinityMap.mxd Map Revised: 14 July 2015 cgonzales



W True North S N E

Project North

0 150 300

Feet

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to
NAVD88 vertical datum. Cornwall Landfill Site boundary, Landau 2016,
Whatcom Waterway Site Unit boundaries, Anchor QEA 2015.

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

- Storm Drain Pipe
- City Owned Property, Former R.G. Haley
- Cornwall Property
- Port of Bellingham Property
- BNSF Railroad
- Cornwall Landfill Management Unit 2
- Whatcom Waterway Monitored Natural Recovery Site Units
- Boundary of Haley Sediment SMS Benthic Exceedance
- Boundary of Smear Zone
- Inner Harbor Line
- Potentially Mobile LNAPL at Shoreline
- Excavation, Capping, and Armoring
- Enhanced Natural Recovery

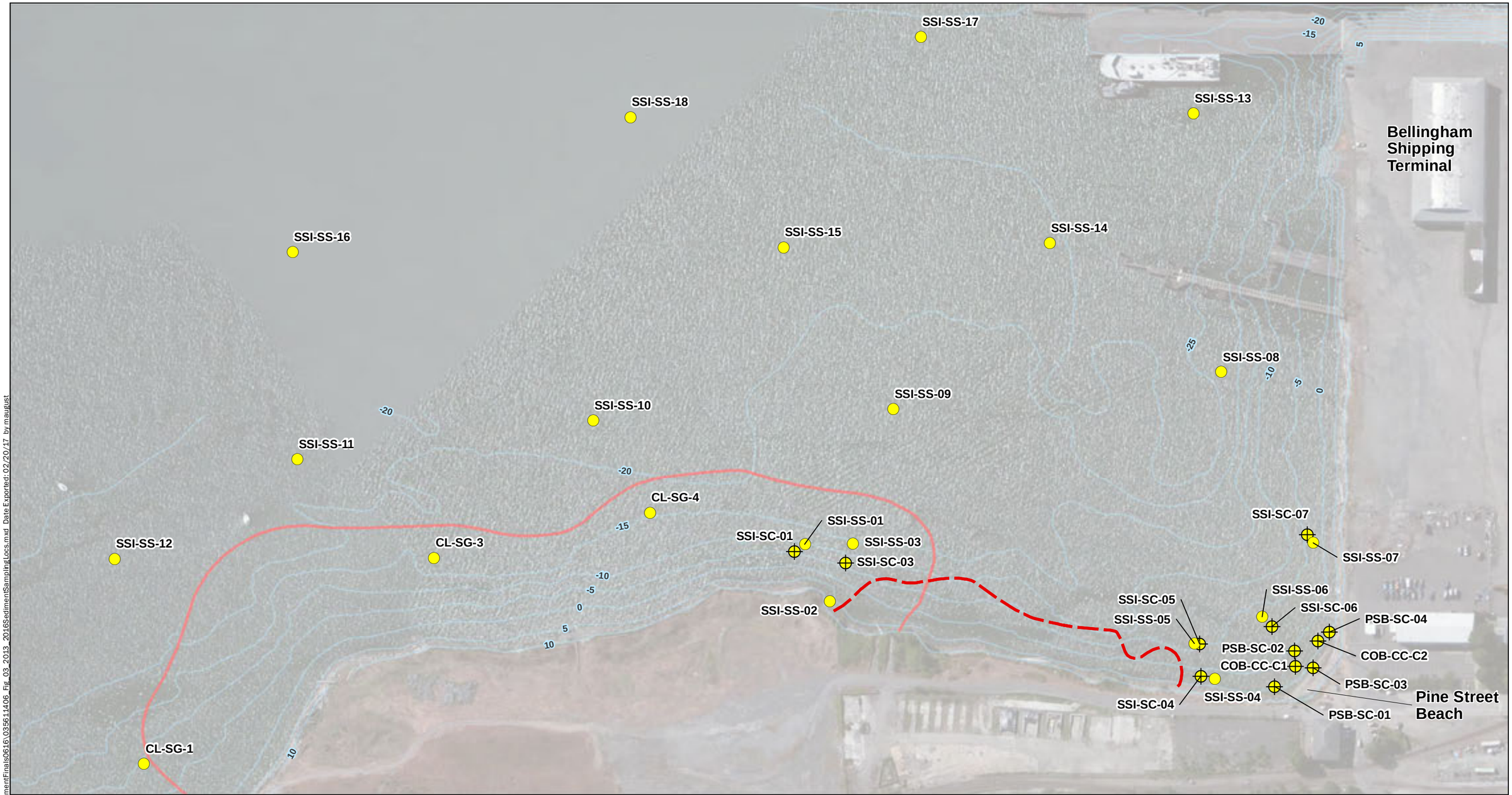
Preferred Cleanup Action Alternative From the Feasibility Study - Sediment Components

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 2

Path: \\ynpz-1\Projects\0\00356114\GIS\MXDs\SedimentFinals\061603561406_Fig_02_PreferredCleanupActionAltCombined.mxd Map Revised: 20 February 2017 maugust



Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Composite sample locations (COB-CC-C1 and COB-CC-C2) represented as centroid of 3 sample locations.
4. Refer to Table 1 for actual sampling locations.

Data Source: ESRI Data & Maps

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

- Surface Sediment Sample Location
- Subsurface Sediment Sample Location
- Cornwall Landfill Management Unit 2
- Boundary of Haley Sediment SMS Benthic Exceedances

True North / Project North

200 0 200

Feet

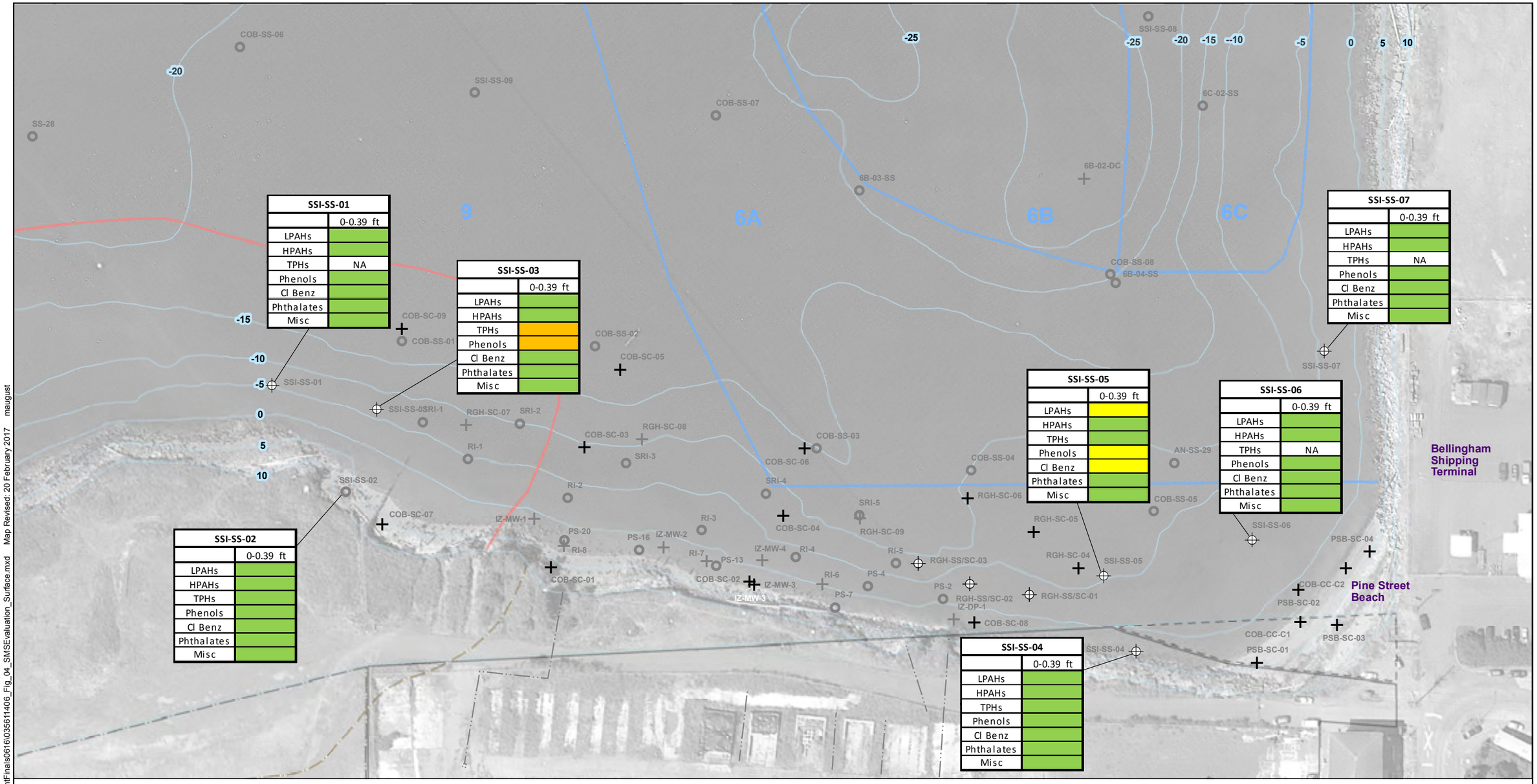
2013-2016 Sediment Sampling Locations

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 3

\\wnpz-1\Projects\0\0356114\GIS WKDs\SedimentFinals\0616\0356114.06_Fig_03_2013_2016SedimentSamplingLocs.mxd Date Exported: 02/20/17 by maugust



Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum. Cornwall Landfill Site boundary, Landau 2016, Whatcom Waterway Site Unit boundaries, Anchor QEA 2015.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document.
3. Sample location symbols are gray where not evaluated.

Legend

Supplemental Sediment Investigation Sample Data

- Exceeds CSL/2LAET Chemical Criterion for One or More Site Contaminants
- Exceeds SCO/LAET Chemical Criterion for One or More Site Contaminants
- Meets SMS Chemical Criteria for Site Contaminants

Key

LPAHs = Low molecular weight PAHs
HPAHs = High molecular weight PAHs
TPHs = Total petroleum hydrocarbons
Cl Benz = Chlorinated benzenes
Misc = Miscellaneous organic compounds
NA = Not Analyzed

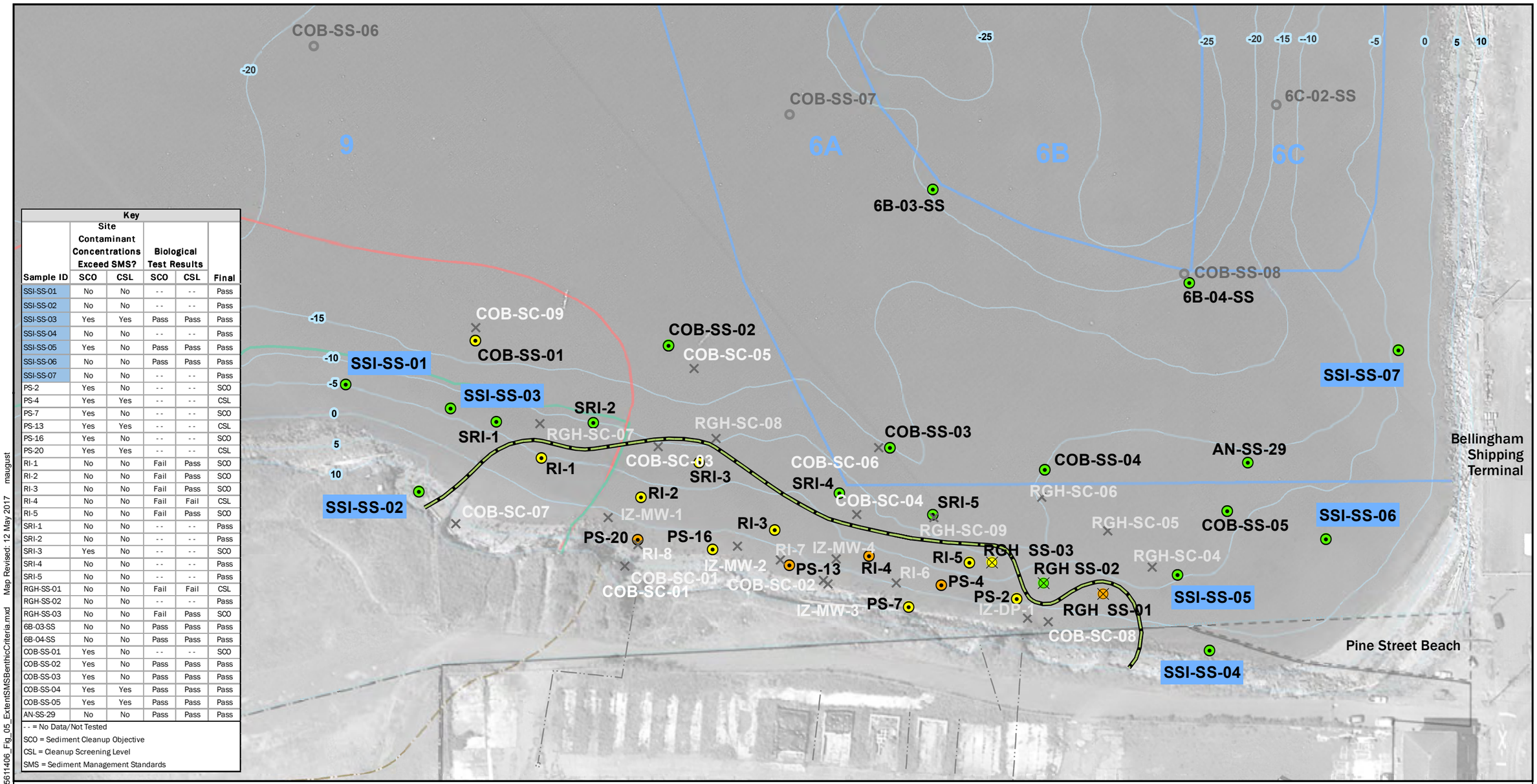
SMS Evaluation - Surface Sediment Data

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 4

Path: \\ynpz-1\Projects\0\0356114\GIS\MXDs\SedimentFinals\0616\0356114O6_Fig_04_SMSEvaluation_Surface.mxd Map Revised: 20 February 2017 maugust



Key					
	Site Contaminant Concentrations Exceed SMS?		Biological Test Results		
Sample ID	SCO	CSL	SCO	CSL	Final
SSI-SS-01	No	No	- -	- -	Pass
SSI-SS-02	No	No	- -	- -	Pass
SSI-SS-03	Yes	Yes	Pass	Pass	Pass
SSI-SS-04	No	No	- -	- -	Pass
SSI-SS-05	Yes	No	Pass	Pass	Pass
SSI-SS-06	No	No	Pass	Pass	Pass
SSI-SS-07	No	No	- -	- -	Pass
PS-2	Yes	No	- -	- -	SCO
PS-4	Yes	Yes	- -	- -	CSL
PS-7	Yes	No	- -	- -	SCO
PS-13	Yes	Yes	- -	- -	CSL
PS-16	Yes	No	- -	- -	SCO
PS-20	Yes	Yes	- -	- -	CSL
RI-1	No	No	Fail	Pass	SCO
RI-2	No	No	Fail	Pass	SCO
RI-3	No	No	Fail	Pass	SCO
RI-4	No	No	Fail	Fail	CSL
RI-5	No	No	Fail	Pass	SCO
SRI-1	No	No	- -	- -	Pass
SRI-2	No	No	- -	- -	Pass
SRI-3	Yes	No	- -	- -	SCO
SRI-4	No	No	- -	- -	Pass
SRI-5	No	No	- -	- -	Pass
RGH-SS-01	No	No	Fail	Fail	CSL
RGH-SS-02	No	No	- -	- -	Pass
RGH-SS-03	No	No	Fail	Pass	SCO
6B-03-SS	No	No	Pass	Pass	Pass
6B-04-SS	No	No	Pass	Pass	Pass
COB-SS-01	Yes	No	- -	- -	SCO
COB-SS-02	Yes	No	Pass	Pass	Pass
COB-SS-03	Yes	No	Pass	Pass	Pass
COB-SS-04	Yes	Yes	Pass	Pass	Pass
COB-SS-05	Yes	Yes	Pass	Pass	Pass
AN-SS-29	No	No	Pass	Pass	Pass

- - = No Data/Not Tested
SCO = Sediment Cleanup Objective
CSL = Cleanup Screening Level
SMS = Sediment Management Standards

True North
Project North
0 50 100
Feet

Sample Type
- Surface Sediment Sample Location
- Subsurface Sediment Sample Location
- Surface and Subsurface Sediment Sample Location

Sediment Sample Results
- Exceeds CSL/2LAET Chemical or Biological Criterion for One or More Site Contaminants
- Exceeds SCO/LAET Chemical or Biological Criterion for One or More Site Contaminants
- Meets SMS Benthic Criteria for Site Contaminants
- Estimated boundary of sediment exceedances of SMS benthic chemical and/or toxicity criteria
- Supplemental Sediment Investigation Sample Data

[1] Surface = 0-0.39 ft below mudline.

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document.

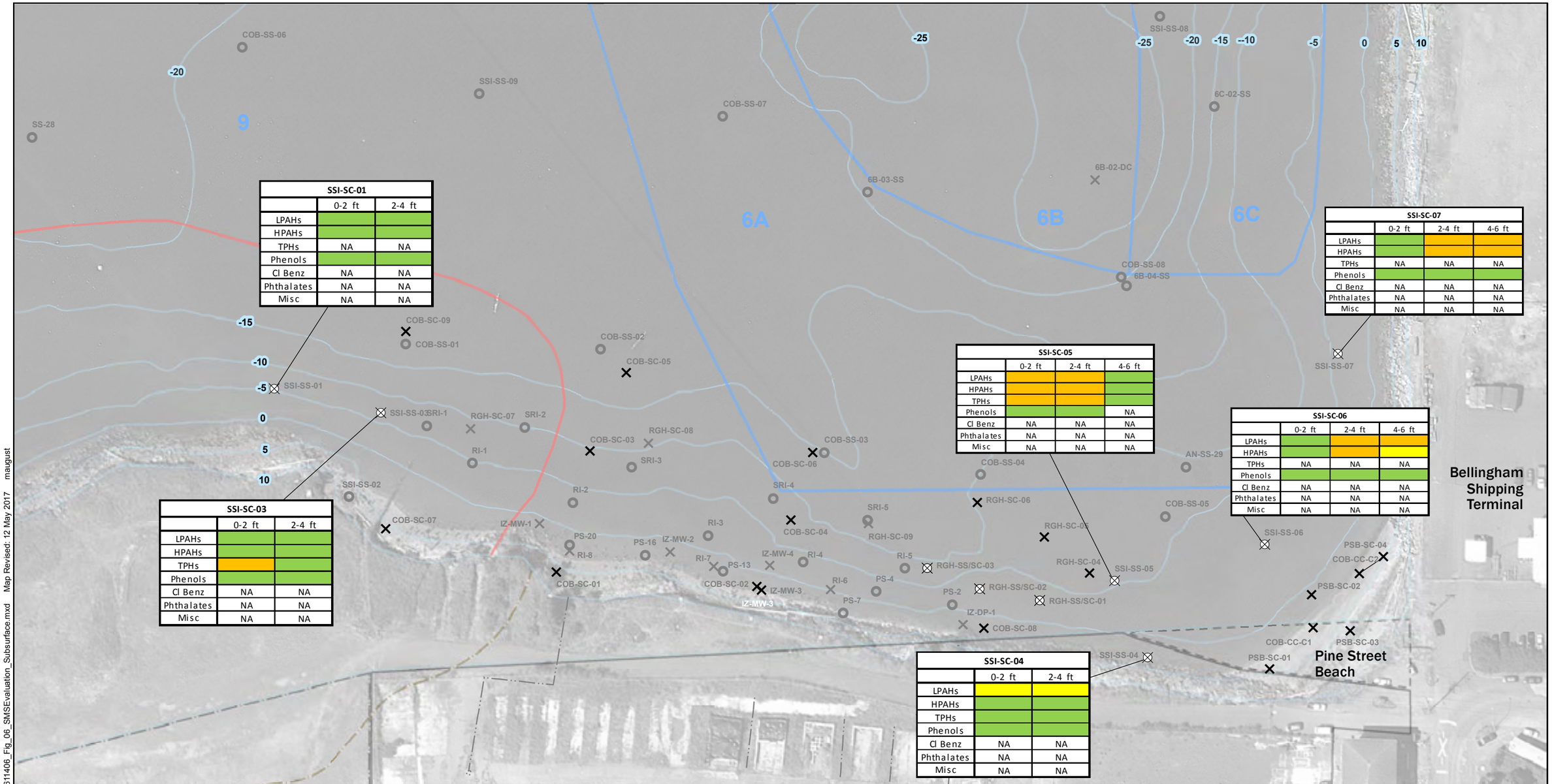
Extent of SMS Benthic Criteria Exceedances in Surface[1] Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 5

Path: P:\00356114\GIS\MXDs\SedimentFinals\06160356114406_Fig_05_ExtentSMSBenthicCriteria.mxd Map Revised: 12 May 2017 maugust



SSI-SC-01		
	0-2 ft	2-4 ft
LPAHs		
HPAHs		
TPHs	NA	NA
Phenols		
Cl Benz	NA	NA
Phthalates	NA	NA
Misc	NA	NA

SSI-SC-03		
	0-2 ft	2-4 ft
LPAHs		
HPAHs		
TPHs		
Phenols		
Cl Benz	NA	NA
Phthalates	NA	NA
Misc	NA	NA

SSI-SC-05			
	0-2 ft	2-4 ft	4-6 ft
LPAHs			
HPAHs			
TPHs			
Phenols			NA
Cl Benz	NA	NA	NA
Phthalates	NA	NA	NA
Misc	NA	NA	NA

SSI-SC-07			
	0-2 ft	2-4 ft	4-6 ft
LPAHs			
HPAHs			
TPHs	NA	NA	NA
Phenols			
Cl Benz	NA	NA	NA
Phthalates	NA	NA	NA
Misc	NA	NA	NA

SSI-SC-06			
	0-2 ft	2-4 ft	4-6 ft
LPAHs			
HPAHs			
TPHs	NA	NA	NA
Phenols			
Cl Benz	NA	NA	NA
Phthalates	NA	NA	NA
Misc	NA	NA	NA

SSI-SC-04		
	0-2 ft	2-4 ft
LPAHs		
HPAHs		
TPHs		
Phenols		
Cl Benz	NA	NA
Phthalates	NA	NA
Misc	NA	NA

True North
Project North
W
N
S
E

Legend

Supplemental Sediment Investigation Sample Data

- Exceeds CSL/2LAET Chemical Criterion for One or More Site Contaminants
- Exceeds SCO/LAET Chemical Criterion for One or More Site Contaminants
- Meets SMS Chemical Criteria for Site Contaminants

Key

LPAHs = Low molecular weight PAHs
HPAHs = High molecular weight PAHs
TPHs = Total petroleum hydrocarbons
Cl Benz = Chlorinated benzenes
Misc = Miscellaneous organic compounds
NA = Not analyzed

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum. Cornwall Landfill Site boundary, Landau 2016, Whatcom Waterway Site Unit boundaries, Anchor QEA 2015.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document.
3. Sample location symbols are gray where not evaluated.

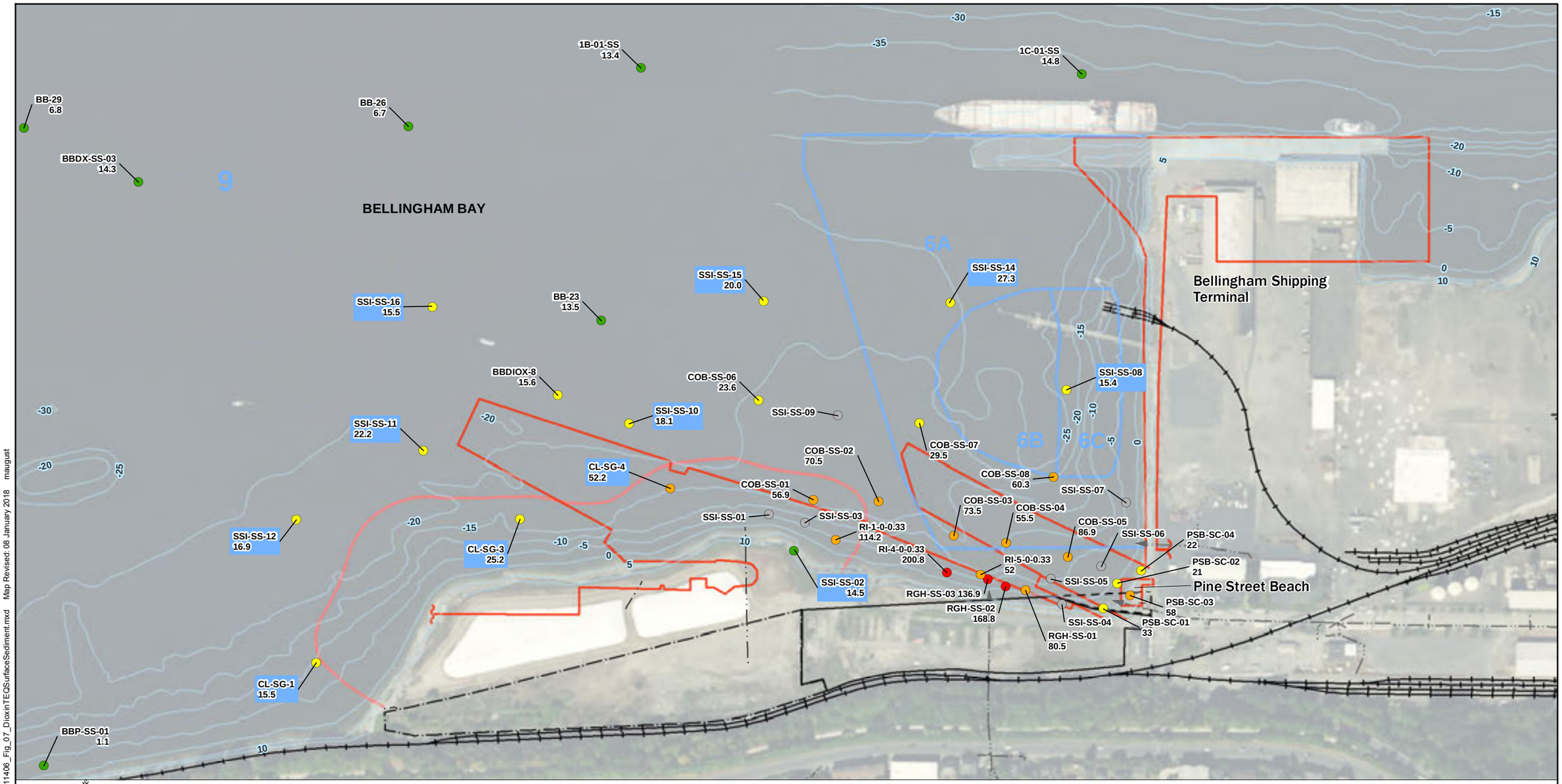
SMS Evaluation - Subsurface Sediment Data

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 6

Path: P:\0035611\4\GIS\MXDs\SedimentFinals\061603561406_Fig_06_SMSEvaluation_Subsurface.mxd Map Revised: 12 May 2017 maugust



Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum. Cornwall Landfill Site boundary, Landau 2016, Whatcom Waterway Site Unit boundaries, Anchor QEA 2015.

Notes:
1. Preliminary cleanup level = 15 ng/kg TEQ.
2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Surface Sediment Dioxin TEQ Concentration (ng/kg)
- ≤15 (Preliminary Cleanup Level)
- >15≤50
- >50≤120
- >120
- Not Analyzed

- Storm Drain Pipe
- City-Owned Property, Former R.G. Haley
- Cornwall Property
- Port of Bellingham Property
- BNSF Railroad
- Cornwall Landfill Management Unit 2
- Whatcom Waterway Monitored Natural Recovery Site Units
- Contour (5-ft interval)

- Supplemental Sediment Investigation Sample Data
- Footprint of Historic Over-Water Structure

[1]Surface = 0-0.39 ft below mudline (blm) except for sample labels noted by *, which are 0-2 ft blm.

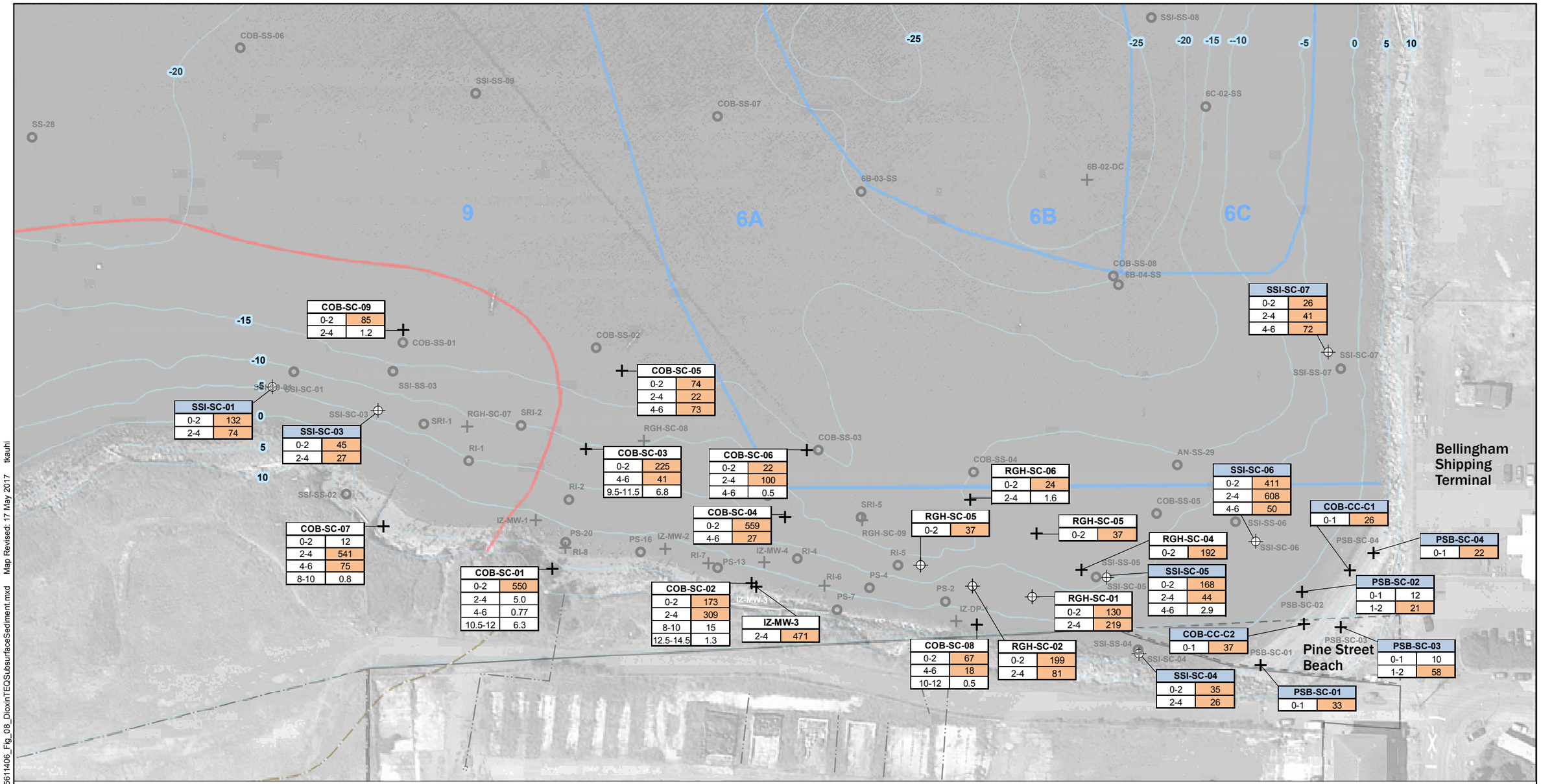
Dioxin TEQ Concentrations in Surface[1] Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 7

Path: P:\00356114\GIS\MXDs\SedimentFinals\061603561406_Fig_07_DioxinTEQSurfaceSediment.mxd Map Revised: 08 January 2018 maugust



Map Revised: 17 May 2017 tkauhi

Path: P:\0035611 4\GIS\MXDs\SedimentFinals\061603561 1406_Fig_08_DioxinTEQSubsurfaceSediment.mxd

True North
Project North
W
S
N
E
0 50 100
Feet

Dioxin TEQ Results

Location	
Depth below mud line (ft)	Result (ng/kg)

Sample Type

- Surface Sediment Sample Location
- Subsurface Sediment Sample Location
- Surface and Subsurface Sediment Sample Location
- Supplemental Sediment Investigation Sample Data
- Exceeds Preliminary Cleanup Level (15 ng/kg) TEQ
- Cornwall Landfill Management Unit 2
- Whatcom Waterway Monitored Natural Recovery Site Units

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum. Cornwall Landfill Site boundary, Landau 2016, Whatcom Waterway Site Unit boundaries, Anchor QEA 2015.

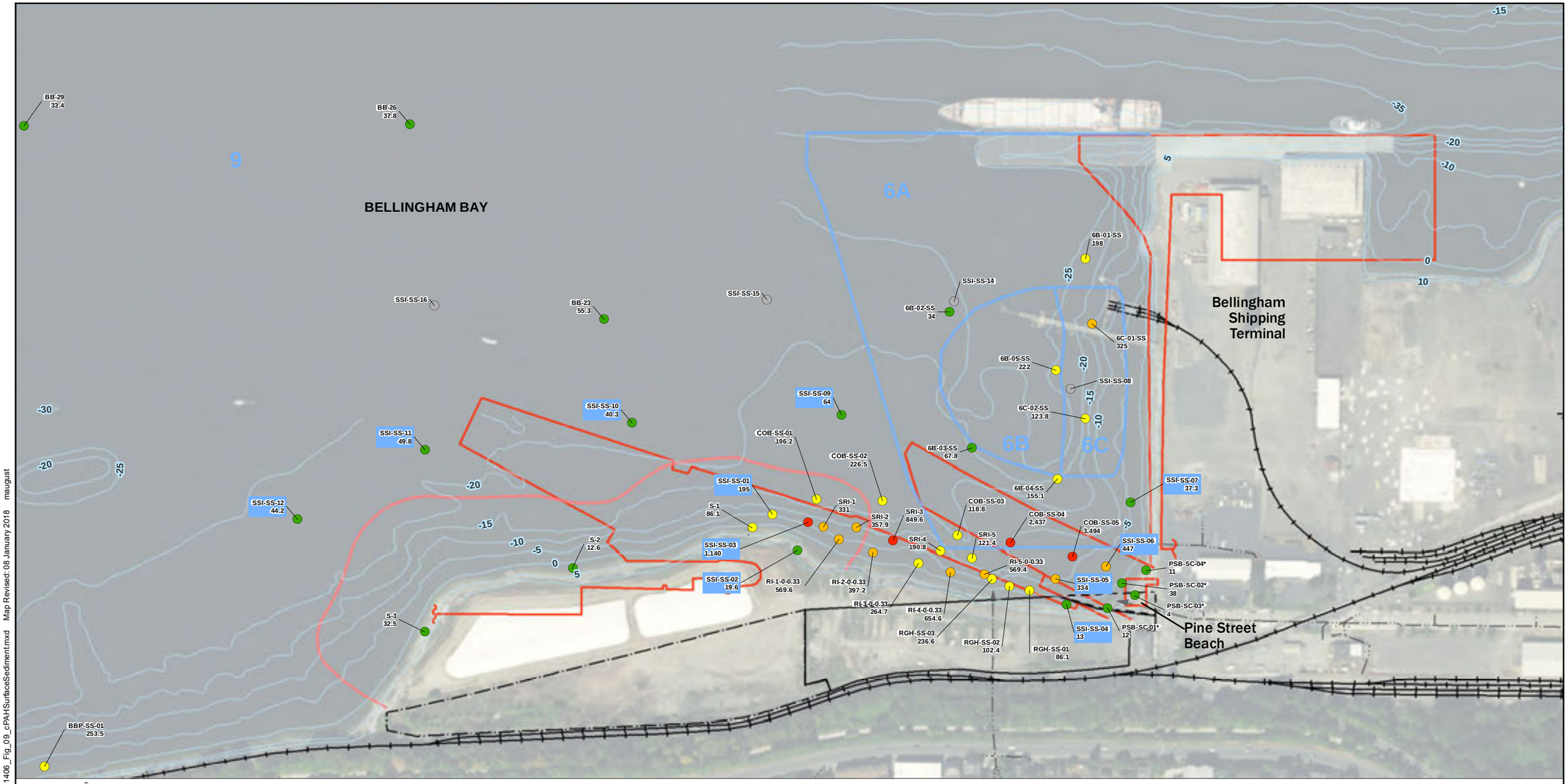
Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document.
3. Sample location symbols are gray wherenot evaluated.

Dioxin TEQ Concentrations in Subsurface Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 8



Path: P:\0\0356114\GIS\MXDs\SedimentFinals\061603561406_Fig_09_cPAHSurfaceSediment.mxd Map Revised: 08 January 2018 maugust

W True North N S E Project North

0 150 300
Feet

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum. Cornwall Landfill Site boundary, Landau 2016, Whatcom Waterway Site Unit boundaries, Anchor QEA 2015.

Notes:
1. Preliminary cleanup level = 86 µg/kg TEQ.
2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Surface Sediment cPAH TEQ Concentration (µg/kg)
- ≤86 (Preliminary Cleanup Level)
- >86≤300
- >300≤680
- >680
- Not Analyzed

- Storm Drain Pipe
- City-Owned Property, Former R.G. Haley
- Cornwall Property
- Port of Bellingham Property
- BNSF Railroad
- Cornwall Landfill Management Unit 2
- Whatcom Waterway Monitored Natural Recovery Site Units
- Bathymetric Contour (5-ft interval)
- Footprint of Historical Over-Water Structure
- Supplemental Sediment Investigation Sample Data

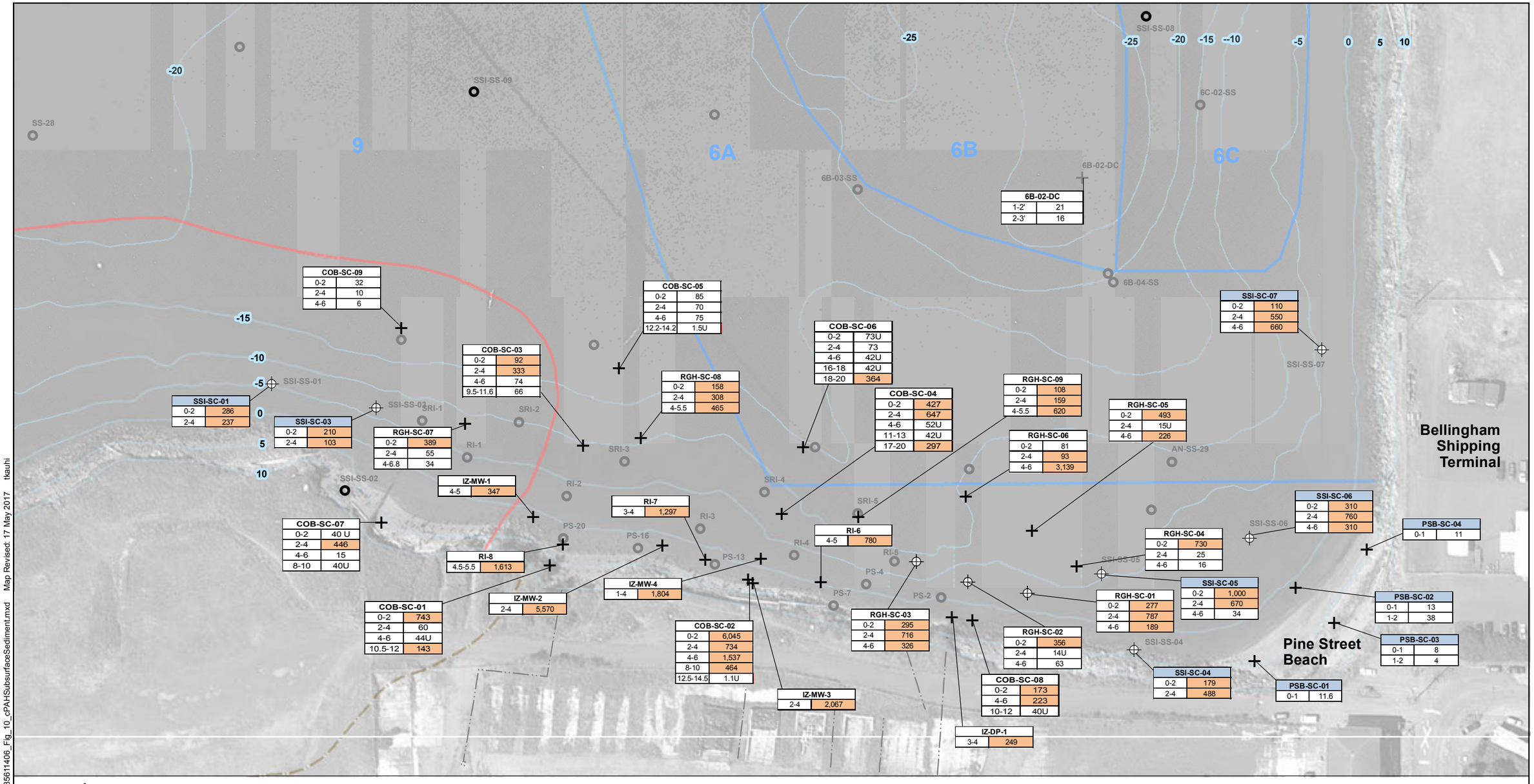
[1]Surface = 0-0.39 ft below mudline (blm) except for sample labels noted by *, which are 0-2 ft blm.

cPAH TEQ Concentrations in Surface[1] Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 9



True North
Project North
W N S E

0 50 100
Feet

cPAH TEQ Results

Location	
Depth below mud line (ft)	Concentration (µg/kg)

Concentrations are expressed as the toxic equivalent (TEQ) of benzo(a)pyrene

Sample Type

- Surface Sediment Sample Location
- Subsurface Sediment Sample Location
- Surface and Subsurface Sediment Sample Location
- Supplemental Sediment Investigation Sample Data
- Exceeds Preliminary Cleanup Level (86 µg/kg TEQ)
- Cornwall Landfill Management Unit 2
- Whatcom Waterway Monitored Natural Recovery Site Units

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document.
3. Sample location symbols are gray where tests not performed.
4. Reported values rounded for presentation.

cPAH TEQ Concentrations in Subsurface Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 10

Path: P:\0\0356114\GIS\MXDs\SedimentFinals\0616\0356114O6_Fig_10_cPAHSubsurfaceSediment.mxd Map Revised: 17 May 2017 tkauhi

BELLINGHAM BAY

9

6A

6B

6C

Bellingham
Shipping
Terminal

Pine Street Beach

SSI-SS-16
SSI-SS-15
SSI-SS-14
SSI-SS-09
85U
SSI-SS-10
SSI-SS-11
SSI-SS-12
SSI-SS-08
6B-03-SS
56
6B-04-SS
86
SSI-SS-07
95U
COB-SS-02
460
COB-SS-01
500
SRI-1
300
SSI-SS-01
94U
RI-1-0-0.33
160
SRI-3
560
COB-SS-03
560
COB-SS-04
320
SRI-5
300
COB-SS-05
370
SSI-SS-06
360
PSB-SC-04
33
SSI-SS-03
170
SRI-2
290
SRI-4
300
RI-2-0-0.33
180
RI-5-0-0.33
55
PSB-SC-02
26
SSI-SS-02
93U
PS-20
4,700
PS-16
1,100
SSI-SS-05
580
RI-3-0-0.33
510
PS-13
800
PS-7
100
PS-4
3,200
PS-2
26
RGH-SS-01
83
PSB-SC-03
20
RI-4-0-0.33
240
RGH-SS-03
180
RGH-SS-02
51
SSI-SS-04
94U
PSB-SC-01
18

-30 -20 -25 -20 -15 -10 -5 0 5 10 -25 -15 -20 -15 -10 -5 -35 -20 -10 -5 0 10 10

True North
W N S E
Project North
0 150 300
Feet

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to
NAVD88 vertical datum. Cornwall Landfill Site boundary, Landau 2016,
Whatcom Waterway Site Unit boundaries, Anchor QEA 2015.

Notes:
1. Preliminary cleanup level = 100 µg/kg.
2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
4. U = chemical not detected at identified detection limit.

Surface Sediment Concentration (µg/kg)
- ≤100 (Preliminary Cleanup Level)
- >100≤350
- >350≤790
- >790
- Not Analyzed

- Storm Drain Pipe
- City-Owned Property, Former R.G. Haley
- Cornwall Property
- Port of Bellingham Property
- BNSF Railroad
- Cornwall Landfill Management Unit 2
- Whatcom Waterway Monitored Natural Recovery Site Units
- Bathymetric Contour (5-ft interval)
- Supplemental Sediment Investigation Sample Data
- Footprint of Historic Over-Water Structure

[1]Surface = 0-0.39 ft below mudline (blm) except for sample labels noted by *, which are 0-2 ft blm.

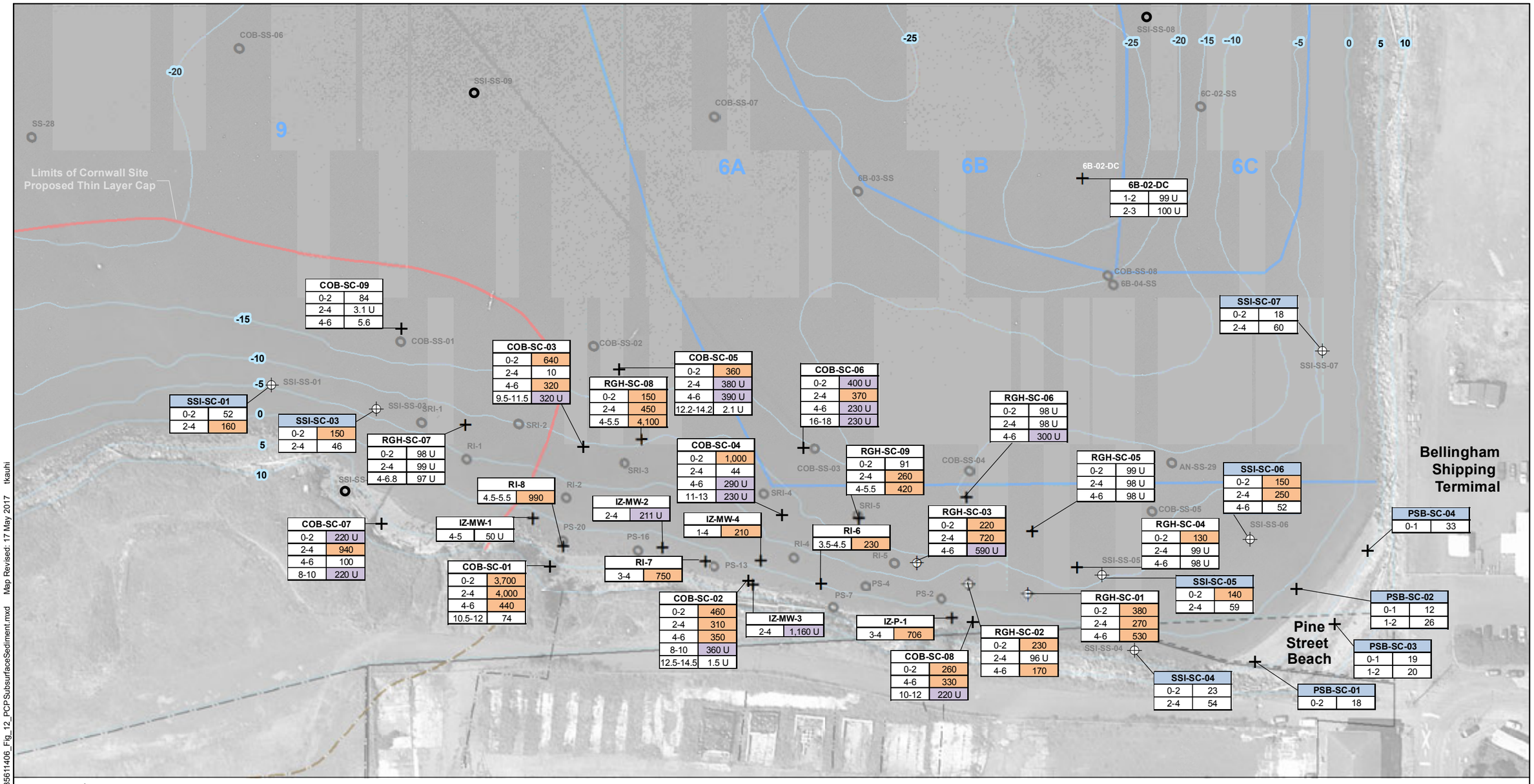
Pentachlorophenol Concentrations in Surface[1] Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 11

Path: P:\0\0356114\GIS\MXDs\SedimentFinals\061603561406_Fig_11_PCPSurfaceSediment.mxd Map Revised: 08 January 2018 maugust



COB-SC-09	
0-2	84
2-4	3.1 U
4-6	5.6

SSI-SC-01	
0-2	52
2-4	160

SSI-SC-03	
0-2	150
2-4	46

RGH-SC-07	
0-2	98 U
2-4	99 U
4-6.8	97 U

COB-SC-03	
0-2	640
2-4	10
4-6	320
9.5-11.5	320 U

RGH-SC-08	
0-2	150
2-4	450
4-5.5	4,100

COB-SC-05	
0-2	360
2-4	380 U
4-6	390 U
12.2-14.2	2.1 U

COB-SC-04	
0-2	1,000
2-4	44
4-6	290 U
11-13	230 U

RI-8	
4.5-5.5	990

IZ-MW-2	
2-4	211 U

IZ-MW-4	
1-4	210

IZ-MW-1	
4-5	50 U

RI-6	
3.5-4.5	230

RI-7	
3-4	750

COB-SC-07	
0-2	220 U
2-4	940
4-6	100
8-10	220 U

COB-SC-01	
0-2	3,700
2-4	4,000
4-6	440
10.5-12	74

COB-SC-02	
0-2	460
2-4	310
4-6	350
8-10	360 U
12.5-14.5	1.5 U

IZ-MW-3	
2-4	1,160 U

IZ-P-1	
3-4	706

COB-SC-08	
0-2	260
4-6	330
10-12	220 U

COB-SC-06	
0-2	400 U
2-4	370
4-6	230 U
16-18	230 U

RGH-SC-09	
0-2	91
2-4	260
4-5.5	420

RGH-SC-03	
0-2	220
2-4	720
4-6	590 U

RGH-SC-02	
0-2	230
2-4	96 U
4-6	170

RGH-SC-06	
0-2	98 U
2-4	98 U
4-6	300 U

RGH-SC-05	
0-2	99 U
2-4	98 U
4-6	98 U

RGH-SC-04	
0-2	130
2-4	99 U
4-6	98 U

RGH-SC-01	
0-2	380
2-4	270
4-6	530

SSI-SC-07	
0-2	18
2-4	60

SSI-SC-06	
0-2	150
2-4	250
4-6	52

SSI-SC-05	
0-2	140
2-4	59

SSI-SC-04	
0-2	23
2-4	54

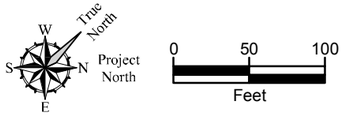
PSB-SC-04	
0-1	33

PSB-SC-02	
0-1	12
1-2	26

PSB-SC-03	
0-1	19
1-2	20

PSB-SC-01	
0-2	18

6B-02-DC	
1-2	99 U
2-3	100 U



0 50 100
Feet

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.
Cornwall Landfill Site boundary, Landau 2016,
Whatcom Waterway Site Unit boundaries, Anchor QEA 2015.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document.
3. Sample location symbols are grey where tests not performed.
4. U = chemical not detected at identified detection limit.
5. Reported values rounded for presentation.

Pentachlorophenol Results

Location	
Depth below mud line (ft)	Result (µg/kg)

Sample Type

- Surface Sediment Sample Location
- Subsurface Sediment Sample Location
- Surface and Subsurface Sediment Sample Location

- Supplemental Sediment Investigation Sample Data
- Exceeds Preliminary Cleanup Level (100 µg/kg)
- Not Detected. DL > Preliminary Cleanup Level
- Cornwall Landfill Management Unit 2
- Whatcom Waterway Monitored Natural Recovery Site Units

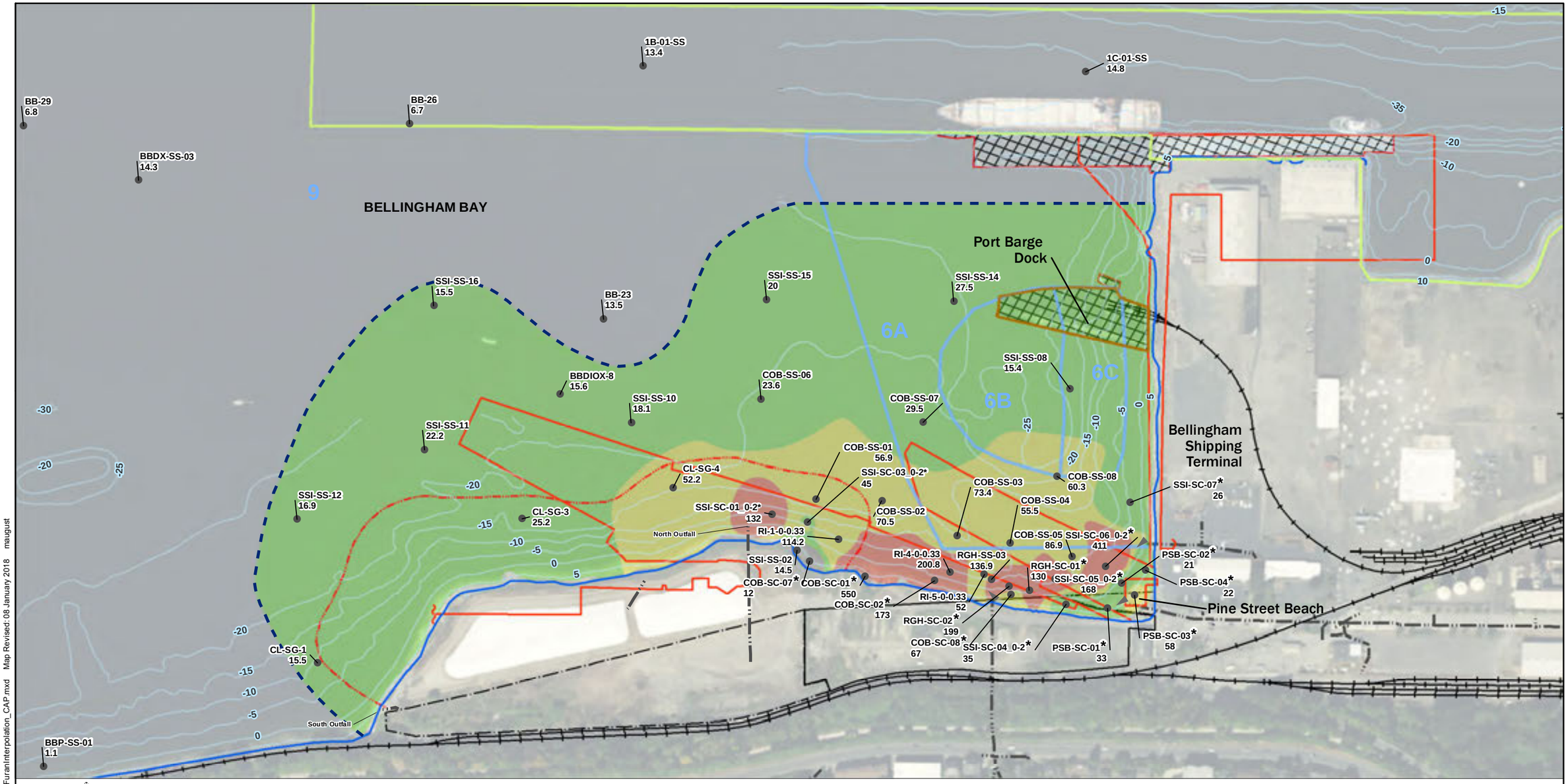
Pentachlorophenol Concentrations in Subsurface Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 12

Path: P:\0035611\GIS\MXDs\SedimentFinals\061603561\406_Fig_12_PCPSubsurfaceSediment.mxd Map Revised: 17 May 2017 tkauhi



W True North S Project North N E

0 150 300 Feet

Surface Sediment Dioxin TEQ Concentration (ng/kg)

- ≤15 (Preliminary Cleanup Level)
- >15≤45
- >45≤120
- >120
- Estimated Extent of Preliminary Cleanup Level Exceedance (Regional Background)

Current

- Storm Drain Pipe
- BNSF Railroad
- Present-day Over-water Structure
- Current Shoreline
- Bathymetric Contour (5-ft interval)

Property Lines

- City-Owned Property, Former R.G. Haley
- Cornwall Property
- Port of Bellingham Property

Proposed Remedies

- Proposed Cornwall Avenue Landfill Sediment Remedy
- Whatcom Waterway Monitored Natural Recovery Site Units
- Whatcom Waterway Dredging or Capping Site Units
- Whatcom Waterway Capping with Armoring
- Footprint of Historical Over-Water Structure

[1]Surface = 0-0.39 ft below mudline (blm), except for sample labels noted by *, which are 0-2 ft blm.

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
1. Preliminary cleanup level = 15 ng/kg TEQ.
2. Interpolations settings: IDW Power=6, Neighbors=8, Reach=600ft.
3. The locations of all features shown are approximate.
4. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Interpolated Extent of Dioxin/Furan TEQ in Surface[1] Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 13

Path: P:\0\0356114\GIS\MXDs\0356114O6_Fig_13_DioxinFuranInterpolation_CAP.mxd Map Revised: 08 January 2018 maugust

True North
Project North
W N S E
0 150 300
Feet

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
1. Preliminary cleanup level = 86 µg/kg TEQ.
2. Interpolation settings: IDW Power=6, Neighbors=8, Reach=600ft.
3. The locations of all features shown are approximate.
4. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Surface Sediment cPAH TEQ Concentration (µg/kg)
- ≤86 (Preliminary Cleanup Level)
- >86 ≤ 300
- >300 ≤ 680
- >680
- Estimated Extent of Preliminary Cleanup Level Exceedance (Regional Background)

Current
- Storm Drain Pipe
- BNSF Railroad
- Present-day Over-water Structure
- Current Shoreline
- Contour (5-ft interval)

Property Lines
- City-Owned Property, Former R.G. Haley International
- Cornwall Property
- Port of Bellingham Property

Proposed Remedies
- Proposed Cornwall Avenue Landfill Sediment Remedy
- Whatcom Waterway Monitored Natural Recovery Site Units
- Whatcom Waterway Capping with Armoring
- Whatcom Waterway Dredging or Capping Site Units
- Footprint of Historic Over-Water Structure

[1]Surface = 0-0.39 ft below mudline (blm), except for sample labels noted by *, which are 0-2 ft blm.

[2]The cPAH TEQ for this sample excludes dibenz (a,h) anthracene because a concentration for this compound was not reported.

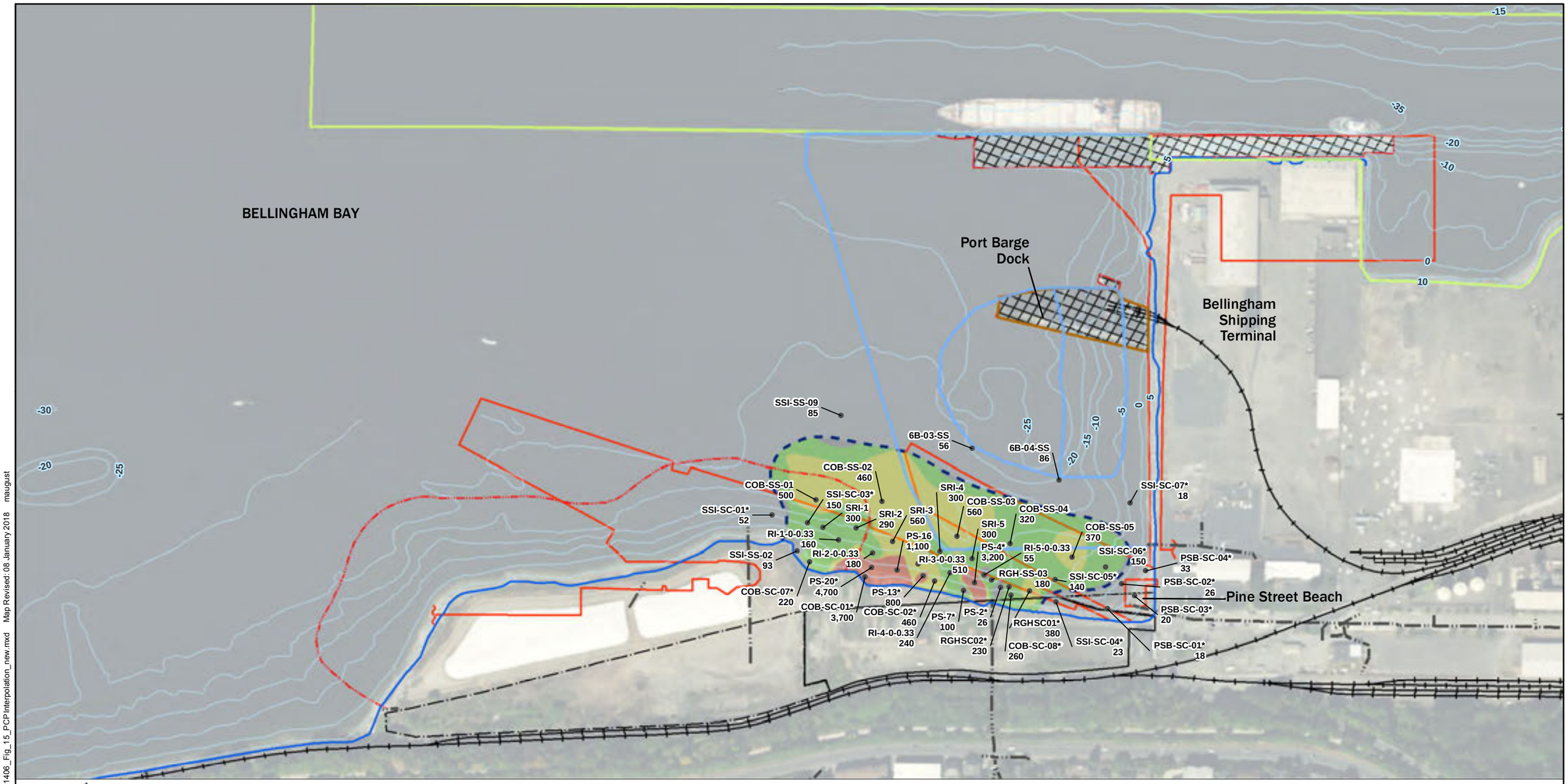
Interpolated Extent of cPAH TEQ in Surface[1] Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 14

Path: P:\00356114\GIS\MXDs\SedimentFinals\0616\035611406_Fig_14_cPAH.mxd Map Revised: 08 January 2018 maugust



Path: P:\0\0356114\GIS\MXDs\SedimentFinals\061603611406_Fig_15_PCPInterpolation_new.mxd Map Revised: 08 January 2018 maugust

True North
Project North
0 150 300
Feet

Surface Sediment Pentachlorophenol Concentration (µg/kg)
- ≤100 (Preliminary Cleanup Level)
- >100≤350
- >350≤790
- >790
- Estimated Extent of Preliminary Cleanup Level Exceedance

Current
- Storm Drain Pipe
- BNSF Railroad
- Present-day Over-water Structure
- Current Shoreline
- Contour (5-ft interval)

Property Lines
- City-Owned Property, Former R.G. Haley
- Cornwall Property
- Port of Bellingham Property

Proposed Remedies
- Proposed Cornwall Avenue Landfill Sediment Remedy
- Whatcom Waterway Monitored Natural Recovery Site Units
- Whatcom Waterway Capping with Armoring
- Whatcom Waterway Dredging or Capping Site Units
- Footprint of Historic Over-Water Structure

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
1. Preliminary cleanup level = 100 µg/kg.
2. Interpolations settings: IDW Power=6, Neighbors=8, Reach=600ft.
3. The locations of all features shown are approximate.
4. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

[1]Surface = 0-0.39 ft below mudline (blm), except for sample labels noted by *, which are 0-2 ft blm.

Interpolated Extent of Pentachlorophenol in Surface[1] Sediment

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure 15

APPENDICES

GeoEngineers

APPENDIX A
Field Logs and Forms

A.1 Pine Street Beach
Field Forms - 2013

Site: RG Haley

Weather: Cloudy, 60s

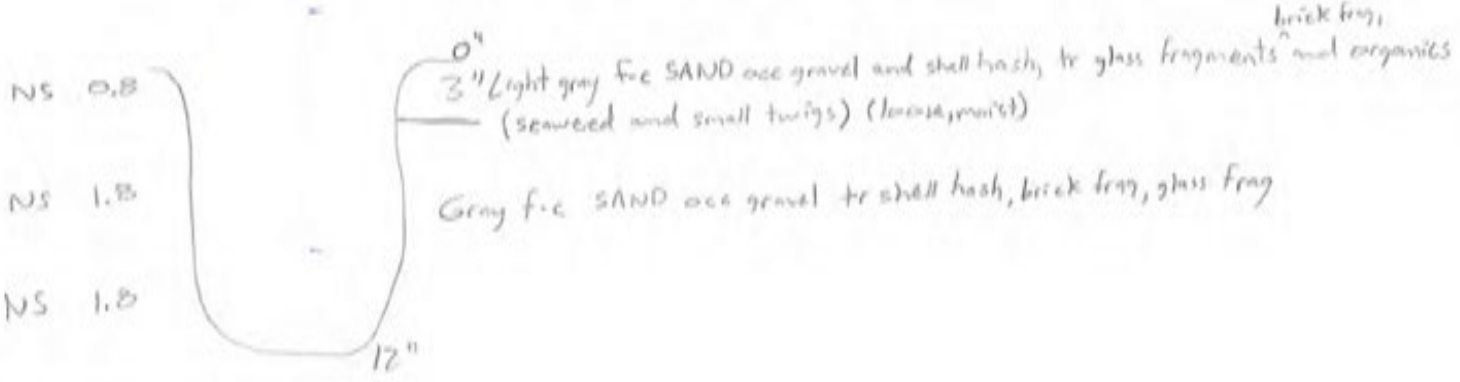
Date: 8/17/13

Time: 0740

Loc: COB-CC-D1

Tide: High: 8.45' @ 12:44 am Low: -0.98 @ 8:39 am Datum: MLLW, NOAA Cherry Point ID 9449424

Sample Description



Odor: None

Sheen: NS

PID: 0.8-1.8

Live Organisms: None

Site: RG Haley

Weather: See D1

Date: 8/17/13

Time: 08:05

Loc: COB-CC-D2

Tide: High: See D1 Low: Datum:

Sample Description

Sheen	PID	
NS	0.8	0" Gray fc SAND occ gravel + shell hash, glass frag., brick frag
NS	1.1	12"

Odor: None Sheen: NS PID: ~~0.1~~ 0.8-1.1

Live Organisms: None

Site: RG Haley

Weather: See D1

Date: 8/17/13

Time: 0820

Loc: COB-CC-D3

Tide: High: See D1 Low: Datum:

Sample Description

Dark gray f-c SAND w/silt, gravel, tr shell hash, tr glass frag, brick frag
ex hole 12"

Odor: v slight sulfur Sheen: NS PID: 4.2

Live organisms: None

Site: RG Haley

Weather: See D1

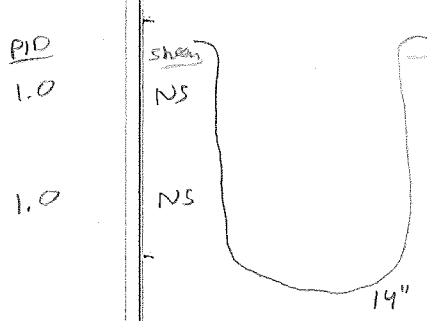
Date: 8/17/13

Time: 0945

Loc: COB-CC-D4

Tide: High: See D1 Low: Datum:

Sample Description



removed 2" wood/soil layer

Brown fine SAND tr shell hash, brick frag, glass frag, org (tr woody matl) (loose, moist)

Odor: None Sheen: NS PID: 1.0

Live organisms: None

Site: RG Haley

Weather: See D1

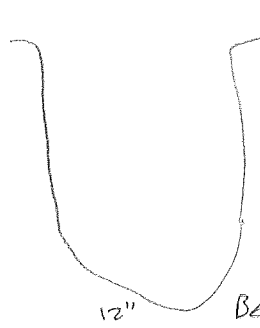
Date: 8/17/13

Time: 0925

Loc: COB-CC-D5

Tide: High: See D1 Low: Datum:

Sample Description



NS 1.1

NS 1.7

Gray f-m SAND and shell hash, occ gravel, tr glass and brick frag, tr wood (tr sawdust, ~0.25" lens in N sidewall)

Becomes wet @12", one live clam @4", one live clam @12"

Odor: None Sheen: NS PID: 1.1-1.7

Live Org: 2 live clams

Site: RG Haley

Weather: See D1

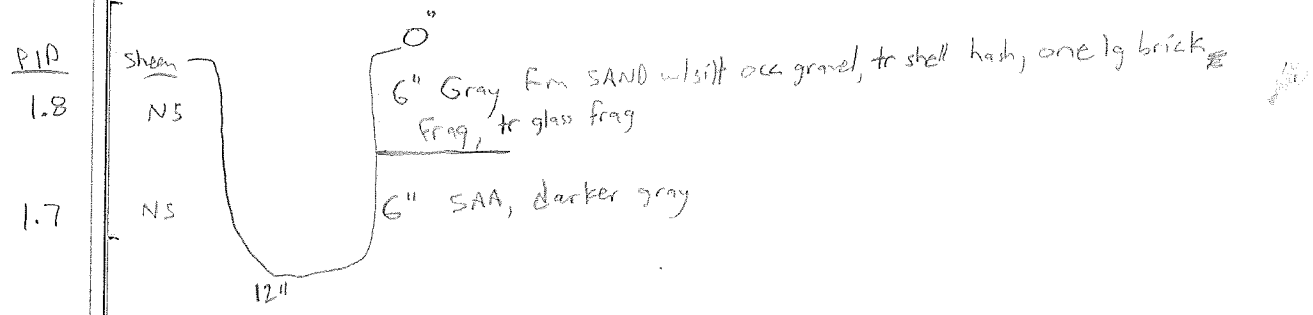
Date: 8/17/13

Time: 0855

Loc: COB-CC-D6

Tide: High: See D1 Low: Datum:

Sample Description



Odor: slight sulfur Sheen: NS PID: 1.7-1.8

Live Org: Live clams
One large centipede-like org (see pic)
Several small worms

A.2 Supplemental Sediment Investigation Field Forms - 2015

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: Mike, Chad, Paul, Claudia

Sample Location: SS1-SS-01

Date: 10/15/15

Weather: Sunny, Warm

Vessel: Teton

Sampling Method: Power Grab

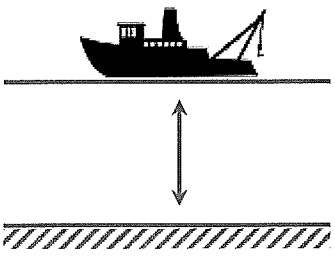
Target Depth (ft): 12cm

Target Coordinates:

Long/Easting:

Lat/Northing:

(See navigation report for actual)



Water Elevation:

Datum:

Depth to Mudline: 8.31

Time: 1231

Mudline Elevation:

Datum:

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	—	Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe): Mostly brick, glass, rock and clam

Other Debris (describe):

See back for additional attempts

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SSI-SS-01

10/15/15

Attempt 1 Brick, glass, rock + clam
Attempt 2 low volume, brick, glass, ~~glass~~ tile
" 3 rock, brick
" 4. rock, clam, brick
" 5 two big rocks (4" approx. diam)
" 6 two more big rocks (4" to 6" diam)
" 7 brick, large rock
" 8 brick, rocks, clam

} rejected

All rejected. above
Relocated Approx 10 feet

Attemp 9 9cm of penetration. — COMPOSITE
" 10 insufficient volume, rocks in jaws — rejected
" 11 6cm of penetration — COMPOSITE
" 12 clams, rocks, washed out — rejected
" 13 16 cm penetration — COMPOSITE
" 14 Tile back splash (8" long) — rejected
" 15 4cm penetration — COMPOSITE

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew:

Sample Location: SG1-SS-01

Date: 10/15/15

Weather: Sunny, warm

Vessel: Tipton

Sampling Method: Power Grab

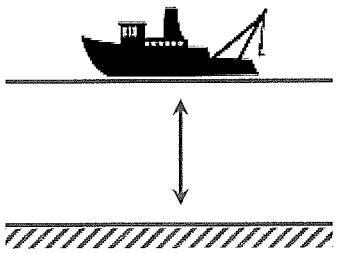
Target Depth (ft): 12cm

Target Coordinates:

Long/Easting:

Lat/Northing:

(See navigation report for actual)



Water Elevation:

Datum:

Depth to Mudline: 9.5'

Time: 1246

Mudline Elevation:

Datum:

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
9	9 cm	(Yes) No	Discrete or (Composite?)

Fill out for accepted grab only—

↳ Goob #9, #11, #13, #15, #18

Sediment Type (circle): Cobble Gravel Coarse Sand (Medium Sand Fine Sand) Silt/Clay

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

approx 1" rocks

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): Shell fragments, whole shells

Other Debris (describe): Glass

see attempt #11 notes

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): None.

RPD depth (cm): 0

See notes on back →

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): very Light Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations:

PID = 0 ppm

Logged by:

10/15/15

SS1-SS-01

Attempt 16	Rock in jaw, washed out	Rejected
17	"	"
18	6 cm penetration	COMPOSITE

DONE

Samples collected SS1-SS-01_0-12
SS1-SS-DUP-03

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew:

Sample Location: SS1-SS-01

Date: 10/15/15

Weather: Sunny, warm

Vessel: Teton

Sampling Method: Power Grab

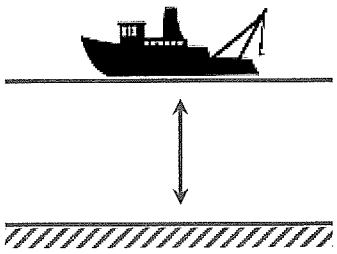
Target Depth (ft): 12cm

Target Coordinates:

Long/Easting:

Lat/Northing:

(See navigation report for actual)



Water Elevation:

Datum:

Depth to Mudline: 9.5'

Time: 12:59

Mudline Elevation:

Datum:

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
11	6 cm	Yes No	Discrete or Composite?

Fill out for accepted grab only— fine to med Gravel with fine to coarse sand

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

whole clams

Other Debris (describe):

glass

Grab # 9
#11
#13
#15
#18

One composite sample

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

None

RPD depth (cm): 0

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): very Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

SS1-SS-01_0-12 and SS1-SS-DUP-03

Comments/Other Observations:

SS1-SS-01_0-12 4 jars to ARI + 1 bucket for bioassay (2-gal)

PID = 0 ppm

SS1-SS-DUP-03 4 jars to ARI

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/15/15

Project No.: 0356-114-06 *Weather:* Sunny, warm

Subcontractor: Gravity Environmental LLC *Vessel:* Teton

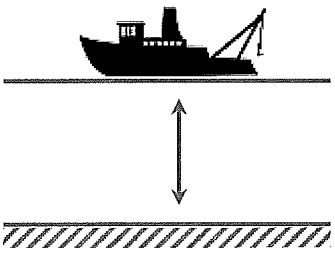
Sampling Crew: _____ *Sampling Method:* Power Grab

Sample Location: SS1-SS-01 *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: 9.5'

Time: 1305

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
13	6 cm	(Yes) No	Discrete or (Composite?)

Fill out for accepted grab only— fine to coarse gravel w/ fine to coarse sand and silt

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75% roots

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe):

Shells, worms

Other Debris (describe):

Glass,

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe):

None, too coarse

RPD depth (cm): (0)

Sediment Odor Type (circle): (None) Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong (NA)

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/15/15

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

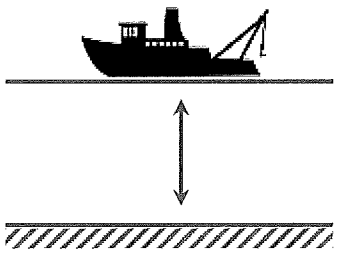
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-01 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: 9.5'

Time: 1310

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
15	4 cm	(Yes) No	Discrete or (Composite?)

Fill out for accepted grab only— fine to ~~med~~ coarse gravel w/ fine to coarse sand and silt

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe):

Shells, Clams

Other Debris (describe):

Glass

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe):

None, too coarse

RPD depth (cm): ( )

Sediment Odor Type (circle): (None) Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong (NA)

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: _____

Sample Location: SS1-SS-01

Date: 10/15/15

Weather: Sunny, warm

Vessel: Tretop

Sampling Method: Power Grab

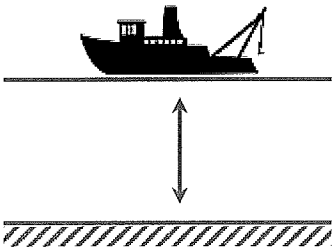
Target Depth (ft): 12 cm

Target Coordinates:

Long/Easting: _____

(See navigation report for actual)

Lat/Northing: _____



Water Elevation: _____

Datum: _____

Depth to Mudline: 9.5'

Time: 1315

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
18	6cm	(Yes) No	Discrete or (Composite?)

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay — fine to coarse gravel w/ fine to coarse sand → see attempt 11 noted

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe):

Shells, Clams

Other Debris (describe):

Glass

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe):

None, too coarse

RPD depth (cm): ( )

Sediment Odor Type (circle): (None) Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong (N/A)

Petroleum Sheen (circle): None (Slight) Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: RR, GL, CV

Sample Location: SS1-SS-01

Target Coordinates:

Long/Easting:

(See navigation report for actual)

Date: 10/12/15

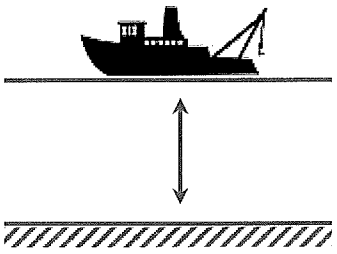
Weather: lt rain, hi 50s

Vessel: Tieton

Sampling Method: Power grab

Target Depth (ft): 12 cm

Lat/Northing:



Water Elevation: ~3'

Datum: NAVD88

Depth to Mudline: 4.4'

Time: 11:04

Mudline Elevation: -1.4

Datum: NAVD88

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	0	Yes (No)	~~Discrete~~ or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): gravel and cobbles

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by: GRL

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

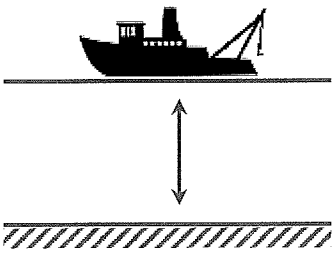
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: ~~SS+~~ SS1-SS-01 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: _____

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): cobble, mussels. Moved ~5' offshore for next attempt

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by: GM

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12

Project No.: 0356-114-06 *Weather:* _____

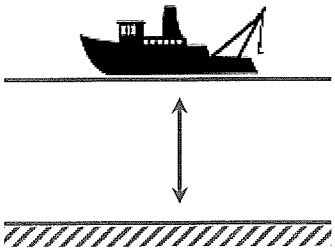
Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-01 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____
(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: 5.8'

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
3		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): Cobbles, gravel

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12

Project No.: 0356-114-06 *Weather:* _____

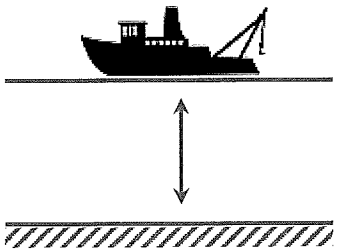
Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-01 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____
(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: 6.5'

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
4		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): Contains one cobble in jaws

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12

Project No.: 0356-114-06 *Weather:* _____

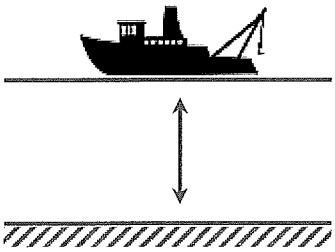
Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-01 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____
(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: _____

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
5		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): Cobbles, a few ~~clams~~ clams

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12

Project No.: 0356-114-06 *Weather:* _____

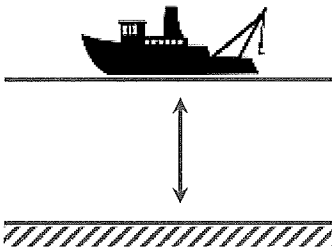
Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-01 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____
(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: _____

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
6		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): Cobbles

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project: R.G. Haley Supplemental Sediment Investigation

Date: 10/15/15

Project No.: 0356-114-06

Weather: overcast, cool

Subcontractor: Gravity Environmental LLC

Vessel: N/A sampled from boat to

Sampling Crew: Paul

Sampling Method: by hand, spoon

Sample Location: SSI-SS-02

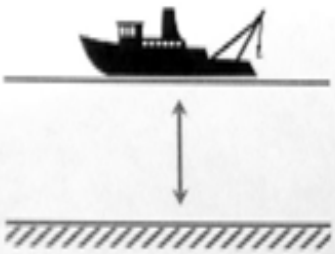
Target Depth (ft): 4-5"

Target Coordinates: ~122-49356

Long/Easting: ~122.49020

Lat/Northing: 48.7408Z

(See navigation report for actual)



Water Elevation: 4.0

Datum: MLLW

Depth to Mudline: 0

Time: 1220 1200

Mudline Elevation:

Datum:

Acceptance Criteria:

- Overlying water present
- Low turbidity in overlying water
- Grab not over-filled
- Sediment surface ~flat
- No winnowing/washout
- Target penetration achieved

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	12	(Yes) No	Discrete or (Composite?)

Fill out for accepted grab only—

Sediment Type (circle): Cobble (Gravel) Coarse Sand Medium Sand Fine Sand Silt/Clay

w/ F-M Sa

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): (Present) Absent

Vegetation/Biota (describe): kelp

Other Debris (describe): glass, tiles, brick fragments

Sediment Color (circle): Olive (Light Brown) Dark Brown Gray Black

Stratification/Layering (describe): none, shell hash to 5"

RPD depth (cm): 0

Sediment Odor Type (circle): None Petroleum (H_2S) slight

Odor Strength (circle): (Light) Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: PID = 0.0

Logged by: PDR

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

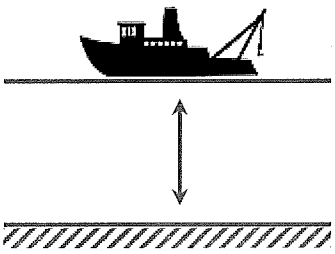
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-03 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: ~~-~~ 2.87

Datum: NAVD88

Depth to Mudline: 3.6

Time: 11:46

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): f-c GRAVEL

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* _____

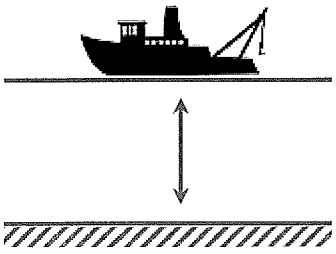
Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-03 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____
(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: _____

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): Cobble; slight sheen on water surface after grab. Dissipates after one minute.

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

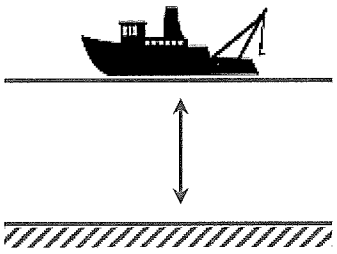
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-03 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: _____

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
3		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/13/15

Project No.: 0356-114-06 — *Weather:* Overcast

Subcontractor: Gravity Environmental LLC — *Vessel:* _____

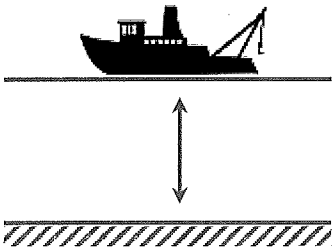
Sampling Crew: PDR, GL, CD — *Sampling Method:* Power Grab

Sample Location: SS1-SS-03 — *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: _____ — *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: Approx 13.5'

Datum: NAVD88

Depth to Mudline: 4.8'

Time: 1109

Mudline Elevation: NAVD88

Datum: ~ -1.3 -11

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1 thru 7		Yes (No)	Discrete or Composite?

Grab Rejected Attempts

1. Brick
2. Washout
3. Debri, brick, glass
4. Brick + asphalt
5. Cobbles, glass, debri
6. Cobbles, glass, rocks
7. Washout w/ glass

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by: CD

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/15/15

Project No.: 0356-114-06 *Weather:* Sunny, warm

Subcontractor: Gravity Environmental LLC *Vessel:* Tiefen

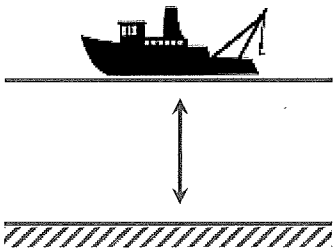
Sampling Crew: Mike, Chad, Paul, Claudia *Sampling Method:* power grab

Sample Location: SS1-SS-03 *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: 9.0'

Time: 1128

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	9 cm	Yes (No)	Discrete or Composite?

Fill out for accepted grab only— insufficient recovery

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: Mike, Chad, Paul, Claudia

Sample Location: SS1-SS-23

Date: 10/15/15

Weather: Sunny, Warm

Vessel: Tieton

Sampling Method: Power Grab

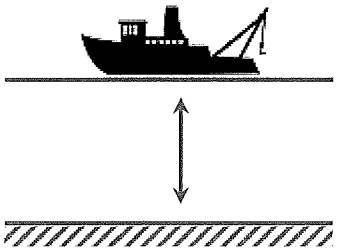
Target Depth (ft): 12 cm

Target Coordinates:

Long/Easting:

Lat/Northing:

(See navigation report for actual)



Water Elevation:

Datum:

Depth to Mudline: 9.0'

Time: ~~1129~~ 1144

Mudline Elevation:

Datum:

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2		Yes (No)	Discrete or Composite?

Fill out for accepted grab only— Rock in the jaw. Debri in grab.

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/15/15

Project No.: 0356-114-06 — *Weather:* Sunny, warm

Subcontractor: Gravity Environmental LLC — *Vessel:* Tieton

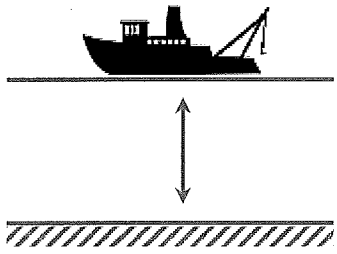
Sampling Crew: Mike, Chad, Paul, Claudia — *Sampling Method:* Power Grab

Sample Location: SS1-SS-03 — *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: _____ — *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: 9.01 12.8'

Time: 1157

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
3	21 cm	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt/Clay) — Silty fine to Med sand w/ trace wood debri

Wood debris (by volume) (circle): (None) (<25%) 25-50% 50-75% >75% — only occ. roots.

Shell hash (circle): Present (Absent) — shells + shell fragments

Vegetation/Biota (describe):

Worms

Other Debris (describe):

Rope — on mud line - weathered lumber. (Planks, construction lumber)

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe):

None. Homogenous

RPD depth (cm): (0)

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): (very) Light Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present — No sheen

Comments/Other Observations:

PID = 0ppm

sample @ 1205
4 Jars to ARI + 1 Brassay bucket ~~for~~ to ARI
~~AND SS1-SS-DUP-03~~ not enough volume

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project: R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: PAUL

Sample Location: SSI - SS - 04

Target Coordinates:

Long/Easting: -122.49076

(See navigation report for actual)

Date: 10/15/15

Weather: overcast, cool

Vessel: N/A sampled @ low tide

Sampling Method: by hand, spoon

Target Depth (ft): 4" - 5"

Lat/Northing: 48.74211

Water Elevation: 3.3

Datum: MLLW

Depth to Mudline: 0

Time: 2230

Mudline Elevation:

Datum:

Acceptance Criteria:

- Overlying water present
- Low turbidity in overlying water
- Grab not over-filled
- Sediment surface ~flat
- No winnowing/washout
- Target penetration achieved

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	12	(Yes) No	Discrete or (Composite?)

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand (Medium Sand) (Fine Sand) Silt/Clay

Wood debris (by volume) (circle): None (<25%) 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): crabs, worms

Other Debris (describe): glass, bricks

Sediment Color (circle): Olive (Light Brown) Dark Brown Gray Black

Stratification/Layering (describe): Large boulders, cobbles & bricks over brown F-M Sa, sand to 4"-5" over more cobbles, bricks

RPD depth (cm): 0

Sediment Odor Type (circle): (None) Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: PID = 0.0

Logged by: PDJ

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/12/15

Project No.: 0356-114-06 — *Weather:* lt rain, 50s

Subcontractor: Gravity Environmental LLC — *Vessel:*

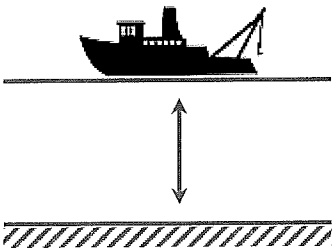
Sampling Crew: GL/CV/PR — *Sampling Method:* Power Grab

Sample Location: SS1 - SS-05 — *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: — *Lat/Northing:*

(See navigation report for actual)



Water Elevation: ~3

Datum: NAVD88

Depth to Mudline: 7.8

Time: 12:00

Mudline Elevation: -4.8

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved* 14

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	14	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand (Fine Sand) (Silt) Clay — >50% silt (organic) <50% f sand

Wood debris (by volume) (circle): None (<25%) 25-50% 50-75% >75% (trace wood).

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): trace worms: very small. Less than 1mm diameter x one to two cm long. Trace shelled animal (two of them). One live clam ~3 cm. ~~Several~~ snails.

Other Debris (describe): 2 small pieces of wood. Splinters ~4 cm in length. Likely processed due to several flat sides. Does not appear to be treated (no odor, PID, sheen, discoloration).

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): Top 2 cm is olive colored, sed is black below 2cm

RPD depth (cm): 2 cm

Sediment Odor Type (circle): (None) Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: No eelgrass
Sample time = 12:00
PID = 0.0

Logged by: GRL

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* Cloudy, SDS

Subcontractor: Gravity Environmental LLC *Vessel:*

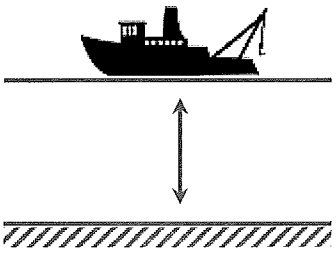
Sampling Crew: GL/PR/CV *Sampling Method:* Power Grab

Sample Location: SS1-SS-~~08~~ 06 *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: *Lat/Northing:*

(See navigation report for actual)



Water Elevation: ~4

Datum: NAVD88

Depth to Mudline: 8.7'

Time: 12:36

Mudline Elevation: -4.7

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved* 17 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	17	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand (Fine Sand) (Silt)/Clay >50% fine sand <50% silt

Wood debris (by volume) (circle): None (<25%) 25-50% 50-75% >75% trace wood: Twigs. Does not appear to be processed.

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): Trace worms as in SS-05. One small flatworm. Dead eelgrass. One live clam, ~3 cm.

Other Debris (describe): —

Sediment Color (circle): Olive Light Brown Dark Brown (Gray) (Black)

Stratification/Layering (describe): ~0.5 cm olive colored

RPD depth (cm): 0.5 cm

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): (Light) Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: Some eelgrass mixed in surface; mostly dead.

PID = 0.0

Sample time = 12:36

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

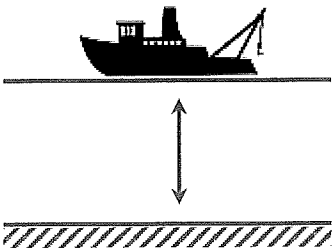
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-07 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: 3.53

Datum: NAVD88

Depth to Mudline: 7.4

Time: 13:05

Mudline Elevation: -3.87

Datum: NAVD88

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): Cobbles

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

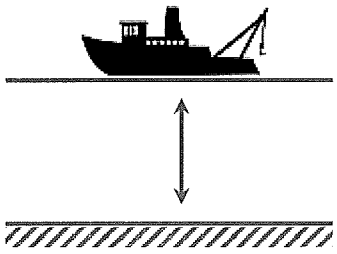
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-55-07 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: _____

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): Cobbles

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

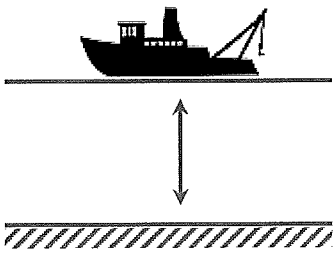
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-07 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: _____

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
3	4 cm	Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* Cloudy, 50s

Subcontractor: Gravity Environmental LLC *Vessel:*

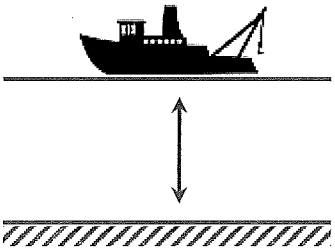
Sampling Crew: *Sampling Method:*

Sample Location: SS1-SS-07 *Target Depth (ft):*

Target Coordinates:

Long/Easting: *Lat/Northing:*

(See navigation report for actual)



Water Elevation:

Datum:

Depth to Mudline:

Time:

Mudline Elevation:

Datum:

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
4	7	Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/12/15

Project No.: 0356-114-06 — *Weather:* lt rain, SDS

Subcontractor: Gravity Environmental LLC — *Vessel:*

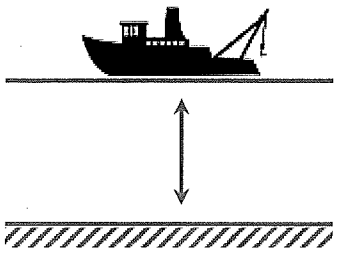
Sampling Crew: — *Sampling Method:* Power grab

Sample Location: SS1-SS-07 — *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: — *Lat/Northing:*

(See navigation report for actual)



Water Elevation: 3.53

Datum: NAVD88

Depth to Mudline: 7.4

Time: 13:05

Mudline Elevation: -3.87

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- • *Target penetration achieved* 11 cm out of 12 (13)

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
5	11	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand (Medium Sand) Fine Sand Silt/Clay + silt, + tg coarse gravel

Wood debris (by volume) (circle): None (<25%) 25-50% 50-75% >75% Trace wood. Not processed. Then fd one piece of processed wood (see "other debris")

Shell hash (circle): (Present) Absent

Vegetation/Biota (describe): One piece live eelgrass. 1 live clam. 1 small ~~snail~~ potentially snail (<1cm)

Other Debris (describe): One piece of wood on surface. Possibly processed because flat on one side. ~5" x 1" x 0.25". No evidence of wood treatment.

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): Top 3cm is olive

RPD depth (cm): 3 cm

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): (Light) Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: Sample time 13:05

PID = 0.6

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/12/15

Project No.: 0356-114-06 — *Weather:* lt rain, 50s

Subcontractor: Gravity Environmental LLC — *Vessel:*

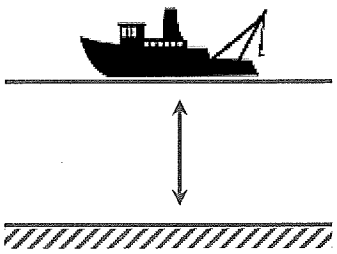
Sampling Crew: — *Sampling Method:* Power grab

Sample Location: SS1-SS-07 — *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: — *Lat/Northing:*

(See navigation report for actual)



Water Elevation: 3.53

Datum: NAVD88

Depth to Mudline: 7.4

Time: 13:05

Mudline Elevation: -3.87

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved*

13 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
6	13	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand (Medium Sand Fine Sand) Silt/Clay + silt, + fg coarse gravel + 1 cobble

Wood debris (by volume) (circle): None (<25%) 25-50% 50-75% >75%

Shell hash (circle): (Present) Absent

Vegetation/Biota (describe): worms, one live clam.

Other Debris (describe): 1 dead clam shell.

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): Top 3 cm olive

RPD depth (cm): 3 cm

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): (Light) Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations:

Sample time 13:05

PID=0.6

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/12/15

Project No.: 0356-114-06 — *Weather:* Clouds, 50s

Subcontractor: Gravity Environmental LLC — *Vessel:*

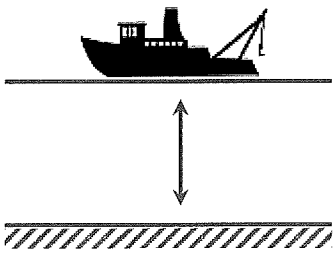
Sampling Crew: — *Sampling Method:* Power Grab

Sample Location: SS1-SS-08 — *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: — *Lat/Northing:*

(See navigation report for actual)



Water Elevation: 4.37

Datum: NAVD88

Depth to Mudline: 26.5

Time: ~~1345~~ 1350

Mudline Elevation: -22.13

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved* 24cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	24 cm	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand (Fine Sand) (Silt)/Clay — >50% silt, <50% sand

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): Dead clam, mussel shells

Other Debris (describe): —

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): —

RPD depth (cm): —

Sediment Odor Type (circle): None Petroleum (H2S)

Odor Strength (circle): Light Moderate Strong (Very Strong)

Petroleum Sheen (circle): None (Slight) Moderate Heavy Product present — <1cm sheen. Somewhat blocky, does not spread. 4 total sheen spots while

Comments/Other Observations: PID = 1.6

Sample time 13:50

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* Clouds, SOS

Subcontractor: Gravity Environmental LLC *Vessel:*

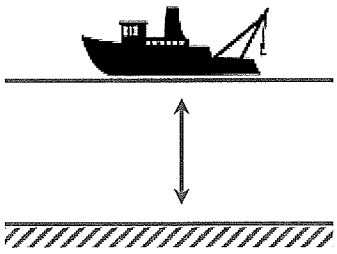
Sampling Crew: *Sampling Method:*

Sample Location: SS1-SS-09 *Target Depth (ft):*

Target Coordinates:

Long/Easting: *Lat/Northing:*

(See navigation report for actual)



Water Elevation: 3.5

Datum: NAVD88

Depth to Mudline: 21.5

Time: 14:05

Mudline Elevation: -18

Datum: NAVD88

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Sampler angled

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	<12 cm	Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* Clouds, 50s

Subcontractor: Gravity Environmental LLC *Vessel:*

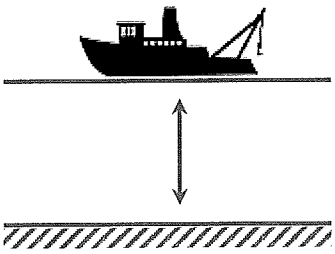
Sampling Crew: *Sampling Method:* Power Grab

Sample Location: SS1-SS-~~08~~ 09 *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: *Lat/Northing:*

(See navigation report for actual)



Water Elevation: 3.5

Datum: NAVD88

Depth to Mudline: 21.5

Time: 14:10

Mudline Elevation: -18

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved* 23 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2	23	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt/Clay) tr fine sand

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): tr shell fragments

Other Debris (describe): —

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): —

RPD depth (cm): —

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): (Light) Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: Sample time = 14:10

PID = 0.0

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew:

Sample Location: SS1-SS-10

Date: 10/12/15

Weather: Clouds, SDS

Vessel:

Sampling Method:

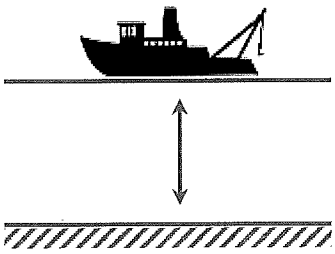
Target Depth (ft):

Target Coordinates:

Long/Easting:

Lat/Northing:

(See navigation report for actual)



Water Elevation: ~5

Datum: NAVD88

Depth to Mudline: 28.8

Time: 14:25

Mudline Elevation: -23.8

Datum: NAVD88

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	over penetration	Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation **Date:** 10/12/15

Project No.: 0356-114-06 **Weather:** Clouds, SDS

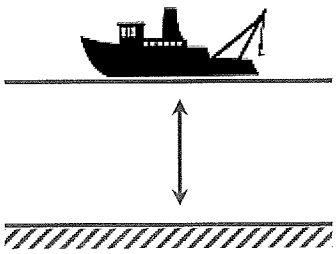
Subcontractor: Gravity Environmental LLC **Vessel:**

Sampling Crew: **Sampling Method:** Power Grab

Sample Location: SS1-SS-10 **Target Depth (ft):** 12 cm

Target Coordinates:

Long/Easting: *Lat/Northing:*
(See navigation report for actual)



Water Elevation: ~5

Datum: NAVD88

Depth to Mudline: 28.8

Time: 14:25

Mudline Elevation: -23.8

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved*

14 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2	14	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt/Clay) tr fine sand

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): —

Other Debris (describe): —

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): Upper 9 cm is silttier; lower 3 cm becomes sandier.

RPD depth (cm): —

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): (Light) Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: Sample time = 14:35

PID = 1.8

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* Cloudy,

Subcontractor: Gravity Environmental LLC *Vessel:*

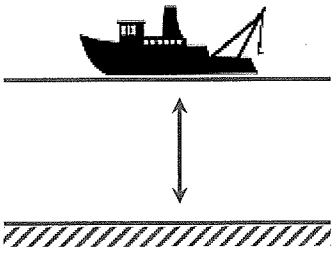
Sampling Crew: *Sampling Method:*

Sample Location: SS1-SS-11 *Target Depth (ft):*

Target Coordinates:

Long/Easting: *Lat/Northing:*

(See navigation report for actual)



Water Elevation: ~5.8

Datum: NAVD88

Depth to Mudline: 30.1

Time: 1530

Mudline Elevation:

Datum:

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* _____

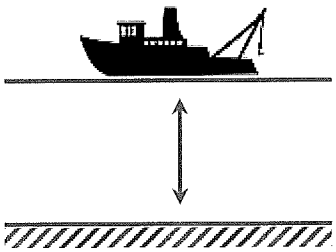
Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1 - SS - 11 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____
(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: _____

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/12/15

Project No.: 0356-114-06 — *Weather:* Clouds, ~~60~~ upper 50's

Subcontractor: Gravity Environmental LLC — *Vessel:*

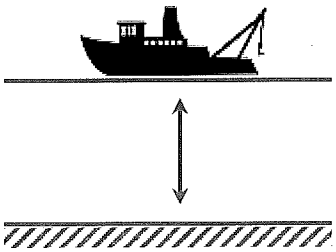
Sampling Crew: — *Sampling Method:* Power Grab

Sample Location: SS1-SS-R11 — *Target Depth (ft):* 12cm

Target Coordinates:

Long/Easting: — *Lat/Northing:*

(See navigation report for actual)



Water Elevation: ~5.8

Datum: NAVD88

Depth to Mudline: 30.1

Time: 15:30

Mudline Elevation: -24.3

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved* 22cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
3	22	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt) Clay

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75% None in sample interval; wood @ 20cm

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): —

Other Debris (describe): —

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): Upper 20 cm is silt; wood is present in jaws of sampler below 20cm. Wood appears processed due to flat sides. No indication of treatment. Largest piece appears at least 8" long

RPD depth (cm): —

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): Light Moderate Strong (Very Strong)

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: Sample time = 15:40

PID = 0.0

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* lt rain, 50s

Subcontractor: Gravity Environmental LLC *Vessel:*

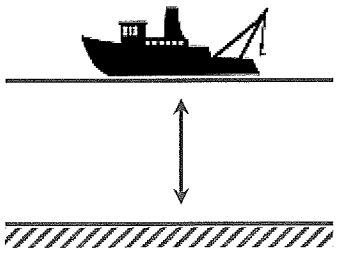
Sampling Crew: *Sampling Method:* Power Grab

Sample Location: SS1-SS-12 *Target Depth (ft):* 12cm

Target Coordinates:

Long/Easting: *Lat/Northing:*

(See navigation report for actual)



Water Elevation: ~5.8

Datum: NAVD88

Depth to Mudline: 29.6

Time: 1400

Mudline Elevation: -23.8

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved*

21cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	21	(Yes) No	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt/Clay)

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): Worms. <1mm thick.

Other Debris (describe): —

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): Silt possibly laminated: not obvious, but faint lamination visible: <1mm laminae.

RPD depth (cm): —

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): Light Moderate (Strong) Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: Sample time = 1600
PID = 0.0

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* Clouds, SDS

Subcontractor: Gravity Environmental LLC *Vessel:*

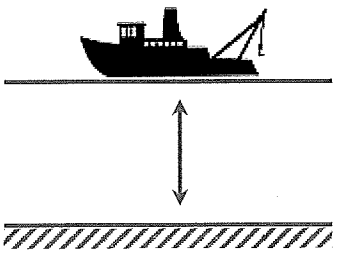
Sampling Crew: *Sampling Method:* Power grab

Sample Location: SS1-SS-13 *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: *Lat/Northing:*

(See navigation report for actual)



Water Elevation: ~6

Datum: NAVD88

Depth to Mudline: 33.3

Time: 16:20

Mudline Elevation: -27.3

Datum: NAVD88

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe): one lg piece wood (not processed)

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

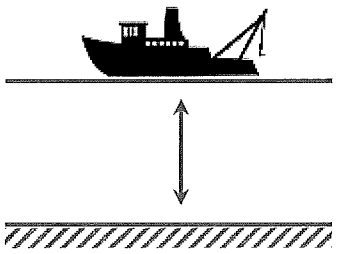
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-13 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: ~6

Datum: NAVD88

Depth to Mudline: 33.3

Time: 16:20

Mudline Elevation: -27.3

Datum: NAVD88

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/12/15

Project No.: 0356-114-06 *Weather:* Clouds, SDS

Subcontractor: Gravity Environmental LLC *Vessel:*

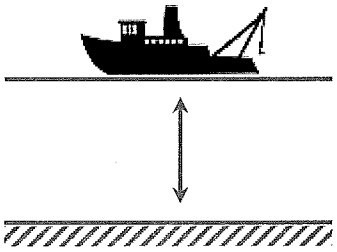
Sampling Crew: *Sampling Method:* Power Grab

Sample Location: SS1-SS-13 *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: *Lat/Northing:*

(See navigation report for actual)



Water Elevation: ~6

Datum: NAVD88

Depth to Mudline: 33.3

Time: 16:20

Mudline Elevation: -27.3

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved*

22 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
3	22	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt)/Clay tr f SAND

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): —

Other Debris (describe): —

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): —

RPD depth (cm): —

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): Light Moderate Strong (Very Strong)

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: Sample time 1430
PID = 0.0

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/13/15

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

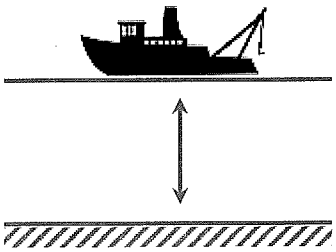
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-14 *Target Depth (ft):* _____

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: 29.4

Time: 0910

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/13/15

Project No.: 0356-114-06 — *Weather:* Overcast

Subcontractor: Gravity Environmental LLC — *Vessel:*

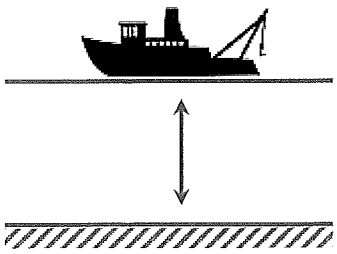
Sampling Crew: GL, CD, PDR — *Sampling Method:* Power Grab

Sample Location: SS1-SS-14 — *Target Depth (ft):* 12cm

Target Coordinates:

Long/Easting: — *Lat/Northing:*

(See navigation report for actual)



Water Elevation: Approx ~5' — *Datum:* NAVD88

Depth to Mudline: 29.4 — *Time:* 0910

Mudline Elevation: -24' — *Datum:* NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved* 16 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2	16	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt) Clay trace w/ fine sand

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): None

Other Debris (describe): Highly weathered/degraded. None. One piece of bark, red, flat inner section, potentially processed

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): None

RPD depth (cm): 0

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): (Light) Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: sample time 0920

PID = 0.2 ppm

4 jars ARI for Archive.

3 " Frontier

Logged by: CD

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: GL/PR

Sample Location: SS1-SS-15

Target Coordinates:

Long/Easting:

(See navigation report for actual)

Date: 10/13/15

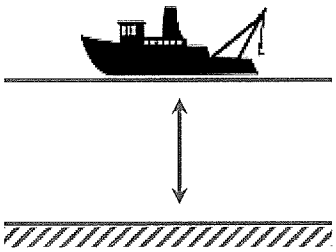
Weather: Clouds, SDs

Vessel:

Sampling Method: Power Grab

Target Depth (ft): 12 cm

Lat/Northing:



Water Elevation: ~5.8

Datum: NAVD88

Depth to Mudline: 27.4 *

Time: 08:30

Mudline Elevation: -21.6

Datum: NAVD88

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations: * Depth inconsistent w/ Figure 5: Fig 5 indicated we should be at ~25' NAVD88.

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/13/15

Project No.: 0356-114-06 *Weather:* _____

Subcontractor: Gravity Environmental LLC _____ *Vessel:* _____

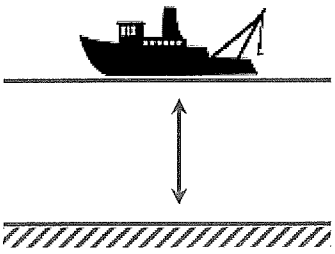
Sampling Crew: _____ *Sampling Method:* _____

Sample Location: SS1-SS-15 *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: _____

Datum: _____

Depth to Mudline: _____

Time: _____

Mudline Elevation: _____

Datum: _____

Acceptance Criteria:

- *Overlying water present*
- *Low turbidity in overlying water*
- *Grab not over-filled*
- *Sediment surface ~flat*
- *No winnowing/washout*
- *Target penetration achieved*

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
2		Yes (No)	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand Silt/Clay

Wood debris (by volume) (circle): None <25% 25-50% 50-75% >75%

Shell hash (circle): Present Absent

Vegetation/Biota (describe):

Other Debris (describe):

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

RPD depth (cm):

Sediment Odor Type (circle): None Petroleum H_2S

Odor Strength (circle): Light Moderate Strong Very Strong

Petroleum Sheen (circle): None Slight Moderate Heavy Product present

Comments/Other Observations:

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew:

Sample Location: SS1-SS-15

Date: 10/13/15

Weather: clouds, 50's

Vessel:

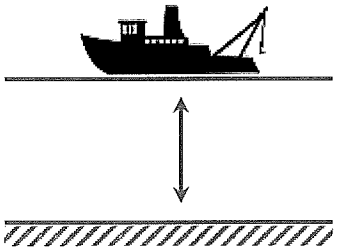
Sampling Method: Power Grab

Target Depth (ft): 12 cm

Target Coordinates:

Long/Easting:
(See navigation report for actual)

Lat/Northing:



Water Elevation:

Datum:

Depth to Mudline:

Time:

Mudline Elevation:

Datum:

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved*

14 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
3	14	(Yes) No	Discrete or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt/Clay)

Wood debris (by volume) (circle): None (<25%) 25-50% 50-75% >75% tr wood debris below ~13 cm wood splinter, possibly processed, no evidence of treatment

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): v small worms, a few shell fragments

Other Debris (describe): —

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe): top 3 cm olive brown

RPD depth (cm): 3 cm

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): (Light) Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: Sample time 08:40
PID = 0.0

Logged by:

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation *Date:* 10/13/15

Project No.: 0356-114-06 *Weather:* Overcast

Subcontractor: Gravity Environmental LLC *Vessel:* _____

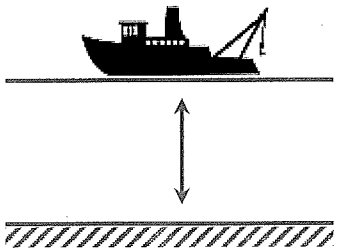
Sampling Crew: GL, CD, PDR *Sampling Method:* Power Grab

Sample Location: SS1-SS-16 *Target Depth (ft):* 12cm

Target Coordinates:

Long/Easting: _____ *Lat/Northing:* _____

(See navigation report for actual)



Water Elevation: Approx ~5'

Datum: NAVD88

Depth to Mudline: 30.4'

Time: 0937

Mudline Elevation: -25'

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved* 14 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	14cm	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt)/Clay trace fine sand

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): None

Other Debris (describe): None

Sediment Color (circle): Olive Light Brown Dark Brown Gray (Black)

Stratification/Layering (describe):

RPD depth (cm): None 0

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): Light (Moderate) Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations:

PID = 0ppm

Sample time 0940

2 to ARI

1 to Frontier

Archived

Logged by: CD

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/13/15

Project No.: 0356-114-06 — *Weather:* Overcast

Subcontractor: Gravity Environmental LLC — *Vessel:*

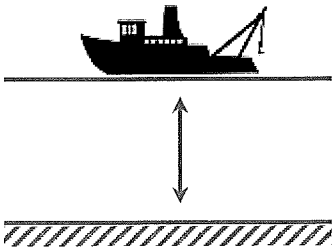
Sampling Crew: GL, CD, ADR — *Sampling Method:* Power Grab

Sample Location: SS1-SS-17 — *Target Depth (ft):* 12 cm

Target Coordinates:

Long/Easting: — *Lat/Northing:*

(See navigation report for actual)



Water Elevation: Approx ~5.5'

Datum: NAVD88

Depth to Mudline: 32.3'

Time: 0957

Mudline Elevation: -27'

Datum: NAVD88

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved* 18 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	18 cm	(Yes) No	Discrete (Composite)?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt/Clay)

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Sticky plastic silt.

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe):

occ. worm, shell fragments

Other Debris (describe):

None

Sediment Color (circle): Olive Light Brown Dark Brown Gray Black

Stratification/Layering (describe):

0 to 4cm soft sed, followed by stiff sediment

RPD depth (cm): 0

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): Light (Moderate) Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations:

PID = 0 ppm

Sample time 1003
4 to ARI
3 to Frontier
Archived

Logged by: CD

SEDIMENT SAMPLING FORM—SURFACE GRABS

Project:R.G. Haley Supplemental Sediment Investigation — *Date:* 10/13/15

Project No.: 0356-114-06 — *Weather:* Overcast

Subcontractor: Gravity Environmental LLC — *Vessel:*

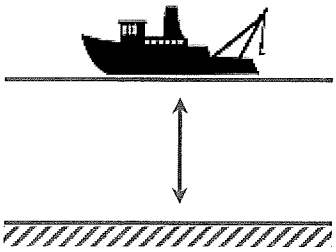
Sampling Crew: GL, CD, PDR — *Sampling Method:* Power Grab

Sample Location: SS1-SS-18 — *Target Depth (ft):* 12cm

Target Coordinates:

Long/Easting: — *Lat/Northing:*

(See navigation report for actual)



Water Elevation: Approx 4.5'

Datum: NAD88

Depth to Mudline: 28.1' w/ angle

Time: 1021

Mudline Elevation: NAD88

Datum: -24'

Acceptance Criteria:

- ✓ *Overlying water present*
- ✓ *Low turbidity in overlying water*
- ✓ *Grab not over-filled*
- ✓ *Sediment surface ~flat*
- ✓ *No winnowing/washout*
- ✓ *Target penetration achieved* 14 cm

Grab No.:	Penetration Depth (cm):	Sample Accepted (circle):	Sample Type (circle):
1	14 cm	(Yes) No	(Discrete) or Composite?

Fill out for accepted grab only—

Sediment Type (circle): Cobble Gravel Coarse Sand Medium Sand Fine Sand (Silt) Clay

Wood debris (by volume) (circle): (None) <25% 25-50% 50-75% >75%

Shell hash (circle): Present (Absent)

Vegetation/Biota (describe): green + brown worms (moderate amount)

Other Debris (describe): None

Sediment Color (circle): Olive Light Brown Dark Brown (Gray) (Black)

Stratification/Layering (describe): None

RPD depth (cm): 1 cm (olive)

Sediment Odor Type (circle): None Petroleum (H_2S)

Odor Strength (circle): (Light) Moderate Strong Very Strong

Petroleum Sheen (circle): (None) Slight Moderate Heavy Product present

Comments/Other Observations: SS1-SS-18_0-12 Sample 1025 and SS1-SS-DUP-02

2 to ARI → "

1 to Fronter → "

PID = 0 ppm

Logged by: CD

Collected Rinsate_151013 from decanned Power Grab

SEDIMENT SAMPLING FORM--CORES

Project: R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: Hannah, Mike, Chad

Sample Location: SS1-SC-01

Target Coordinates:

Long/Easting:

Date: 10/14/15

Weather: Sunny, 60's

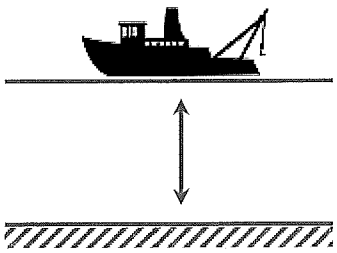
Vessel: Tieton

Sampling Method: Vibracore

Target Depth (ft): 8 ft

Core Lined (circle): (Yes) No

Lat/Northing:



Enter initial loc. info./update for final accepted core:

Water Elevation: 4.75

Datum: MLLW

Depth to Mudline: 8.2 10.4 10.8 ↓ 1800

Time: 1415 ↙ ↓ 1610

Mudline Elevation:

Datum:

Acceptance criteria:

- *Target penetration achieved*
- *Core tube intact/ no obstructions*
- *Calculated compaction < 25%*
- Water

Run No.	Time	Actual		Penetration Depth (ft)	Recovery Length (ft)	Compaction (%)	Accept?
		Long/Easting	Lat/Northing				
1	1420			4	6.5	(possible slough in sampler)	N
2	1455			6	6.5	(possible slough in sampler)	~~N~~ Y
3	1610			5	1.5	—	N
①4	1655			5	3.5	—	N
5	1800			5.5	4	—	N

Comments: #1 recovered excess sediment. Drove only 4 ft, but recovered 6.5'. Likely due to choppiness and movement of corer tube while dropping.

#2 reset spuds for better anchoring, shift to east. About 9ft west of location. Chad sets up new tube. Hold over tube #1.

#3 reposition again and attach frame. Refusal at 5 ft from wood, plastic, hair, brick, shells, tar material

①reuse cleaned core tube from previous run. #4 hit refusal at 5 ft. Slight sheen while pulling out core, sid & wood

Logged by:

#5 failed attempt. Encountered debris at 5ft. Disposed of core. Kept core from 1st run for tomorrow, 3" triangular ceramic plate encountered at base of core tube.

SEDIMENT SAMPLING FORM--CORES

Project: R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: Paul, Hannah, Mike, Chad

Sample Location: SS1-SC-02

Target Coordinates:

Long/Easting:

Date: 10/14/15

Weather: partly sunny, 60's

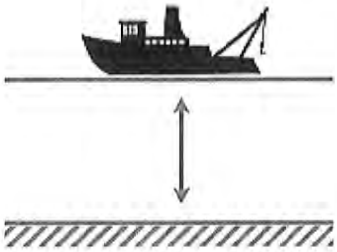
Vessel: Tiefon

Sampling Method: Vibracore

Target Depth (ft): 8'

Core Lined (circle): (Yes) No

Lat/Northing:



Enter initial loc. info./update for final accepted core:

Water Elevation: 7.0

Datum: MLLW

Depth to Mudline: 4.0

Time: 0925

Mudline Elevation:

Datum:

Acceptance criteria:

- *Target penetration achieved*
- *Core tube intact/ no obstructions*
- *Calculated compaction < 25%*
- Water

Run No.	Time	Actual		Penetration Depth (ft)	Recovery Length (ft)	Compaction (%)	Accept?
		Long/Easting	Lat/Northing				
1	0930			0.5	0.5	—	N
① 2	0935			3	0.9	—	N
① 3	0950			1.5	0.5	—	N
① 4	1005			1.5	1.0	—	N

Comments: #1 cobbles and boulders caused refusal just below mudline. No fame.

① Same core tube as previous run

#2 Coarse gravel, glass, bricks

#4 Lit boulder or concrete @ 1.5'

see back for additional observations →

Logged by:

From Hannah McDonough – email 10/19 12:39 pm

SC-02, run 2
3 feet of penetration but only recovered ~1 foot of material

Material was brown sand with shell, gravel, glass, shell, concrete & brick.
Observed glass was clear, green or brown ranging from 1 cm diameter to 5 cm diameter. One piece was likely an old power pole insulator.
Brick fragments were small – < 0.5 inches in length/width

These observations were made on material prior to returning to point of sampling – no opportunity to view layering / stratification in core.

Photos uploaded to P-drive

SEDIMENT SAMPLING FORM--CORES

Project: R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: Paul, Hannah, Mike, Chad

Sample Location: SS1-SC-03

Target Coordinates:

Long/Easting:

Date: 10/14/15

Weather: Sunny, 65°

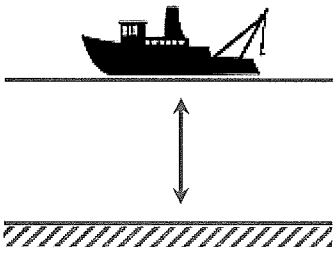
Vessel: Tieton

Sampling Method: Vibracore

Target Depth (ft): 8 ft

Core Lined (circle): (Yes) No

Lat/Northing:



Enter initial loc. info./update for final accepted core:

Water Elevation: 5.0

Datum: MLLW

Depth to Mudline: 7.6 ft

Time: 10

Mudline Elevation:

Datum:

Acceptance criteria:

- *Target penetration achieved*
- *Core tube intact/ no obstructions*
- *Calculated compaction < 25%*

• Water

Run No.	Time	Actual		Penetration Depth (ft)	Recovery Length (ft)	Compaction (%)	Accept?
		Long/Easting	Lat/Northing				
1	1055			7.5	5.0	—	N
2	1200			0.5	0.5	—	N
3	1220			8	8	0	Y

Comments: #1 stop at 1130 after 35 mins of coring. Down about 5 ft. Restart coring after rest @ 1135. No frame, 10 ft tube

#2 reposition boat. Pivot off spud.. Recore with 8 ft tube. Save attempt #1. Stuck for 20 mins at ~0.5 ft. Pull up core. Bottom of tube is chewed up by wood, glass, brick fragments. Processed wood in core.

Logged by:

SEDIMENT SAMPLING FORM--CORES

Project: R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: Paul, Hannah, Mike, Chief

Sample Location: SS1-SC-04

Target Coordinates:

Long/Easting:

Date: 10/14/15

Weather: foggy, cool

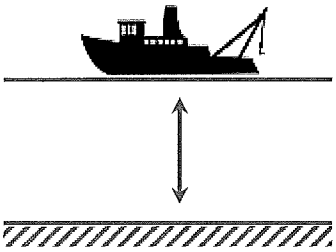
Vessel: Tieton

Sampling Method: V. Actuator

Target Depth (ft): 8'

Core Lined (circle): (Yes) No

Lat/Northing:



Enter initial loc. info./update for final accepted core:

Water Elevation: 7.2

Datum: MLLW

Depth to Mudline: 5.2

Time: 815

Mudline Elevation:

Datum:

Acceptance criteria:

- *Target penetration achieved*
- *Core tube intact/ no obstructions*
- *Calculated compaction < 25%*
- Water

Run No.	Time	Actual Long/Easting	Actual Lat/Northing	Penetration Depth (ft)	Recovery Length (ft)	Compaction (%)	Accept?
1	0825			1.5	1.3	—	✓
(1) 2	0837			2.0	1.5	—	✓
3	0855			3.0	2.5	—	✓
4	0910			3.0	2.0	—	✓

Comments: #1 bolders and cobbles, refusal just below mudline

(1) same core tube as previous run

#2 same as #1 — removed frame for attempt #3

#3 same as #1

Logged by: PBL

SEDIMENT SAMPLING FORM--CORES

Project: R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: Mike, Chad, Paul, Chandra

Sample Location: SSI-SC-4

Target Coordinates:

Long/Easting:

Date: 10/15/15

Weather: clear, cool

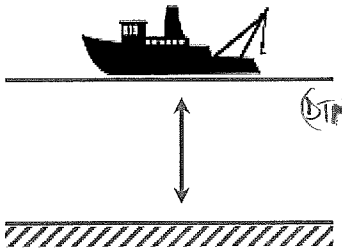
Vessel: Tyeten

Sampling Method: V. Bracore

Target Depth (ft): 8'

Core Lined (circle): (Yes) No

Lat/Northing:



Enter initial loc. info./update for final accepted core:

Water Elevation: 7.8

Datum: MLLW

Depth to Mudline: 6.9'

Time: 0822

Mudline Elevation:

Datum:

Acceptance criteria:

- *Target penetration achieved*
- *Core tube intact/ no obstructions*
- *Calculated compaction < 25%*
- Water

Run No.	Time	Actual		Penetration Depth (ft)	Recovery Length (ft)	Compaction (%)	Accept?
		Long/Easting	Lat/Northing				
1	833		7 meters from target coordinate	2.5	2.5		✓ DTM=6.9'
* 2	921		same location	5.0	4.8		✓ DTM=6.9'
3	1014			2.0	2.0		✓ DTM=6.2'

Comments: (1) same core tube as previous attempt

#1 10' core w/frame

* #2 8' core w/no frame (probing the hammering) (0930-1003) will keep & sample 0-2, 2-4

#3 10' core w/no frame after 10 mins & ~2' penetration core head broke.

Logged by: RDR

SEDIMENT SAMPLING FORM--CORES

Project: R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: Paul, Mike, Chad

Sample Location: SSI-SC-05

Target Coordinates:

Long/Easting:

Date: 10/13/15

Weather: cloudy, 64

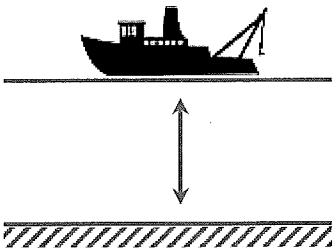
Vessel: Tieton

Sampling Method: Vibracore

Target Depth (ft): 8'

Core Lined (circle): (Yes) No

Lat/Northing:



Enter initial loc. info./update for final accepted core:

Water Elevation: 6 / 5.5 ~~+5.03~~

Datum: MLLW / NAVD88

Depth to Mudline: 9.5

Time: 1537

Mudline Elevation: ~~-4.47~~ -3.5 / -4

Datum: NAVD88 / MLLW

Acceptance criteria:

- *Target penetration achieved*
- *Core tube intact/ no obstructions*
- *Calculated compaction < 25%*
- Water

Run No.	Time	Actual Long/Easting	Actual Lat/Northing	Penetration Depth (ft)	Recovery Length (ft)	Compaction (%)	Accept?
1	1540			8.0	6.2	22%	Y

Comments:

Logged by: PDL

SEDIMENT SAMPLING FORM--CORES

Project: R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: BP, Mike, Chad

Sample Location: SSI-SC-6

Target Coordinates:

Long/Easting:

Date: 10/13/15

Weather: cloudy, 60°

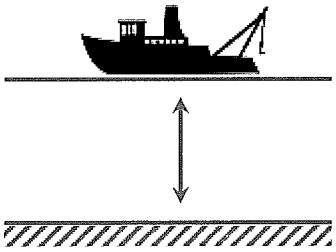
Vessel: Teton

Sampling Method: Vibracore

Target Depth (ft): 8'

Core Lined (circle): (Yes) No

Lat/Northing:



Enter initial loc. info./update for final accepted core:

Water Elevation: 4.3 / 4.3

Datum: MLLW / NAVDBB

Depth to Mudline: 6.8'

Time: 1330

Mudline Elevation: -2.47

Datum: NAVDBB

Acceptance criteria:

- Y • *Target penetration achieved*
- Y • *Core tube intact/ no obstructions*
- Y • *Calculated compaction < 25%*
- Y • Water

Run No.	Time	Actual		Penetration Depth (ft)	Recovery Length (ft)	Compaction (%)	Accept?
		Long/Easting	Lat/Northing				
1	1335			≈6'	4'	33%	✓
2	1350			7.0'	6.3'	10%	Y

Comments: core tube re-used from attempt 1 after sediment removed and flushed w/ seawater

Logged by: BP

SEDIMENT SAMPLING FORM--CORES

Project: R.G. Haley Supplemental Sediment Investigation

Project No.: 0356-114-06

Subcontractor: Gravity Environmental LLC

Sampling Crew: PDR, Mike, Chad

Sample Location: SSI-SG-7

Target Coordinates:

Long/Easting:

Date: 10/13/15

Weather: cloudy, 60°

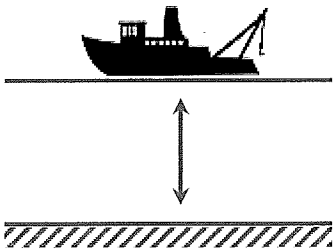
Vessel: Tiction

Sampling Method: Vibracore

Target Depth (ft): 8'

Core Lined (circle): (Yes) No

Lat/Northing:



Enter initial loc. info./update for final accepted core:

Water Elevation: 5.25 / 4.78

Datum: MLLW / NAVD88

Depth to Mudline: 8.2'

Time: 1419

Mudline Elevation: -3.42

Datum: MLLW NAVD88

Acceptance criteria:

- *Target penetration achieved*
- *Core tube intact/ no obstructions*
- *Calculated compaction < 25%*
- Water

Run No.	Time	Actual Long/Easting	Actual Lat/Northing	Penetration Depth (ft)	Recovery Length (ft)	Compaction (%)	Accept?
1	1429			4.5'	3.7'	17%	N
① 2	1445			8.0	7.4'	7.5%	Y

Comments: ① same core tube as previous run

Logged by: PDR

A.3 Supplemental Sediment Investigation Subsurface Logs - 2015

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

A "WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PP	Pocket penetrometer
PPM	Parts per million
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

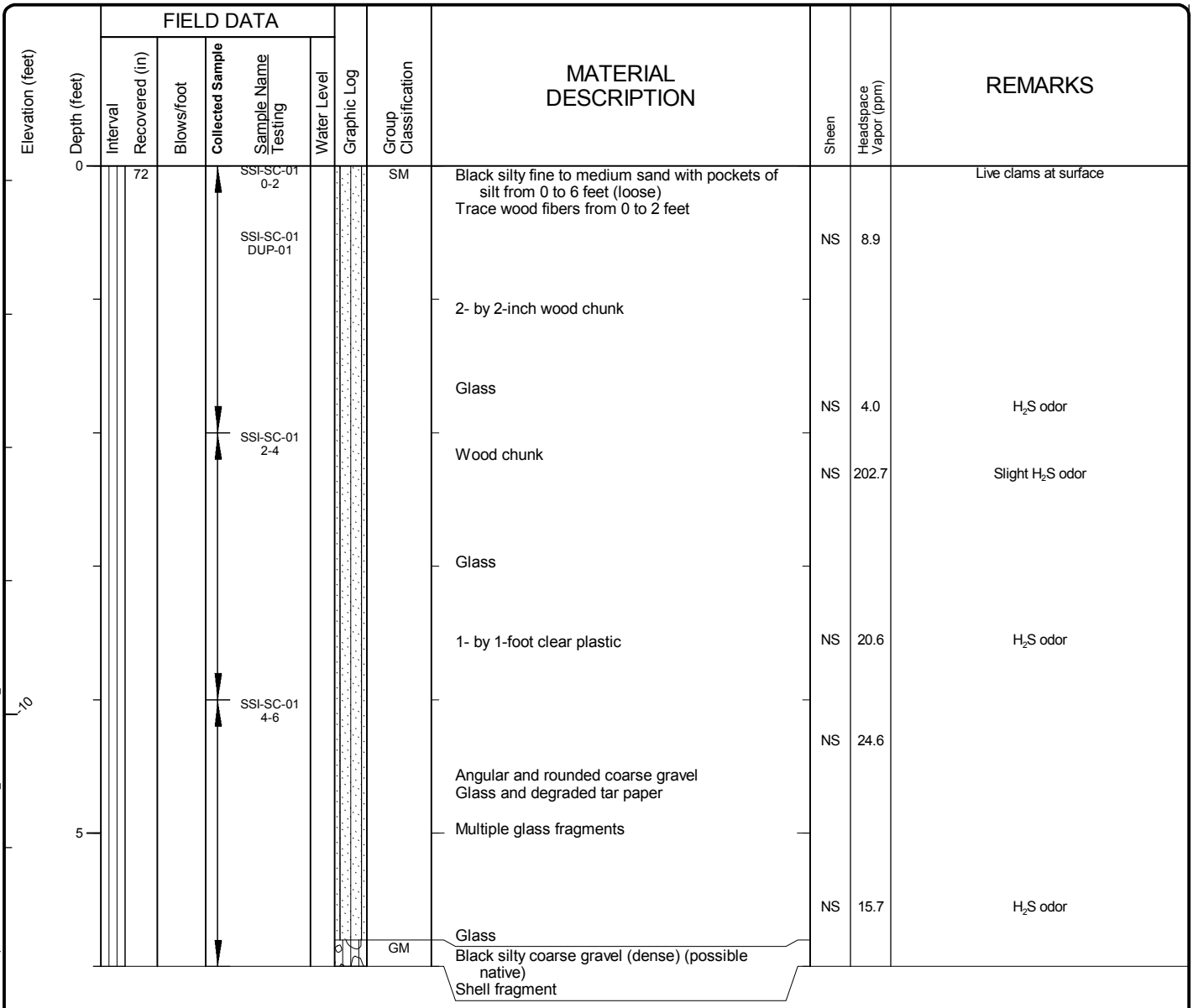
GeoEngineers

FIGURE A-1

Rev. 02/16

Drilled	Start 10/14/2015	End 10/14/2015	Total Depth (ft)	6	Logged By / Checked By	GRL/HM	Driller	Gravity Environmental, LLC	Drilling Method	Vibracore
Mudline Elevation (ft) / Vertical Datum	-5.89 NAVD88		Hammer Data				Drilling Equipment			
Easting (X) / Northing (Y)	1239695.34 639367.68		System Datum	NAD83 (feet)			Groundwater: Date Measured		Depth to Water (ft)	Elevation (ft)

Notes: Water surface elevation 4.51 ft (NAVD88)



Note: Please see Figure A-1 for explanation of symbols

Log of Boring SSI-SC-01

GeoEngineers

Project: R.G. Haley Site
Project Location: Bellingham, Washington
Project Number: 0356-114-06

Figure A-2
Sheet 1 of 1

Drilled	Start 10/14/2015	End 10/14/2015	Total Depth (ft)	8	Logged By / Checked By	GRL	Driller	Gravity Environmental, LLC	Drilling Method	Vibracore
Mudline Elevation (ft) / Vertical Datum	-3.09 NAVD88		Hammer Data				Drilling Equipment			
Easting (X) / Northing (Y)	1239788.45 639426.59		System Datum	NAD83 (feet)			Groundwater: Date Measured	Depth to Water (ft)	Elevation (ft)	

Notes: Water surface elevation 4.51 ft (NAVD88)

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		96			SSI-SC-03 0-2			WD	Brown wood with trace silt (loose) 100% wood content (degraded, processed lumber, some fibers)	SS	104.8	H_2S odor
											NS	15.6	H_2S odor
-5						SSI-SC-03 2-4			SM	Dark gray silty fine to medium sand with trace wood (loose) Trace wood fibers, possible roots	SS	3.2	H_2S odor
									GP	Fine to coarse gravel			
									WD	Tan wood (medium dense) 100% wood content (sawdust, fragments up to 2-inches long)	SS	389.6	H_2S odor
						SSI-SC-03 4-6							
						SSI-SC-03 DUP-02					SS	125.3	H_2S odor
	5										NS	40.8	H_2S odor
						SSI-SC-03 6-8							
-10											SS	90.6	H_2S odor
									SP	Black fine to medium sand with wood (medium dense) (possible native) 25 to 50% wood content (sawdust, fragments up to 2-inches long)	SS	115.5	H_2S odor

Note: Please see Figure A-1 for explanation of symbols

Log of Boring SSI-SC-03

GeoEngineers

Project: R.G. Haley Site
Project Location: Bellingham, Washington
Project Number: 0356-114-06

Figure A-3
Sheet 1 of 1

Drilled Start 10/15/2015	End 10/15/2015	Total Depth (ft) 4	Logged By CVD/PDR Checked By	Driller Gravity Environmental, LLC	Drilling Method Vibracore
Mudline Elevation (ft) 0.41 Vertical Datum NAVD88		Hammer Data		Drilling Equipment	
Easting (X) 1240482.54 Northing (Y) 639785.46		System Datum NAD83 (feet)		Groundwater Date Measured	Depth to Water (ft) / Elevation (ft)
Notes: Water surface elevation 7.31 ft (NAVD88)					

Elevation (feet) / Depth (feet)	FIELD DATA: Interval / Recovered (in)	Blows/foot	Collected Sample / Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
0	48		SSI-SC-04 0-2			SM	Black silty fine sand with debris (shell fragments, occasional glass fragments) (soft)			Shell fragments
			SSI-SC-04 DUP-03					NS	<1	
						SW	Black fine sand with trace silt (dense)	NS	64.6	No wood, no biological material
			SSI-SC-04 2-4			GP	Black fine to coarse gravel with sand and occasional glass fragments (dense)	NS	1.5	No wood, no biological material
								NS	27.6	Moderate H_2S odor
								NS	57.2	Slight H_2S odor
						SM	Gray silty fine to medium sand (dense) <25% wood fibers Grades to black, loose <25% degraded wood chunks >50% shell hash at 3.75 feet	NS	32.4	Slight H_2S odor
								SS	60.1	Moderate H_2S odor

Note: Please see Figure A-1 for explanation of symbols

Log of Boring SSI-SC-04

GeoEngineers

Project: R.G. Haley Site
Project Location: Bellingham, Washington
Project Number: 0356-114-06

Figure A-4
Sheet 1 of 1

Drilled	Start 10/15/2015	End 10/15/2015	Total Depth (ft)	8	Logged By / Checked By	GRL/PDR	Driller	Gravity Environmental, LLC	Drilling Method	Vibracore
Mudline Elevation (ft) / Vertical Datum	-3.49 NAVD88		Hammer Data				Drilling Equipment			
Easting (X) / Northing (Y)	1240432.94 639831.19		System Datum	NAD83 (feet)			Groundwater: Date Measured		Depth to Water (ft)	Elevation (ft)

Notes: Water surface elevation 6.01 ft (NAVD88)

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		72			SSI-SC-05 0-2			SM	Brown silty fine sand (medium dense) <25% milled wood chunks			Trace shell fragments
											SS	67.6	
									ML	Brown silt with wood (soft) <25% wood chips			Trace shell fragments
-5											SS	66.9	H_2S odor
						SSI-SC-05 2-4							
									WD	Brown wood with trace silt (soft) >50% sawdust	NS	94.8	H_2S odor Trace shell fragments
									ML	Gray silt with trace wood (soft)	SS	99.8	H_2S odor No vegetation, no biological material
						SSI-SC-05 4-6							
											NS	32.8	H_2S odor
	5												
											NS	49.1	H_2S odor
						SSI-SC-05 6-8							
-10											NS	147.2	H_2S odor
									WD	Brown wood with trace silt (soft) 100% wood content at top of sample, grading to 25% to 50%			
									PEAT	Gray peat with sand (medium stiff) Degrading wood with barnacles	SS	77.7	H_2S odor

Note: Please see Figure A-1 for explanation of symbols

Log of Boring SSI-SC-05

GeoEngineers

Project: R.G. Haley Site
Project Location: Bellingham, Washington
Project Number: 0356-114-06

Figure A-5
Sheet 1 of 1

Drilled	Start 10/13/2015	End 10/13/2015	Total Depth (ft)	7	Logged By / Checked By	GRL/PDR	Driller	Gravity Environmental, LLC	Drilling Method	Vibracore
Mudline Elevation (ft) / Vertical Datum	-2.79 NAVD88		Hammer Data				Drilling Equipment			
Easting (X) / Northing (Y)	1240514.26 639964.4		System Datum	NAD83 (feet)			Groundwater: Date Measured	Depth to Water (ft)	Elevation (ft)	

Notes: Water surface elevation 4.01 ft (NAVD88)

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		72			SSI-SC-06 0-2			SP	Dark gray fine to medium sand with trace silt (loose) Trace fine roots			Live shellfish
									ML	Gray sandy silt (medium stiff)	NS	1.7	
										Trace non-weathered wood, cut sides/faces	SS	126.9	H_2S odor
						SSI-SC-06 2-4					SS	120.4	H_2S odor
										Becomes graded with sawdust layer (up to 2 inches thick) from 2.5 to 4 feet 25% to 50% wood content			
													Clam shell fragments
											SS	92.0	H_2S odor
						SSI-SC-06 4-6				Becomes graded with trace sawdust <25% wood content	NS	54.0	
										1/2 cm sawdust layer			
	5										NS	7.0	H_2S odor
						SSI-SC-06 6-7					NS	1.2	
										Gray silt (soft)			No vegetation, no biological material
											NS	<1	

Note: Please see Figure A-1 for explanation of symbols

Log of Boring SSI-SC-06

GeoEngineers

Project: R.G. Haley Site
Project Location: Bellingham, Washington
Project Number: 0356-114-06

Figure A-6
Sheet 1 of 1

Drilled	Start 10/13/2015	End 10/13/2015	Total Depth (ft)	8	Logged By / Checked By	GRL/PDR	Driller	Gravity Environmental, LLC	Drilling Method	Vibracore
Mudline Elevation (ft) / Vertical Datum	-3.29 NAVD88		Hammer Data				Drilling Equipment			
Easting (X) / Northing (Y)	1240430.59 / 640152.61		System Datum	NAD83 (feet)			Groundwater: Date Measured		Depth to Water (ft)	Elevation (ft)

Notes: Water surface elevation 4.91 ft (NAVD88)

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		86.5			SSI-SC-07 0-2			SM	Gray silty fine sand (loose) >50% wood content, top 3 inches with milled wood			Trace shell fragments
						SSI-SC-07 DUP-04					NS	60.0	H_2S odor
											NS	101.6	H_2S odor
						SSI-SC-07 2-4				100% wood content			
											NS	274.3	H_2S odor
									WD	Brown degraded wood (loose)			
											NS	140.5	H_2S odor
						SSI-SC-07 4-6							
										Becomes graded with silt >50% wood content	NS	93.0	H_2S odor
	5								ML	Brown silt with wood (soft) <25% wood content	SS	71.5	H_2S odor
						SSI-SC-07 6-8							
									SM	Gray silty fine sand with trace wood (medium dense) Trace wood	NS	23.5	H_2S odor
											NS	6.9	H_2S odor
	10												

Note: Please see Figure A-1 for explanation of symbols

Log of Boring SSI-SC-07

GeoEngineers

Project: R.G. Haley Site
Project Location: Bellingham, Washington
Project Number: 0356-114-06

Figure A-7
Sheet 1 of 1

A.4 Pine Street Beach
Field Forms - 2016

SEDIMENT CORE LOG: PSB-SC-01 (Core Location)

Mudline Elev:	Datum:	Contractor:	Sample Method:	Sampling Equipment:	
~0.34-ft	NAVD 88	NA	GRAB	TROWEL & SPOON	
Coordinates:	Datum:	Tube Length: Penetration Depth: 2' BML	OD/ID: NA Tube Material: NA	Logged by: CD	Checked by:

Depths to nearest 1/10 foot: Total Core Depth	Core Interval	Interval Recovery	Sample Interval (ID)	Classification Symbol	Material/Lithology Description (color, material type, grain size, stratification, density, debris, etc.)	PID/Sheen/Staining (none, slight, moderate, heavy) PID	Sheen	Odor	Vegetation/Biological Material–include type (sawdust, fibers, bark, chips, chunks, twigs, lumber, etc.) and amount of wood debris, by volume (none, <25%, 25-50%, >50%)
0			PSB-SC-01-0-1		Brown f-c sand occ. gravel trace shell hash, glass fragments and bark fragments. (wet to moist)	≤1	NS	No	1-whole clam. no wood
1			PSB-SC-01-1-2 & above		SAA. Grades from brown to tan in color.	≤1	NS	No	no biota no wood
2	/	/	/	/	END OF EXPLORATION	/	/	/	/ / / /
3					Predicted low-tide of 0.34-ft at 9:28 PM (2128) based on NOAA Bellingham, WA Station ID 9449211				
4					Actual coordinates measured w/ portable Trimble GPS, see attached table.				
5									
6									
7									
8									
9									

GeoEngineers

Date: 2/18/16 Sample Start Time: 2100 End Time: 2105

Project: R.G. Haley Supplemental Sediment Investigation

Project Location: Bellingham, WA Project No: 0356-114-06

SEDIMENT CORE LOG: PSB-SC-02 (Core Location)

Mudline Elev:	Datum:	Contractor:	Sample Method:	Sampling Equipment:	
~ 0.34 ft	NAVD 88			TROWEL & SPOON	
Coordinates:	Datum:	Tube Length: Penetration Depth: 2' BML	OD/ID: Tube Material:	Logged by: CD	Checked by:

Depths to nearest 1/10 foot: Total Core Depth	Core Interval	Interval Recovery	Sample Interval (ID)	Classification Symbol	Material/Lithology Description (color, material type, grain size, stratification, density, debris, etc.)	PID/Sheen/Staining (none, slight, moderate, heavy): PID	Sheen	Odor	Vegetation/Biological Material–include type (sawdust, fibers, bark, chips, chunks, twigs, lumber, etc.) and amount of wood debris, by volume (none, <25%, 25-50%, >50%)
0			PSB-SC-02-0-1		Gray f-c sand w/ gravel, shell hash, glass fragments, and brick fragments. (wet)	<1	NS	NO	no biota no wood
1			PSB-SC-02-1-2		Black f-m sand occ gravel trace shell hash, brick fragments (wet)	<1	NS	50	no biota no wood
2									slight odor of sulfur.
	/	/	/	/	END OF EXPLORATION	/	/	/	/ / / /
3									
4									
5									
6									
7									
8									
9									

GeoEngineers

Date: 2/18/16 **Sample Start Time:** 2210 **End Time:** 2215

Project: R.G. Haley Supplemental Sediment Investigation

Project Location: Bellingham, WA **Project No:** 0356-114-06

SEDIMENT CORE LOG: PSB-SC-03 (Core Location)

Mudline Elev:	Datum:	Contractor:	Sample Method:	Sampling Equipment:	
~ 0.34-ft	NAVD 88			TROWEL & SPOON	
Coordinates:	Datum:	Tube Length: Penetration Depth: 2' BML	OD/ID: Tube Material:	Logged by: CD	Checked by:

Depths to nearest 1/10 foot: Total Core Depth	Core Interval	Interval Recovery	Sample Interval (ID)	Classification Symbol	Material/Lithology Description (color, material type, grain size, stratification, density, debris, etc.)	PID/Sheen/Staining (none, slight, moderate, heavy) PID	Sheen	Odor	Vegetation/Biological Material–include type (sawdust, fibers, bark, chips, chunks, twigs, lumber, etc.) and amount of wood debris, by volume (none, <25%, 25-50%, >50%)
0			PSB-SC-03-0-1		Brow to gray f-c sand w/ gravel, glass fragments brick fragments and shell hash (wet)	<1	NS	NO	no biota no wood
1			PSB-SC-03-1-2		SAA	<1	NS	NO	no biota no wood
2	/	/	/	/	END OF EXPLORATION	/	/	/	/ / / /
3									
4									
5									
6									
7									
8									
9									

GeoEngineers

Date: 2/18/16 Sample Start Time: 2140 End Time: 2145

Project: R.G. Haley Supplemental Sediment Investigation

Project Location: Bellingham, WA Project No: 0356-114-06

SEDIMENT CORE LOG: PSB-SC-04 (Core Location)

Mudline Elev: ~0.34-ft	Datum: NAVD88	Contractor:	Sample Method:	Sampling Equipment: TROWEL & SPOON	
Coordinates:	Datum:	Tube Length: / Penetration Depth:	OD/ID: / Tube Material: 2' BML	Logged by: CD	Checked by:

Depths to nearest 1/10 foot: Total Core Depth	Core Interval	Interval Recovery	Sample Interval (ID)	Classification Symbol	Material/Lithology Description (color, material type, grain size, stratification, density, debris, etc.)	PID/Sheen/Staining (none, slight, moderate, heavy): PID	Sheen	Odor	Vegetation/Biological Material–include type (sawdust, fibers, bark, chips, chunks, twigs, lumber, etc.) and amount of wood debris, by volume (none, <25%, 25-50%, >50%)
0			PSB-SC-04-0-1		Brown to gray f-c sand w/ gravel, glass fragments, brick fragments and shell hash. (wet)	<1	NS	ND	no biota no wood
1					SAA.				
			PSB-SC-04-1-2 archive						
2		/	/	/	END OF EXPLORATION	/	/	/	/ / /
3									
4									
5									
6									
7									
8									
9									

GeoEngineers

Date: 2/18/16 **Sample Start Time:** 2125 **End Time:** 2120

Project: R.G. Haley Supplemental Sediment Investigation

Project Location: Bellingham, WA **Project No:** 0356-114-06

APPENDIX B
Photographs

B.1 Supplemental Sediment Investigation Surface - 2015

10/15/15

SSI-SS-01

Attempt 11

10/15/15

SS1-S[illegible]02

10/13/15

SS1-SS-03

3


10/15/15
551-55-04

10/12/15

S S1-SS-05

1

10/12/15

SSI-SS-06

1

10/12/15

SS1-SS-07

6

10/12/15

SS1-SS-08

1

10/12/15

SS1-SS-09

2

10/12/15

SS1-SS-10

2

10/12/15

SS1-SS-11

3

10/12/15

SS1-SS-12

10/12/15

SS1-SS-13

3

10/13/15

SS1-SS-14

2

10/13/15

SS1-SS-15

3

91-55-155

10/13/75

1

17-55-155

10/13/75

10/13/15

SS1-SS-18

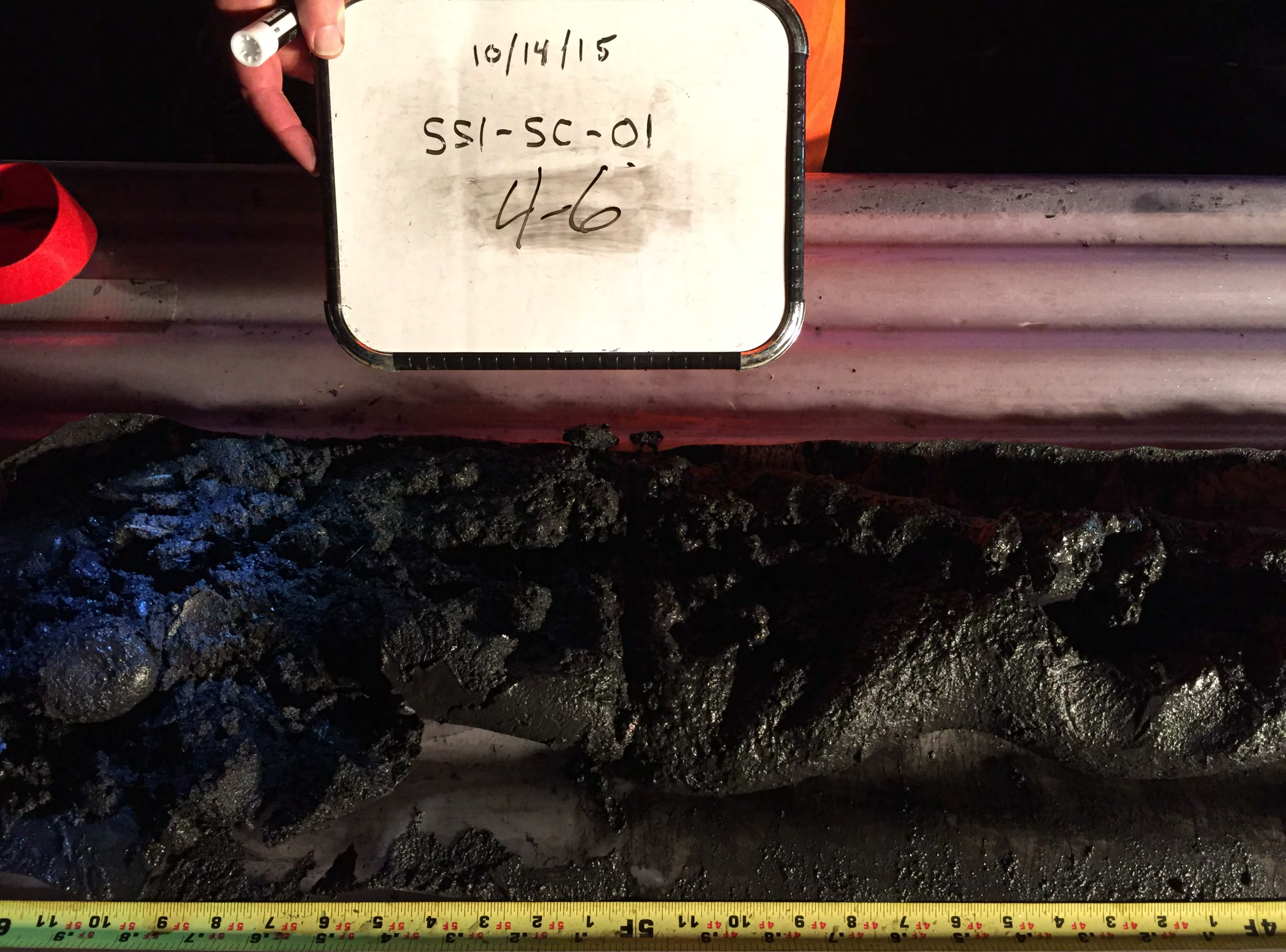
1

SEDIMENT

B.2 Supplemental Sediment Investigation
Suburface - 2015


10/14/15
SS1-SC-01
0-2


4-2
10-25-15
SSI-SC-01
10/14/15


10/14/15
SSI-SC-01
4-6


10/14/15
SS1-SC-03
0-2'


10/14/15
SS1-SC-03
2-4
EXPO
LOW ODOR

10/14/15

SS1-SC-03

4-6


10/14/15
SSI-SC-03
6-8
Expo
low odor
chisel

SS1-SC-04
0-2'
10/15/01


PALRUF
Corrugated PVC Sheet
Plaques de PVC Rigides Ondulées
10/15/15
SSI-SC-04
Z-4'

S S1-SC-05

0-2'

(0-1.5')

10/13/15

SS1-SC-05

2-2

(1.5-3)

10/13/15

SS1-SC-05

4-6

(3-4.5)

S S1-SC-05

6-8

(4.5-6)

10/13/15

SS1-SC-06

0-2'

(0-1.7)


10/13/15
SS1-SC-06
2-4'
(1.7-3.4')
EXPO low odor


10/13/15
SS1-SC-06
4-6'
(3.4-5.1')

10/13/
SSI-S
6-
90-25
(5.1-
(9-1

10/13/15

SS1-SC-07

0-2'

(0-2')

10/13/15

SS1-SC-07

2-4'

(2-4)


10/13/15
SS1-SC-07
4-6'
(4-6')

10/13/15

SS1-SC-07

6-8'

(6-8')

B.3 Pine Street Beach
Surface - 2016

PSB-SC-01-0-1

02/18/16

BOOLEY

PSB-SC-01-1-2'
02/18/16
DOOLEY

PSB-SC-02-0-1'
02/18/16

PSB-SC-02-1-21
02/18/16

PSB-SC-03-0-1

02/18/16

DOOLEY

PSB-SC-03-1-21
02/18/16
DOOLEY

POOLEY

PSB-SC-04-0-1'

02/18/16

PSB-SC-04-1-2'
02/18/16

APPENDIX C
Data Validation Reports

APPENDIX C
DATA VALIDATION SUMMARY

Chemical

Data validation of all sediment data derived from the SSI was performed primarily by GeoEngineers, Inc. (GeoEngineers). However, a set of three sample delivery groups (SDGs) for dioxins/furans collect in 2015 were validated by EcoChem, Inc. Data validation was conducted on all data points originating from the laboratory analytical program activities. As prescribed by this program, the Data Quality Objectives (DQO) established in the SAP were used to assess precision, accuracy, representativeness, completeness, and comparability parameters. Accuracy for all SSI samples was acceptable, as demonstrated by the laboratory control sample and matrix spike and matrix spike duplicate (MS/MSD) percent recovery values. Precision was acceptable, as demonstrated by the MS/MSD and laboratory duplicate relative percent difference (RPD) values, or absolute difference values when appropriate. Laboratory representativeness was acceptable as the correct laboratory methods and sample holding times were met. The laboratory completeness goal of 90 percent was fulfilled, as all of the data points were considered valid after the validation process. Comparability of sampling methods and laboratory methods for this data set relative to previously collected RI data were deemed acceptable and appropriate.

The U.S. Environmental Protection Agency (EPA) defines the requirements for various levels of validation. Validation was conducted in accordance with EPA's Contract Laboratory Program National Functional Guidelines for organics (EPA 2008) and dioxins/furans (EPA 2011). An EPA-defined Stage 2B validation was conducted on 100 percent of the data points. An EPA-defined Stage 4 level validation was conducted on the largest SDG, or 10 percent of the data points. No internal laboratory transcription errors were found through the validation process and all data points were deemed acceptable for their intended use. More detailed descriptions of the qualified data points are available in Attachments C-1 and C-2.

Biological

Bioassay test results were validated by reviewing protocol, test conditions and parameters, results of the reference toxicity test, control and reference performance, and checking endpoint calculations provided in Ramboll's bioassay report (Appendix E). Tests were performed according to protocol, with a few minor exceptions. Temperature and salinity were slightly elevated in the amphipod bioassay (the maximum test temperature was 16.5°versus a maximum 16°as called for in the protocol; a test salinity maximum was 30 parts per thousand (ppt) versus 29 ppt as an upper limit in the protocol). The polychaete bioassay also experienced salinities greater than the upper limit (29 ppt) specified in the protocol (salinity on one or more days was measured at 31 ppt or 32 ppt in all samples). These minor deviations did not adversely affect the performance of these two bioassays, as demonstrated by the control, reference and test responses.

Reference toxicity tests were within the ranges reported by the lab during prior tests, indicating that test organisms were of similar sensitivity as previously tested batches of organisms. Control and reference test results for all bioassays were within the limits required for use in endpoint calculations and evaluations. A subset (approximately 10 percent) of endpoints were recalculated; no errors were discovered. Bioassay results were suitable for site-specific decisions regarding risks to the benthic community and site cleanup.

C.1 Semi-volatile Organic Compounds

Data Validation Report

Plaza 600 Building, 600 Stewart Street, Suite 1700, Seattle, Washington 98101, Telephone: 206.728.2674, Fax: 206.728.2732 www.geoengineers.com

To:	RG Haley Supplemental Investigation and Revised RI
File:	00356-114-06
Date:	January 8, 2018

This report documents the results of a U.S. Environmental Protection Agency (EPA)-defined Stage 2B and Stage 4 data validation (EPA Document 540-R-08-005; EPA 2009) of analytical data from the analyses of sediment samples and the associated laboratory and field quality control (QC) samples collected as part of the 2015 RG Haley Supplemental Sediment Investigation sampling event, located in Bellingham Bay.

This sampling event involved taking sediment cores from Bellingham Bay and dividing each core into representative depths that would characterize the extent of contamination in the Bay. Each core depth was documented in a chain-of-custody (COC) and sent to a laboratory for storage and/or analysis in the form of labeled sample containers, along with the COC requesting specific analysis by the laboratory (First Round Analyses). Some samples were requested to be immediately archived, or stored at -20 degrees Celcius in a freezer, until further analytical requests could be made by GeoEngineers. These archived requests (Second and Third Round Analyses) would be based on site information to be obtained from the First Round Analyses data set.

The validation of the analytical suites that involve High Resolution/Mass Spectrometry (dioxins/furans by Method 1613B) in the First Round Analyses as the validation of this analytic method was performed by a third party validator. The findings of this validation are reported in a separate memo prepared by EcoChem, Inc. (Attachment C-2). However, any validation of Method 1613B of the Second and Third Round Analyses are included in this memo.

Also included in this memo are three sediment samples that were collected by Landau Associates (labeled in Table 1-A).

OBJECTIVE AND QUALITY CONTROL ELEMENTS

GeoEngineers, Inc. (GeoEngineers) completed the data validation consistent with the EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (EPA, 2008), the National Functional Guidelines for Inorganic Superfund Data Review (EPA 2014), and the EPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review (EPA, 2011) in order to determine if the laboratory analytical results meet the project specific objectives and are usable for their intended purpose. Data usability was assessed by evaluating if:

- The samples were analyzed using well-defined and acceptable methods that provide reporting limits below applicable regulatory criteria;
- The precision and accuracy of the data are well-defined and sufficient to provide defensible data; and
- The quality assurance/quality control (QA/QC) procedures utilized by the laboratory meet acceptable industry practices and standards.

In accordance with the Quality Assurance Project Plan (Appendix B of the Final Work Plan, Supplemental Sediment Investigation; GeoEngineers, 2015), the data validation included review of the following QC elements:

- Data Package Completeness
- Chain-of-Custody Documentation
- Holding Times and Sample Preservation
- Surrogate Recoveries
- Method Blanks
- Laboratory Control Samples (LCS)
- Field Duplicates
- Initial Calibrations (ICALs)
- Continuing Calibrations (CCALs)
- Miscellaneous
- Reporting Limits

VALIDATED SAMPLE DELIVERY GROUPS

Data validation included review of the sample delivery groups (SDGs) listed below in Table 1-A.

TABLE 1-A: SUMMARY OF VALIDATED SAMPLE DELIVERY GROUPS

Primary SDG	Samples Validated
AHU9	CL-SG-3_0-0.33 and CL-SG-4_0-0.33 (Samples were collected by Landau Associates for dioxins/furans only)
AKF6	CL-SG-1_0-0.33 (Samples were collected by Landau Associates for dioxins/furans only)
AOL1 **(Level 4 validation)**	SSI-SS-05_0-0.39, SSI-SS-06_0-0.39, SSI-SS-07_0-0.39, SSI-SS-08_0-0.39, SSI-SS-09_0-0.39, SSI-SS-10_0-0.39, SSI-SS-11_0-0.39, SSI-SS-12_0-0.39, Rinseate-151012
AOM9	SSI-SC-05_0-2, SSI-SC-05_2-4, SSI-SC-06_0-2, SSI-SC-06_2-4, SSI-SC-07_0-2, SSI-SC-DUP-04, SSI-SC-07_2-4, and Rinsate_151013
AOR4	SSI-SC-01_0-2, SSI-SC-DUP-01, SSI-SC-01_2-4, SSI-SC-03_0-2, SSI-SC-03_2-4, and Rinseate-151014
AOS3	SSI-SS-01_0-0.39, SSI-SS-DUP-03, SSI-SS-03_0-0.39, SSI-SC-04_0-2, SSI-SC-DUP-03, and SSI-SC-04_2-4
AOS6	SSI-SS-02_0-0.39 and SSI-SS-04_0-0.39
AUJ6	SSI-SC-05_4-6, SSI-SC-06_4-6, and SSI-SC-06_4-6
AWM5	SSI-SS-09_0-0.39 (Pentachlorophenol ONLY)

Primary SDG	Samples Validated
AWJ5	PSB-SC-01_0-1, PSB-SC-02_0-1, PSB-SC-02_1-2, PSB-SC-03_0-1, PSB-SC-03_1-2, and PSB-SC-04_0-1
9350	SSI-SS-14_0-0.39, SSI-SS-15_0-0.39, and SSI-SS-16_0-0.39
9351 (Level 4 Validation)	SSI-SS-08_0-0.39, SSI-SS-10_0-0.39, SSI-SS-11_0-0.39, SSI-SS-12_0-0.39 (Validated by EcoChem)
9353	SSI-SC-05_4-6, SSI-SC-06_4-6, and SSI-SC-07_4-6 (Validated by GeoEngineers) SSI-SC-03_0-2, SSI-SC-03_2-4, SSI-SC-05_0-2, SSI-SC-05_2-4, SSI-SC-06_0-2, SSI-SC-06_2-4, SSI-SC-07_0-2, SSI-SC-07_2-4, and SSI-SC-DUP-04 (Validated by EcoChem)
9354	SSI-SC-01_0-2, SSI-SC-01_2-4, SSI-SC-04_0-2, SSI-SC-04_2-4, SSI-SC-DUP-01, SSI-SC-DUP-03 (Validated by EcoChem)
9571	SSI-SS-02_0-0.39
9648	PSB-SC-01_0-1, PSB-SC-02_0-1, PSB-SC-02_1-2, PSB-SC-03_0-1, PSB-SC-03_1-2, and PSB-SC-04_0-1

CHEMICAL ANALYSIS PERFORMED

Analytical Resources, Inc. (ARI), located in Tukwila, Washington, performed laboratory analysis on the sediment samples using one or more of the following methods:

- Total solids by Standard Method 2540G
- Total organic carbon by SW9060M
- Total petroleum hydrocarbons by NWTPH-Dx (Silica Gel treated)
- Semivolatile organic compounds (SVOCs) by Method SW8270D
- Polycyclic aromatic hydrocarbons (PAHs) and four other selected semivolatiles (PAHs) by Method SW8270-SIM
- Pentachlorophenol by Method SW8041 (SW8270-SIM with clean-up if matrix interference was encountered)
- Tetra through octa-chlorinated dioxins and furans by Method 1613B

Frontier Analytical Laboratory (Frontier) located in El Dorado Hills, California, performed laboratory analysis on the sediment samples using the following methods:

- Tetra through octa-chlorinated dioxins and furans by Method 1613B

The following Sample Delivery Groups (SDGs) were validated by EcoChem, Inc. in Seattle, Washington. The validation report/memo is provided as an attachment to Appendix C of the data report.

TABLE 1-B: SUMMARY OF SUB-CONTRACTED VALIDATION SAMPLE DELIVERY GROUPS

Primary SDG	Samples Validated
9351	SSI-SS-08_0-0.39, SSI-SS-10_0-0.39, SSI-SS-11_0-0.39, and SSI-SS-12_0-0.39
9353	SSI-SC-03_0-2 , SSI-SC-03_2-4, SSI-SC-05_0-2 , SSI-SC-05_2-4, SSI-SC-06_0-2, SSI-SC-06_2-4, SSI-SC-07_0-2, SSI-SC-07_2-4, and SSI-SC-DUP-04
9354	SSI-SC-01_0-2, SSI-SC-01_2-4, SSI-SC-04_0-2, SSI-SC-04_2-4, SSI-SC-DUP-01, and SSI-SC-DUP-03

DATA VALIDATION SUMMARY

The results for each of the QC elements are summarized below.

Data Package Completeness

ARI provided the required deliverables for data validation according to the National Functional Guidelines. The laboratory followed adequate corrective action processes and identified anomalies were discussed in the relevant laboratory case narrative.

Chain-of-Custody Documentation

Chain-of-custody (COC) forms were originally filled out by GeoEngineers or Landau Associates and were provided with the laboratory analytical reports in the same data package along with pertinent email communications. The COCs were accurate, appropriately signed, and complete when submitted to the lab.

All samples were archived at the laboratory upon receipt.

Holding Times and Sample Preservation

The sample holding time is defined as the time that elapses between sample collection and sample analysis. Maximum holding time criteria exist for each analysis to help ensure that the analyte concentrations found at the time of analysis reflect the concentration present at the time of sample collection. Established holding times were met for all chemical analyses. The sample coolers arrived at the laboratory at the appropriate temperatures of between 2 and 6°C, with the exceptions below:

SDG AOM9: One out of six sample coolers was recieved by the laboratory with a temperature reading of 7.2°C. As the sample coolers were received on the same day as they were sent from GeoEngineers, no action was taken for this outlier.

Upon arrival at both laboratories, each sediment sample was stored in a freezer at -20°C in case any would be requested for analysis after a first-round assessment was completed by GeoEngineers and Ecology.

Surrogate/Labeled Compound Recoveries

A surrogate or a labeled compound is a compound that is chemically similar to the organic analytes of interest, but unlikely to be found in any environmental sample. Surrogates are used for organic analyses and are added to all samples, standards, and blanks to serve as an accuracy and specificity check of

each analysis. The surrogates are added to the samples at a known concentration and percent recoveries are calculated following analysis. All surrogate percent recoveries for field samples were within the laboratory control limits, with the following exceptions:

SDG AOL1: (SIM-PAHs) The %R value for d10-2-methylnapthalene was less than the control limit in Sample SSI-SS-09_0-0.39. The positive results and reporting limits for all analytes in this sample were qualifited as estimated (J/UJ) in this sample.

SDG AOR4: (Pentachlorophenol) The %R value for 2,4,6-tribromophenol was greater than the control limit in Sample SSI-SC-DUP-01. The positive result for this analyte in this sample was qualified as estimated (J) in this sample.

SDG AUJ6: (SIM-PAHs) The %R values for d10-fluoranthene, d10-2-methylnephthalene, and d14-debenzo(a,h)anthracene were less than the control limits in the matrix spike sample SSI-SC-06_4-6. No action is required for individual QC samples unless the data indicates the presence of a systemic outlier.

Method and Equipment Rinsate Blanks

Method blanks are analyzed to ensure that laboratory procedures and reagents do not introduce measurable concentrations of the analytes of interest. A method blank was analyzed with each batch of samples, at a frequency of 1 per 20 samples. For all sample batches, method blanks for all applicable methods were analyzed at the required frequency. None of the analytes of interest were detected above the reporting limits in any of the method blanks.

SDG AHU9: (Dioxins/Furans) There was a positive result, which was greater than 3x the reporting limit, for OCDD in the method blank extracted on 6/18/15 (Lab Sample ID: MB-061815). The associated field samples exhibited positive results for this analyte. However, in each case the sample concentrations were greater than 10x the amount found in the blank. Also, there were positive results for 1,2,3,4,6,7,8-HPCDD, and 1,2,3,4,6,7,8-HPCDF (less than the reporting limit) in this same method blank. The associated field samples exhibited positive results for these analytes. However, in each case the sample concentrations were greater than 5x the amount found in the blank.

According to the guidelines above, no qualifications were required for these trace amounts in the blank.

SDG AKF6: (Dioxins/Furans) There was a positive result, which was less than 3x the reporting limit, for OCDD in the method blank extracted on 8/10/15 (Lab Sample ID: MB-081015). The associated field sample exhibited a positive result for this analyte. However, in this case the sample concentration was greater than 10x the amount found in the blank and greater than 3x the reporting limit. Also, there was a positive result for 1,2,3,4,7,8,9-HPCDF which was less than the reporting limit in this same method blank. The associated field sample exhibited a positive result for these analyte; however, the sample concentration was greater than 10x the amount found in the blank and greater than the reporting limit.

According to the guidelines above, no qualifications were required for these trace amounts in the blank.

SDG AOL1: (SVOCs) There was a positive result for diethylphthalate in the method blank extracted on 10/21/15 (Lab Sample ID: MB-102115). The associated field samples exhibited positive results which were less than 10x the amount found in the method blank. The positive results for diethylphthalate were qualified (U) as not-detected in the following samples: SSI-SS-05_0-0.39, SSI-SS-06_0-0.39, and SSI-SS-07_0-0.39.

SDG A0S3, A0S6: (SVOCs) There was a positive result for diethylphthalate in the method blank extracted on 10/23/15 (Lab Sample ID: MB-102315). The associated field samples exhibited positive results which were less than 10x the amount found in the method blank. The positive results for diethylphthalate were qualified (U) as not-detected in the following samples: SSI-SS-03_0-0.39, SSI-SS-01_0-0.39, SSI-SS-DUP-3, SSI-SS-02_0-0.39, and SSI-SS-04_0-0.39.

Equipment rinsate blanks were collected at the site in order to ensure that the equipment used in the sampling procedures do not cross contaminate other samples with concentrations of the analytes of interest. Equipment Rinsate blanks were collected at a frequency of once per day of field sampling.

There were four equipment rinsate blanks collected for this sampling event: Rinseate-151012, Rinsate-151013, Rinseate-151014, and Rinsate-151015. None of the analytes of interest were detected above the reporting limits in any of blanks, with the exceptions below:

(Dioxins/Furans): The four equipment blanks and the field samples were analyzed at two separate laboratories. The equipment blanks were analyzed at ARI, whereas the entire set of field samples (both surface and subsurface) were analyzed at Frontier Analytical. In the validation process, each equipment blank was first assessed for method blank contamination, in order to determine which potential contaminants were attributable to the laboratory, and which contaminants originated at the site. After this initial assessment was concluded, each only the equipment blank collected on October 14, 2015 (Rinsate-151015 above) was shown to contain trace amounts of Dioxin/Furan contamination generally below the reporting limits of the blank. As the associated field sample concentrations were higher than 10x the amount found in the equipment blank, no further qualifiers were applied.

Matrix Spikes/Matrix Spike Duplicates

Since the actual analyte concentration in an environmental sample is not known, the accuracy of a particular analysis is usually inferred by performing a matrix spike (MS) analysis on one sample from the associated batch, known as the parent sample. One aliquot of the sample is analyzed in the normal manner and then a second aliquot of the sample is spiked with a known amount of analyte concentration and analyzed. From these analyses, a percent recovery (%R) is calculated. Matrix spike duplicate (MSD) analyses are generally performed for organic analyses as a precision check and analyzed in the same sequence as a matrix spike. Using the result values from the MS and MSD, the relative percent difference (RPD) is calculated. The %R control limits for MS and MSD analyses are specified in the laboratory documents, as are the RPD control limits for MS/MSD sample sets.

For inorganic organic methods, the matrix spike is followed by a post-digestion spike sample if any element percent recoveries were outside the control limits in the matrix spike. The %R control limits for inorganic matrix spikes are 75 percent to 125 percent. The %R control limits for organic MS/MSD sample sets are the internal laboratory limits which are updated once per year.

One MS/MSD analysis should be performed for every analytical batch or every 20 field samples, whichever is more frequent. The frequency requirements were met for all analyses and the %R and RPD values were within the proper control limits, with the following exceptions:

SDG A0L1: (SVOCs) The laboratory performed an MS/MSD sample set on Sample SSI-SS-07_0-0.39. The MSD %R values for benzo(a)pyrene, Total benzofluoranthenes, chrysene, fluoranthene, and pyrene were greater than the control limits in this QC sample set. However, the corresponding MS %R values for each of these analytes were within the control limits. Therefore, no qualifiers were applied.

Also, the RPD values for benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, Total benzofluoranthenes, chrysene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, and pyrene exceeded the control limits in the same sample set. As the precision criteria for these analytes were within the control limits in all other QC paramters, no action was taken.

(SIM-SVOCs) The laboratory performed an MS/MSD sample set on Sample SSI-SS-07_0-0.39. The RPD value for dibenz(a,h)anthracene exceeded the control limit of 30 percent in the sample set. As the precision criteria for this analyte was within the control limits in all other QC paramters, no action was taken.

SDG AOM9: (TOC) The laboratory performed a matrix spike on Sample SSI-SC-07_2-4. The TOC MS %R value exceeded the control limit in this QC sample. However, the measurement is not considered meaningful as per the NFG documents because the parent sample concentration was greater than four times the amount spiked into the sample. No further action was taken.

(PAHs) The laboratory performed an MS/MSD sample set on Sample SSI-SC-07_2-4. There was no recovery for eight analytes in this QC sample set. However, it was noted that no less than six parent sample analyte concentrations exceeded their respective calibration ranges in the parent sample. The laboratory did not dilute the MS/MSD sample set. In this case, professional judgement was used in validation to determine that the instrumentation at this point could have been saturated by these target analtyes mentioned and left incapable of producing meaningful measurements of matrix accuracy and precision for other target analtyes. Therefore, no futher action was taken for any outliers in this MS/MSD sample set.

SDG AOR4: (TOC) The laboratory performed a matrix spike on Sample SSI-SC-01_2-4. The TOC MS %R value was less than the control limit in this QC sample. The positive result for TOC was qualified as estimated (J) in the parent sample.

(SIM-PAHs) The laboratory performed an MS/MSD sample set on Sample SSI-SC-01_2-4. The %R values for pyrene were both greater than the control limits. Also, the MSD %R values for seven target analytes were greater than the control limits; however, the corresponding MS %R values for each analyte were within their respective control limits. Also, the RPD values for six target analytes exceeded the control limits. As the precision criteria for these analytes were within the control limits in all other QC paramters, no action was taken.

(Chlorophenols) The laboratory performed an MS/MSD sample set on Sample SSI-SC-01_2-4. The MS/MSD %R values for pentachlorophenol were less than the control limits in this sample set. The positive result for pentachlorophenol was qualified as estimated (J) in the parent sample.

SDG AOS3: (SVOCs) The laboratory performed an MS/MSD sample set on Sample SSI-SS-01_0-0.39. The RPD value for benzyl alcohol exceeded the control limits in the sample set. There was no positive result for this analtye in the parent sample, therefore no further qualification was required.

SDG AUJ6: (SIM-PAHs) The laboratory performed an MS/MSD sample set on Sample SSI-SC-06_4-6. Several %R and RPD values were outside of the control limits because several target analyte concentrations exceeded the amount spiked into the sample, therefore no further qualification was required.

Laboratory Control Samples/Ongoing Precision and Recovery Samples

A laboratory control sample (LCS) or an Ongoing Precision and Recovery Sample (OPR) is a blank sample that is spiked with a known amount of analyte and then analyzed. These internal QC samples are similar to an MS, but without the possibility of matrix interference. Given that matrix interference is not an issue, the LCS/OPR control limits for accuracy and precision are usually more rigorous than for MS/MSD analyses. Additionally, data qualification based on LCS/OPR analyses would apply to all samples in the associated batch, instead of just the parent sample. The percent recovery (%R) control limits for an LCS/OPR analyses are specified in the laboratory documents, as are the RPD control limits for LCS/LCSD sample sets.

One LCS/LCSD or OPR analysis should be performed for every analytical batch or every 20 field samples, whichever is more frequent. The frequency requirements were met for all analyses and the %R and RPD values were within the proper control limits.

SDG AOS3 & AOS6: (SVOCs) The %R value for benzyl alcohol was less than the control limits in the blank spike extracted on 10/23/15 (LCS-102315). The positive results for detected samples and the reporting limits for non-detected samples were qualified as estimated (J/UJ) in samples SSI-SS-01_0-0.39, SSI-SS-02_0-0.39, SSI-SS-03_0-0.39, SSI-SS-DUP-3, and SSI-SS-04_0-0.39.

Field Duplicates

In order to assess precision, field duplicate samples were collected and analyzed along with the reviewed sample batches. The duplicate samples were analyzed for the same parameters as the associated parent samples. Precision is determined by calculating the RPD between each pair of samples. If one or more of the sample analytes has a concentration less than five times the reporting limit for that sample, then the absolute difference is used as a performance metric instead of the RPD. The RPD control limit for sediment samples is 50 percent. The absolute difference control limit is 2 times the reporting limit.

SDG AOS3: One of two field duplicate sample pairs, SSI-SS-01_0-0.39/SSI-SS-DUP-03, was submitted with this sample delivery group.

(SVOC): The RPD/absolute difference values exceeded the control limits for phenol, fluoranthene, pyrene, benzo(a)anthracene, indeno(1,2,3-cd)pyrene, and Total benzofluoranthenes. The positive results and reporting limits for any of these analytes that were not-detected were qualified as estimated (J/UJ) in both samples.

SDG AOR4: One field duplicate sample pair, SSI-SC-01_0-2/SSI-SC-DUP-01, was submitted with this sample delivery group.

(SIM-PAHs) The RPD/absolute difference values exceeded the control limits for 2-methylnaphthalene and acenaphthylene. The positive results and reporting limits for any of these analytes that were not-detected were qualified as estimated (J/UJ) in both samples.

SDG AOM9: One field duplicate sample pair, SSI-SC-07_0-2/SSI-SC-Dup-04, was submitted with this sample delivery group.

SDG AOS3: One field duplicate sample pair, SSI-SC-04_0-2/SSI-SC-Dup-03, was submitted with this sample delivery group.

(NWTPH-Dx) The RPD/absolute difference value exceeded the control limit for Diesel range hydrocarbons. The positive result was qualified as estimated (J/UJ) in both samples.

Initial Calibrations (ICALs)

All initial calibrations were conducted according to the laboratory methods and consisted of the appropriate number of standards. For inorganic analyses, all percent recoveries were within the control limits of 90 percent and 110 percent. For organic analyses, all percent relative standard deviation (%RSD) and relative response factors (RRF) values were within the control limits stated in either the EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA, 2008) or the EPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review (EPA 2011).

Continuing Calibrations (CCALs)

All continuing calibrations were conducted according to the laboratory methods and consisted of the appropriate number of standards. For inorganic analyses, all percent recoveries were within the control limits of 90 percent and 110 percent. For organic analyses, all percent difference (%D) and relative response factors (RRF) values were within the control limits in either the EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 2008) or the EPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review (EPA 2011).

Internal Standards (Low Resolution Mass Spectrometry)

Like the surrogate, an internal standard is a compound that is chemically similar to the analytes of interest, but unlikely to be found in any environmental sample. Internal standards are used only for the mass spectrometry instrumentation and are usually added to the sample aliquot after extraction has taken place. The internal standard should be analyzed at the beginning of a 12 hour sample run. For organic analyses, the control limits for internal standard recoveries are 50 percent to 200 percent of the calibration standard. For inorganic analyses, the control limits for internal standard recoveries are 60 percent to 125 percent of the calibration standard. All internal standard recoveries were within the control limits.

Dilutions

(PAHs and SVOCs) There were several cases where target analytes exceeded the linear calibarion range of the analytical instrument. In these cases, the laboratory flagged these analytes with an “E”, and re-analyzed these samples at various dilutions. In each case, both sets of data were reported by the laboratory. In order to avoid duplicate analytical reporting, the validation labeled all “E” flags with Do-Not-Report (DNR). Correspondingly, the validation labeled all other analytes in the dilutions with Do-Not-Report so that only one concise set of analytes per sample were to be used for this project.

Miscellaneous

SDG AHU9 and AKF6 (Dioxin/Furans): The positive results for several compounds were noted by the laboratory to represent the estimated maximum possible concentration (EMPC) for these analytes in Samples CL-SG-1_0-0.33, CL-SG-3_0-0.33 and CL-SG-4_0-0.33. This is typically due to the compounds exhibiting ion abundance ratios that are outside of the allowable control limits set forth in the the EPA method and the National Functional Guidelines. In each case the concentrations were qualified as not detected (U) at the elevated reporting limits.

Also, the laboratory noted that congeners 1,2,3,4,7,8-HxCDF and 2,3,4,6,7,8-HxCDF coeluted with Polybrominated diphenyl ethers (PBDE) in Sample CL-SG-1_0-0.33. In some cases, these congeners were already qualified as not detected above. However, in the case of 1,2,3,4,7,8-HxCDF, there was no additional EMPC qualification. This congener was qualified as estimated (J) in Sample CL-SG-1_0-0.33.

SDG A0L1 (SVOCs): The benzyl alcohol results were noted by the laboratory to be cases of low spectral mass spectrometer matches in Samples SSI-SS-05_0-0.39 and SSI-SS-06_0-0.39. The positive results for these analytes were qualified as estimated (J) in both samples.

SDG A0M9 (Pentachlorophenol): The column confirmation RPD value for pentachlorophenol was greater than 40 percent in Sample SSI-SC-05_2-4. The positive result for pentachlorophenol was qualified as (NJ) in this sample.

SDG A0R4 (Pentachlorophenol): The column confirmation RPD value for pentachlorophenol was greater than 40 percent in Samples SSI-SC-01_2-4, SSI-SC-03_0-2, and SSI-SC-03_2-4. The positive results for pentachlorophenol were qualified as (NJ) in these samples.

SDG A0S3 (SVOCs): The phenol and benzyl alcohol results were noted by the laboratory to be cases of low spectral mass spectrometer matches in Sample SSI-SS-03_0-0.39. The positive results for these analytes were qualified as estimated (J) in this sample.

Pentachlorophenol: The column confirmation RPD values for pentachlorophenol were greater than 40 percent in Samples SSI-SC-04_0-2 and SSI-SC-DUP-03. The positive results for pentachlorophenol were qualified as (NJ) in these samples.

SDG AWJ5 (Pentachlorophenol): The column confirmation RPD value for pentachlorophenol was greater than 40 percent in Sample PSB-SC-03-0-1. The positive result for pentachlorophenol was qualified as (NJ) in this sample.

SDG 9350 (Dioxin/Furans): The positive results for Total TCDF, Total PeCDF, and Total HxCDF were flagged as EMPCs in Sample SSI-SS-14_0-0.39. The positive result for Total PeCDD was flagged as an EMPC in Sample SSI-SS-15_0-0.39. Also, the positive results for Total TCDF and Total PeCDF were flagged as EMPCs in Sample SSI-SS-16_0-0.39. In each case the concentrations were qualified as not detected (U) at the elevated reporting limits.

SDG 9353 (Dioxin/Furans): The positive result for Total TCDF was flagged as an EMPC in Sample SSI-SC-05_4-6. The positive results for Total TCDF, Total PeCDF, and Total HxCDF were flagged as EMPCs in Sample SSI-SC-06_4-6. The positive results for Total TCDF, Total PeCDF, and Total HxCDF were flagged as EMPCs in Sample SSI-SC-07_4-6. In each case the concentrations were qualified as not detected (U) at the elevated reporting limits.

Also, the laboratory noted that Total TCDD coeluted with PBDE in Sample SSI-SC-07_4-6. In the case, there was no additional EMPC qualification. Therefore, this homologue group result was qualified as estimated (J) in Sample SSI-SC-07_4-6.

SDG 9648 (Dioxin/Furans): The positive results for Total HxCDF were flagged as an EMPC in Samples PSB-SC-01_1-0-1, PSB-SC-03_1-2, and PSB-SC-04_0-1. In each case the concentrations for HxCDF were qualified as not detected (U) at the elevated reporting limits.

Also, the laboratory noted that Total TCDD coeluted with PBDE in samples PSB-SC-01_0-1, PSB-SC-02_0-1, and PSB-SC-02_1-2. In each case, there were no additional EMPC qualifications. These homologue group results were qualified as estimated (J) in all three samples.

Reporting Limits

In all sample analyses, the positive results for all target analytes were quantitated using instrument responses that were appropriately within the calibration curve used for that instrument. All data met the established criteria for this QC element with one exception below:

- **SDG AHU9** (Dioxins/Furans): The congener OCDD was reported to exceed the linear calibration range of the instrument in Samples CL-SG-3_0-0.33 and CL-SG-4_0-0.33. The positive results for these congeners were qualified as estimated (J) in these samples.

OVERALL ASSESSMENT

As was determined by this data validation, the laboratory followed the specified analytical methods. Accuracy was acceptable, as demonstrated by the labeled compounds and OPR sample %R values. Precision could not be assessed for this sampling event as there were no laboratory/field duplicates analyzed. All data are acceptable for the intended use, with the qualifications listed below.

Selected data were qualified as estimated (J/UJ) because of the following:

- Low spectral matches (mass spectrometer analysis)
- Matrix spike %R and RPD outliers
- Laboratory control sample %R outliers
- Surrogate %R outliers
- Field duplicate RPD outliers

Selected data were qualified as estimated (U) because of the following:

- Method blank contamination
- Estimated maximum possible concentrations (ion abundance ratio outliers)

Selected data were qualified as tentatively identified (NJ) because of the following:

- Primary/secondary column confirmation %RSD outliers

REFERENCES

GeoEngineers, Inc. 2015. “Final Work Plan Supplemental Sediment Investigation”, prepared for City of Bellingham, August 21, 2015

U.S. Environmental Protection Agency (EPA). 2008. “Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review,” EPA-540-R-08-01. September 2008.

U.S. Environmental Protection Agency (EPA). 2009. "Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use," EPA-540-R-08-005. January 2009.

U.S. Environmental Protection Agency (EPA). 2011. "Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review," EPA-540-R-11-016. September 2011.

U.S. Environmental Protection Agency (EPA). 2014. "National Functional Guidelines for Inorganic Superfund Data Review," EPA-540-R-13-001. August 2014.

C.2 Dioxins/Furans

DATA VALIDATION REPORT

SUPPLEMENTAL SEDIMENT INVESTIGATION
R.G. HALEY SITE – BELLINGHAM, WA

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PROJECT NARRATIVE

Basis for the Data Validation

This report summarizes the results of summary and full validation (EPA Stage 2B, EPA Stage 4) performed on sediment and quality control sample data for the R.G. Haley Supplemental Sediment Investigation. A complete list of samples is provided in the **Sample Index**.

Samples were analyzed by Frontier Analytical Laboratory, El Dorado Hills, California. The analytical method and EcoChem project chemists are noted below:

ANALYSIS	METHOD	PRIMARY REVIEW	SECONDARY REVIEW
Dioxin/Furan Compounds	1613B	E. Clayton	C. Ransom

The data were reviewed using guidance and quality control criteria documented in the analytical methods; *Supplemental Sediment Investigation, R.G. Haley Site, Bellingham Washington, Quality Assurance Project Plan (QAPP)* (GeoEngineers August 21, 2015) and *National Functional Guidelines for Chlorinated Dioxin/Furan Data Review* (USEPA 2011).

EcoChem's goal in assigning data assessment qualifiers is to assist in proper data interpretation. If values are estimated (J or UJ), data may be used for site evaluation and risk assessment purposes but reasons for data qualification should be taken into consideration when interpreting sample concentrations. If values are assigned an R, the data are to be rejected and should not be used for any site evaluation purposes. If values have no data qualifier assigned, then the data meet the data quality objectives as stated in the documents and methods referenced above.

Data qualifier definitions, reason codes, and validation criteria are included as **APPENDIX A**. A Qualified Data Summary Table is included in **APPENDIX B**. Data Validation Worksheets and project associated communications will be kept on file at EcoChem, Inc. A qualified laboratory electronic data deliverable (EDD) is also submitted with this report.

Sample Index
R.G. Haley Site - Supplemental Sediment Investigation

SDG	Sample ID	Laboratory ID	Dioxins
9351	SSI-SS-08_0-12	9351-001	✓
9351	SSI-SS-10_0-12	9351-002	✓
9351	SSI-SS-11_0-12	9351-003	✓
9351	SSI-SS-12_0-12	9351-004	✓
9353	SSI-SC-03_0-2	9353-014	✓
9353	SSI-SC-03_2-4	9353-015	✓
9353	SSI-SC-05_0-2	9353-010	✓
9353	SSI-SC-05_2-4	9353-011	✓
9353	SSI-SC-06_0-2	9353-001	✓
9353	SSI-SC-06_2-4	9353-002	✓
9353	SSI-SC-07_0-2	9353-005	✓
9353	SSI-SC-07_2-4	9353-007	✓
9353	SSI-SC-DUP-04	9353-006	✓
9354	SSI-SC-01_0-2	9354-001	✓
9354	SSI-SC-01_2-4	9354-002	✓
9354	SSI-SC-04_0-2	9354-006	✓
9354	SSI-SC-04_2-4	9354-007	✓
9354	SSI-SC-DUP-01	9354-004	✓
9354	SSI-SC-DUP-03	9354-005	✓

DATA VALIDATION REPORT
R.G. Haley Site – Supplemental Sediment Investigation
Dioxin/Furan Compounds by Method 1613B

This report documents the review of analytical data from the analysis of sediment samples and the associated laboratory and field quality control (QC) samples. Samples were analyzed by Frontier Analytical Laboratory., El Dorado Hills, California. Refer to the SAMPLE INDEX for a complete list of samples.

SDG	NUMBER OF SAMPLES	VALIDATION LEVEL
9351	4 Sediment	EPA Stage 4
9353	9 Sediment	EPA Stage 2B
9354	6 Sediment	EPA Stage 2B

DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

SDG 9351: All client identifications (ID) on chain-of-custody (COC) were missing the final segment of "_0-12". Samples were logged in according the IDs on the sample containers.

EDD TO HARDCOPY VERIFICATION

Sample results and related quality control data were received as an electronic data deliverable (EDD) and laboratory report. The EDD was verified against the laboratory report (10%). No errors were noted.

TECHNICAL DATA VALIDATION

The quality control (QC) requirements reviewed are summarized in the following table:

✓	Sample Receipt, Preservation, and Holding Times	✓	Ongoing Precision and Recovery (OPR)
✓	System Performance and Resolution Checks	2	Field Duplicates
✓	Initial Calibration (ICAL)	✓	Target Analyte List
✓	Calibration Verification	2	Reported Results
✓	Blanks (Laboratory and Field)	2	Compound Identification
✓	Labeled Compound Recovery	1	Calculation Verification
1	Matrix Spike/Matrix Spike Duplicates (MS/MSD)		

✓ ***Stated method quality objectives (MQO) and QC criteria have been met. No outliers are noted or discussed.***

1 ***Quality control results are discussed below, but no data were qualified.***

2 ***Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.***

Matrix Spike/Matrix Spike Duplicates

Samples were inadvertently marked for matrix spike/matrix spike duplicate (MS/MSD) analysis on the COCs, however MS/MSDs are not required by the analytical method or the quality assurance project plan (QAPP). The MS/MSD results were not used to evaluate laboratory precision or accuracy.

Field Duplicates

The field duplicate relative percent difference (RPD) control limit is 50% for concentrations greater than 5x the reporting limit (RL). For concentrations less than 5x the RL, the difference between the sample result and the duplicate result must be less than 2x the RL. Outlier results were estimated (J-9). Field duplicate samples and any outliers are noted below.

SDG 9353: One set of field duplicates was submitted: SSI-SC-07_0-2 and SSI-SC-DUP-04. The difference between the two results for 1,2,3,6,7,8-HxCDF was greater than the control limit.

SDG 9354: Two sets of field duplicates were submitted: SSI-SC-01_0-2 & SSI-SC-DUP-01 and SSI-SC-04_0-2 & SSI-SC-DUP-03.

For samples SSI-SC-01_0-2 and SSI-SC-DUP-01, the RPD values for OCDD, 1,2,3,4,6,7,8-HpCDD, Total HpCDD, Total HpCDF, Total HXCDF, OCDF, 1,2,3,4,7,8,9-HpCDF, and 1,2,3,4,6,7,8-HpCDF were greater than the control limit.

For samples SSI-SC-04_0-2 and SSI-SC-DUP-03, the RPD value for Total TCDD was greater than the control limit.

Reported Results

SDG 9353: The laboratory assigned an "E" flag to two OCDD results to indicate the concentrations exceeded the calibration range of the instrument. These results were estimated (J-20).

Compound Identification

The method requires the confirmation of 2,3,7,8-TCDF using an alternate GC column if the column that is typically used cannot fully separate 2,3,7,8-TCDF from closely eluting non-target TCDF isomers. The laboratory did performed a second column confirmation as necessary. Result reported from the confirmation column were flagged with an "F".

The laboratory assigned an "M" flag to one or more analytes to indicate that the ion ratio criterion for positive identification was not met. Since the ion abundance ratio is the primary identification criterion for high resolution mass spectroscopy, an outlier indicates that the reported result may be a false positive. These "M" flagged results were qualified as not detected (U-25) at the reported concentration. The laboratory also assigned "M" flags to total homolog groups. In these cases, the result for the group was estimated (J-25).

Diphenyl ether interferences were present in some samples. The laboratory assigned a "D" flag to the results affected by these interferences. These results were estimated (J-23) to indicate a potential high bias. No action was taken for results qualified as not-detected based on ion ratio outliers.

Calculation Verification

SDG 9351: Several results were verified by recalculation from the raw data. No calculation or transcription errors were found.

OVERALL ASSESSMENT

As determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions noted above, accuracy was acceptable as demonstrated by the labeled compound and OPR recoveries and precision was acceptable as demonstrated by the OPR and field duplicate RPD values.

Detection limits were elevated based on ion ratio outliers. Results were estimated because they exceeded the calibration range or due to diphenyl ether interference. Results for total homolog groups with "M" flags were also estimated.

All data, as qualified, are acceptable for use.

ECOCHEM
Data Quality

APPENDIX A

DATA QUALIFIER DEFINITIONS
REASON CODES
AND CRITERIA TABLES

DATA VALIDATION QUALIFIER CODES
Based on National Functional Guidelines

The following definitions provide brief explanations of the qualifiers assigned to results in the data review process.

U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents the approximate concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

The following is an EcoChem qualifier that may also be assigned during the data review process:

DNR	Do not report; a more appropriate result is reported from another analysis or dilution.

DATA QUALIFIER REASON CODES

Group	Code	Reason for Qualification
Sample Handling	1	Improper Sample Handling or Sample Preservation (i.e., headspace, cooler temperature, pH, summa canister pressure); Exceeded Holding Times
Instrument Performance	24	Instrument Performance (i.e., tune, resolution, retention time window, endrin breakdown, lock-mass)
	5A	Initial Calibration (RF, %RSD, r^2)
	5B	Calibration Verification (CCV, CCAL; RF, %D, %R) Use bias flags (H,L)[1] where appropriate
	5C	Initial Calibration Verification (ICV %D, %R) Use bias flags (H,L)[1] where appropriate
Blank Contamination	6	Field Blank Contamination (Equipment Rinsate, Trip Blank, etc.)
	7	Lab Blank Contamination (i.e., method blank, instrument blank, etc.) Use low bias flag (L)[1] for negative instrument blanks
Precision and Accuracy	8	Matrix Spike (MS and/or MSD) Recoveries Use bias flags (H,L)[1] where appropriate
	9	Precision (all replicates: LCS/LCSD, MS/MSD, Lab Replicate, Field Replicate)
	10	Laboratory Control Sample Recoveries (a.k.a. Blank Spikes) Use bias flags (H,L)[1] where appropriate
	12	Reference Material Use bias flags (H,L)[1] where appropriate
	13	Surrogate Spike Recoveries (a.k.a. labeled compounds, recovery standards) Use bias flags (H,L)[1] where appropriate
Interferences	16	ICP/ICP-MS Serial Dilution Percent Difference
	17	ICP/ICP-MS Interference Check Standard Recovery Use bias flags (H,L)[1] where appropriate
	19	Internal Standard Performance (i.e., area, retention time, recovery)
	22	Elevated Detection Limit due to Interference (i.e., chemical and/or matrix)
	23	Bias from Matrix Interference (i.e. diphenyl ether, PCB/pesticides)
Identification and Quantitation	2	Chromatographic pattern in sample does not match pattern of calibration standard
	3	2nd column confirmation (RPD or %D)
	4	Tentatively Identified Compound (TIC) (associated with NJ only)
	20	Calibration Range or Linear Range Exceeded
	25	Compound Identification (i.e., ion ratio, retention time, relative abundance, etc.)
Miscellaneous	11	A more appropriate result is reported (multiple reported analyses i.e., dilutions, re-extractions, etc. Associated with "R" and "DNR" only)
	14	Other (See DV report for details)
	26	Method QC information not provided

[1] H = high bias indicated
L = low bias indicated

Dioxin/Furan Analysis by HRMS
(Based on Dioxin NFG 2011 and Methods EPA 1613B and SW-846 8290)

QC Element	Acceptance Criteria	Source of Criteria	Action for Non-Conformance	Reason Code	Discussion and Comments
Sample Handling					
Cooler/Storage Temperature Preservation	Waters/Solids ≤ 6°C & in the dark Tissues <-10°C & in the dark **Preservation Aqueous:** If Cl_2 is present Thiosulfate must be added and if pH > 9 it must be adjusted to 7 - 9	NFG [1] Method[2]	J(pos)/R(ND) if thiosulfate not added if Cl_2 present; J(pos)/UJ(ND) if pH not adjusted J(pos)/UJ(ND) if temp > 20°C	1	**EcoChem PJ, see TM-05**
Holding Time	**If properly stored, 1 year or:** **Extraction (all matrices):** 30 days from collection **Analysis (all matrices)**: 45 days from extraction	NFG [1] Method[2]	If not properly stored or HT exceedance: J(pos)/UJ(ND)	1	**EcoChem PJ, see TM-05** Gross exceedance = > 1 year 2011 NFG **Note:** Under CWA, SDWA, and RCRA the HT for H2O is 7 days.
Instrument Performance					
Mass Resolution (Tuning)	PFK (Perfluorokerosene) ≥10,000 resolving power at m/z 304.9824. Exact mass of m/z 380.9760 w/in 5 ppm of theoretical value (380.97410 to 380.97790) . Analyzed prior to ICAL and at the start and end of each 12 hr. shift.	NFG [1] Method [2]	R(pos/ND) all analytes in all samples associated with the tune	24	Notify PM
Windows Defining Mix	Peaks for first and last eluters must be within established retention time windows for each selector group (chlorination level)	NFG [1] Method [2]	If peaks are not completely within windows (clipped): If natives are ok, J(pos)/UJ(ND) homologs (Totals) If natives are affected, R all results for that selector group	24	Notify PM
Column Performance Mix	Both mixes must be analyzed before ICAL and CCAL Valley < 25% (valley = (x/y)*100%) where x = ht. of TCDD (or TCDF) & y = baseline to bottom of valley For all isomers eluting near the 2378-TCDD (TCDF) peak (TCDD only for 8290)	NFG [1] Method [2]	J(pos) if valley > 25%	24	**EcoChem PJ, see TM-05, Rev. 2**; Note: TCDF is evaluated only if second column confirmation is performed
Initial Calibration **Sensitivity**	S/N ratio > 10 for all native and labeled compounds in CS1 std.	NFG [1] Method [2]	If <10, elevate Det. Limit or R(ND)	5A	
Initial Calibration **Selectivity**	Ion Abundance ratios within QC limits (Table 8 of method 8290) (Table 9 of method 1613B)	NFG [1] Method [2]	If 2 or more ion ratios are out for one compound in ICAL, J(pos)	5A	**EcoChem PJ, see TM-05, Rev. 2**

Dioxin/Furan Analysis by HRMS
(Based on Dioxin NFG 2011 and Methods EPA 1613B and SW-846 8290)

QC Element	Acceptance Criteria	Source of Criteria	Action for Non-Conformance	Reason Code	Discussion and Comments
Instrument Performance (continued)					
Initial Calibration (Minimum 5 stds.) **Stability**	%RSD < 20% for native compounds %RSD <30% for labeled compounds (%RSD < 35% for labeled compounds under 1613b)	NFG [1] Method [2]	J(pos) natives if %RSD > 20%	5A	
	Absolute RT of $^{13}C_{12}$-1234-TCDD >25 min on DB5 & >15 min on DB-225	NFG [1] Method [2]	Narrate, no action		**EcoChem PJ, see TM-05, Rev. 2**
Continuing Calibration (Prior to each 12 hr. shift) **Sensitivity**	S/N ratio for CS3 standard > 10	NFG [1] Method [2]	If <10, elevate Det. Limit or R(ND)	5B	
Continuing Calibration (Prior to each 12 hr. shift) **Selectivity**	Ion Abundance ratios within QC limits (Table 8 of method 8290) (Table 9 of method 1613B)	NFG [1] Method [2]	For congener with ion ratio outlier, J(pos) natives in all samples associated with CCAL. No action for labeled congener ion ratio outliers.	25	**EcoChem PJ, see TM-05**
Continuing Calibration (Prior to each 12 hr. shift) **Stability**	%D+/-20% for native compounds %D +/-30% for labeled compounds **(Must meet limits in Table 6, Method 1613B)** If %D in the closing CCAL are within 25%/35%, the mean RF from the two CCAL may be used to calculate samples **(Section 8.3.2.4 of 8290)**.	NFG [1] Method [2]	**Labeled compounds:** Narrate, no action. **Native compounds:** 1613: J(pos)/UJ(ND)if %D is outside Table 6 limits J(pos)/R(ND) if %D is +/-75% of Table 6 limits 8290: J(pos)/UJ(ND) if %D = 20% - 75% J(pos)/R(ND) if %D > 75%	5B (H,L)[3]	
	Absolute RT of $^{13}C_{12}$-1234-TCDD and $^{13}C_{12}$-123789-HxCDD should be ± 15 seconds of ICAL RRT for all other compounds must meet criteria listed in Table 2 Method 1316.	NFG [1] Method [2]	Narrate, no action	5B	**EcoChem PJ, see TM-05**
Blank Contamination					
Method Blank (MB)	MB: One per matrix per batch of (of ≤ 20 samples) No detected compounds > RL	NFG [1] Method [2]	U(pos) if result is < 5X action level.	7	**Hierarchy of blank review:** **#1 - Review MB, qualify as needed** **#2 - Review FB , qualify as needed**
Field Blank (FB)	FB: frequency as per QAPP No detected compounds > RL		U(pos) if result is < 5X action level.	6	

Dioxin/Furan Analysis by HRMS
(Based on Dioxin NFG 2011 and Methods EPA 1613B and SW-846 8290)

QC Element	Acceptance Criteria	Source of Criteria	Action for Non-Conformance	Reason Code	Discussion and Comments
Precision and Accuracy					
MS/MSD (recovery)	**MS/MSD not typically required for HRMS analyses.** If lab analyzes MS/MSD then one set per matrix per batch (of ≤ 20 samples) Use most current laboratory control limits	EcoChem standard policy	J(pos) if both %R > UCL - high bias J(pos)/UJ(ND) if both %R < LCL - low bias J(pos)/R(ND) if both %R < 10% - very low bias J(pos)/UJ(ND) if one > UCL & one < LCL, with no bias **PJ if only one %R outlier**	8 (H,L)[3]	No action if only one spike %R is outside criteria. No action if parent concentration is >4x the amount spiked. Qualify parent sample only unless other QC indicates systematic problems.
MS/MSD (RPD)	**MS/MSD not typically required for HRMS analyses.** If lab analyzes MS/MSD then one set per matrix per batch (of ≤ 20 samples) Use most current laboratory control limits	EcoChem standard policy	J(pos) in parent sample if RPD > CL	9	Qualify parent sample only.
LCS (or OPR)	One per lab batch (of ≤ 20 samples) Use most current laboratory control limits **or** Limits from Table 6 of 1613B	NFG [(1)] Method [(2)]	J(pos) if %R > UCL - high bias J(pos)/UJ(ND) if %R < LCL - low bias J(pos)/R(ND) if %R < 10% - very low bias	10 (H,L)[3]	No action if only one spike %R is outside criteria, when LCSD is analyzed. Qualify all associated samples.
LCS/LCSD (RPD)	**LCSD not typically required for HRMS analyses.** One set per matrix and batch of 20 samples RPD < 35%	Method [(2)] Ecochem standard policy	J(pos) assoc. compound in all samples if RPD > CL	9	Qualify all associated samples.
Lab Duplicate (RPD)	**Lab Dup not typically required for HRMS analyses.** One per lab batch (of ≤ 20 samples) Use most current laboratory control limits	EcoChem standard policy	J(pos)/UJ(ND) if RPD > CL	9	
Labeled Compounds (Internal Standards)	Added to all samples %R = 40% - 135% in all samples 8290 %R must meet limits in Table 7 Method 1613B	NFG [(1)] Method [(2)]	J(pos) if %R > UCL - high bias J(pos)/UJ(ND) if %R < LCL - low bias J(pos)/R(ND) if %R < 10% - very low bias	13 (H,L)[3]	
Field Duplicates	Solids: RPD <50% OR difference < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR difference < 1X RL (for results < 5X RL)	EcoChem standard policy	Narrate and qualify if required by project	9	**Use professional judgment**

Dioxin/Furan Analysis by HRMS
(Based on Dioxin NFG 2011 and Methods EPA 1613B and SW-846 8290)

QC Element	Acceptance Criteria	Source of Criteria	Action for Non-Conformance	Reason Code	Discussion and Comments
Compound ID and Calculation					
Quantitation/ Identification	All ions for each isomer must maximize within ± 2 seconds. S/N ratio >2.5 Ion ratios must meet criteria listed in Table 8 Method 8290, or Table 9 of 1613B; RRTs w/in limits in Table 2 of 1613B	NFG [1] Method [2]	Narrate in report; qualify if necessary NJ(pos) for retention time outliers. U(pos) for ion ratio outliers.	25	**EcoChem PJ, see TM-05**
EMPC (estimated maximum possible concentration)	If quantitation identification criteria are not met, laboratory should report an EMPC value.	NFG [1] Method [2]	If laboratory correctly reported an EMPC value, qualify the native compound U(pos) to indicate that the value is a detection limit and qualify total homolog groups J (pos)	25	**Use professional judgment See TM-18**
Interferences	Interferences from chlorodiphenyl ether compounds	NFG [1] Method [2]	J(pos)/UJ(ND) if present	23	**See TM-16**
	Lock masses must not deviate ± 20% from values in Table 8 of 1613B	Method [2]	J(pos)/UJ(ND) if present	24	**See TM-17**
Second Column Confirmation	All 2,3,7,8-TCDF hits must be confirmed on a DB-225 (or equiv) column. All QC criteria must also be met for the confirmation analysis.	NFG [1] Method [2]	Report the DB-225 value. If not performed use PJ.	3	DNR-11 DB5 result if both results from both columns are reported. **EcoChem PJ, see TM-05**
Calculation Check	Check 10% of field & QC sample results	EcoChem standard policy	Contact laboratory for resolution and/or corrective action	na	Full data validation only.
Electronic Data Deliverable (EDD)					
Verification of EDD to hardcopy data	EcoChem verify @ 10% unless problems noted; then increase level up to 100% for next several packages.		Depending on scope of problem, correct at EcoChem (minor issues) to resubmittal by laboratory (major issues).	na	EcoChem Project Manager and/or Database Administrator will work with lab to provide long-term corrective action.
Dilutions, Re-extractions and/or Reanalyses	Report only one result per analyte	Standard reporting policy	Use "DNR" to flag results that will not be reported.	11	

(pos) - positive (detected) results; (ND) - not detected results

[1] National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins (CDDs) & Chlorinated Dibenzofurans (CDFs) Data Review, September 2011

[2] Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry (HRGC/HRMS), USEPA SW-846, Method 8290

[2] EPA Method 1613, Rev.B, Tetra-through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGS/HRMS, October 1994

[3] NFG 2013 suggests using "+ / -" to indicate bias; EcoChem has chosen "H" = high bias indicated; "L" = low bias indicated.

ECOCHEM
Data Quality

APPENDIX B

QUALIFIED DATA SUMMARY TABLE

Qualified Data Summary Table
R.G. Haley Site - Supplemental Sediment Investigation

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Flag	DV Qualifier	DV Reason
9351	SSI-SS-08_0-12	9351-001	EPA1613B	Total HxCDF	129	pg/g	D,M	J	23,25
9351	SSI-SS-08_0-12	9351-001	EPA1613B	Total PeCDF	30.3	pg/g	D,M	J	23,25
9351	SSI-SS-08_0-12	9351-001	EPA1613B	Total TCDF	22.1	pg/g	D,M	J	23,25
9351	SSI-SS-10_0-12	9351-002	EPA1613B	Total HxCDF	116	pg/g	D,M	J	23,25
9351	SSI-SS-10_0-12	9351-002	EPA1613B	Total PeCDF	34.4	pg/g	D,M	J	23,25
9351	SSI-SS-10_0-12	9351-002	EPA1613B	Total TCDF	48.9	pg/g	D,M	J	23,25
9351	SSI-SS-11_0-12	9351-003	EPA1613B	1,2,3,6,7,8-HxCDF	2.89	pg/g	D,J,M	U	25
9351	SSI-SS-11_0-12	9351-003	EPA1613B	Total HxCDF	107	pg/g	D,M	J	23,25
9351	SSI-SS-11_0-12	9351-003	EPA1613B	Total PeCDF	39.9	pg/g	D,M	J	23,25
9351	SSI-SS-11_0-12	9351-003	EPA1613B	Total TCDF	77.4	pg/g	D,M	J	23,25
9351	SSI-SS-12_0-12	9351-004	EPA1613B	Total HxCDF	79.6	pg/g	D,M	J	23,25
9351	SSI-SS-12_0-12	9351-004	EPA1613B	Total PeCDF	30.2	pg/g	D,M	J	23,25
9351	SSI-SS-12_0-12	9351-004	EPA1613B	Total TCDF	56.9	pg/g	D,M	J	23,25
9353	SSI-SC-03_0-2	9353-014	EPA1613B	Total HxCDF	260.0	pg/g	D,M	J	23,25
9353	SSI-SC-03_0-2	9353-014	EPA1613B	Total PeCDF	94.1	pg/g	D,M	J	23,25
9353	SSI-SC-03_0-2	9353-014	EPA1613B	Total TCDF	86.9	pg/g	D,M	J	23,25
9353	SSI-SC-03_2-4	9353-015	EPA1613B	Total HxCDF	150.0	pg/g	D,M	J	23,25
9353	SSI-SC-03_2-4	9353-015	EPA1613B	Total PeCDF	46.2	pg/g	D,M	J	23,25
9353	SSI-SC-03_2-4	9353-015	EPA1613B	Total TCDF	33.3	pg/g	D,M	J	23,25
9353	SSI-SC-05_0-2	9353-010	EPA1613B	Total HxCDF	1710	pg/g	D,M	J	23,25
9353	SSI-SC-05_0-2	9353-010	EPA1613B	Total PeCDF	358	pg/g	D,M	J	23,25
9353	SSI-SC-05_0-2	9353-010	EPA1613B	Total TCDF	183	pg/g	D,M	J	23,25
9353	SSI-SC-05_2-4	9353-011	EPA1613B	Total HxCDF	475	pg/g	D,M	J	23,25
9353	SSI-SC-05_2-4	9353-011	EPA1613B	Total PeCDF	132	pg/g	D,M	J	23,25
9353	SSI-SC-05_2-4	9353-011	EPA1613B	Total TCDF	159	pg/g	D,M	J	23,25
9353	SSI-SC-06_0-2	9353-001	EPA1613B	1,2,3,6,7,8-HxCDF	74.9	pg/g	D,M	U	25
9353	SSI-SC-06_0-2	9353-001	EPA1613B	OCDD	80600	pg/g	E	J	20
9353	SSI-SC-06_0-2	9353-001	EPA1613B	Total HxCDF	5090	pg/g	D,M	J	23,25
9353	SSI-SC-06_0-2	9353-001	EPA1613B	Total PeCDF	1090	pg/g	D,M	J	23,25
9353	SSI-SC-06_0-2	9353-001	EPA1613B	Total TCDF	310.0	pg/g	D,M	J	23,25
9353	SSI-SC-06_2-4	9353-002	EPA1613B	OCDD	163000	pg/g	E	J	20

Qualified Data Summary Table
R.G. Haley Site - Supplemental Sediment Investigation

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Flag	DV Qualifier	DV Reason
9353	SSI-SC-06_2-4	9353-002	EPA1613B	Total HxCDF	6720	pg/g	D,M	J	23,25
9353	SSI-SC-06_2-4	9353-002	EPA1613B	Total PeCDF	911	pg/g	D,M	J	23,25
9353	SSI-SC-06_2-4	9353-002	EPA1613B	Total TCDF	442	pg/g	D,M	J	23,25
9353	SSI-SC-07_0-2	9353-005	EPA1613B	1,2,3,6,7,8-HxCDF	5.36	pg/g		J	9
9353	SSI-SC-07_0-2	9353-005	EPA1613B	Total HxCDF	246	pg/g	D,M	J	23,25
9353	SSI-SC-07_0-2	9353-005	EPA1613B	Total PeCDF	72.6	pg/g	D,M	J	23,25
9353	SSI-SC-07_0-2	9353-005	EPA1613B	Total TCDF	35.6	pg/g	D,M	J	23,25
9353	SSI-SC-07_2-4	9353-007	EPA1613B	Total HxCDF	439	pg/g	D,M	J	23,25
9353	SSI-SC-07_2-4	9353-007	EPA1613B	Total PeCDF	144	pg/g	D,M	J	23,25
9353	SSI-SC-07_2-4	9353-007	EPA1613B	Total TCDD	25.7	pg/g	M	J	25
9353	SSI-SC-07_2-4	9353-007	EPA1613B	Total TCDF	50.1	pg/g	D,M	J	23,25
9353	SSI-SC-DUP-04	9353-006	EPA1613B	1,2,3,6,7,8-HxCDF	10.8	pg/g		J	9
9353	SSI-SC-DUP-04	9353-006	EPA1613B	Total HxCDF	294	pg/g	D,M	J	23,25
9353	SSI-SC-DUP-04	9353-006	EPA1613B	Total PeCDF	83.6	pg/g	D,M	J	23,25
9353	SSI-SC-DUP-04	9353-006	EPA1613B	Total TCDF	38.6	pg/g	D,M	J	23,25
9354	SSI-SC-01_0-2	9354-001	EPA1613B	1,2,3,4,6,7,8-HpCDD	6000	pg/g		J	9
9354	SSI-SC-01_0-2	9354-001	EPA1613B	1,2,3,4,6,7,8-HpCDF	578	pg/g		J	9
9354	SSI-SC-01_0-2	9354-001	EPA1613B	1,2,3,4,7,8,9-HpCDF	29.2	pg/g		J	9
9354	SSI-SC-01_0-2	9354-001	EPA1613B	OCDD	68000	pg/g		J	9
9354	SSI-SC-01_0-2	9354-001	EPA1613B	OCDF	3050	pg/g		J	9
9354	SSI-SC-01_0-2	9354-001	EPA1613B	Total HpCDD	12000	pg/g		J	9
9354	SSI-SC-01_0-2	9354-001	EPA1613B	Total HpCDF	2910	pg/g		J	9
9354	SSI-SC-01_0-2	9354-001	EPA1613B	Total HxCDF	716	pg/g	D,M	J	9,23,25
9354	SSI-SC-01_0-2	9354-001	EPA1613B	Total PeCDF	133	pg/g	D,M	J	23,25
9354	SSI-SC-01_0-2	9354-001	EPA1613B	Total TCDF	71.5	pg/g	D,M	J	23,25
9354	SSI-SC-01_2-4	9354-002	EPA1613B	Total HxCDF	419	pg/g	D,M	J	23,25
9354	SSI-SC-01_2-4	9354-002	EPA1613B	Total TCDF	70.8	pg/g	D,M	J	23,25
9354	SSI-SC-04_0-2	9354-006	EPA1613B	Total TCDD	22.7	pg/g		J	9
9354	SSI-SC-04_0-2	9354-006	EPA1613B	Total TCDF	24.6	pg/g	M	J	25
9354	SSI-SC-04_2-4	9354-007	EPA1613B	Total HxCDF	366	pg/g	D,M	J	9,23,25
9354	SSI-SC-04_2-4	9354-007	EPA1613B	Total PeCDF	75.1	pg/g	D,M	J	23,25

Qualified Data Summary Table
R.G. Haley Site - Supplemental Sediment Investigation

SDG	Sample ID	Lab ID	Method	Analyte	Result	Units	Lab Flag	DV Qualifier	DV Reason
9354	SSI-SC-04_2-4	9354-007	EPA1613B	Total TCDF	60.4	pg/g	D,M	J	23,25
9354	SSI-SC-DUP-01	9354-004	EPA1613B	1,2,3,4,6,7,8-HpCDD	2190	pg/g		J	9
9354	SSI-SC-DUP-01	9354-004	EPA1613B	1,2,3,4,6,7,8-HpCDF	234	pg/g		J	9
9354	SSI-SC-DUP-01	9354-004	EPA1613B	1,2,3,4,7,8,9-HpCDF	13.8	pg/g		J	9
9354	SSI-SC-DUP-01	9354-004	EPA1613B	OCDD	22300	pg/g		J	9
9354	SSI-SC-DUP-01	9354-004	EPA1613B	OCDF	629	pg/g		J	9
9354	SSI-SC-DUP-01	9354-004	EPA1613B	Total HpCDD	4550	pg/g		J	9
9354	SSI-SC-DUP-01	9354-004	EPA1613B	Total HpCDF	821	pg/g		J	9
9354	SSI-SC-DUP-01	9354-004	EPA1613B	Total HxCDF	421	pg/g	D,M	J	23,25
9354	SSI-SC-DUP-01	9354-004	EPA1613B	Total PeCDF	126	pg/g	D,M	J	23,25
9354	SSI-SC-DUP-01	9354-004	EPA1613B	Total TCDF	67.2	pg/g	D,M	J	23,25
9354	SSI-SC-DUP-03	9354-005	EPA1613B	Total TCDD	41.0	pg/g		J	9

APPENDIX D
Updated RI Data Summary Statistics

Table D-1

Updated Remedial Investigation Summary Statistics

R.G. Haley Site

Bellingham, Washington

Sediment Depth Zone	Analyte	Total Samples per Depth Zone	Frequency of Detection (%)	Minimum Detection Limit	Maximum Detection Limit	Minimum Dectected Concentration	Mean Dectected Concentration	Median Detected Concentration	Maximum Detected Concentration	Maximum Concentration - TOC-Normalized	Frequency of Exceedance - Detects Only (%)	Magnitude of Exceedance of Dry-weight Screening Levels	Magnitude of Exceedance of TOC-normalized Screening Levels	Dry-weight Sediment Screening Level	TOC-Normalized Screening Level
Surface	Diesel-range hydrocarbons	13	46.2	6.1	21	12	57.0	18.0	220	NA	Evaluated as part of TPH	Evaluated as part of TPH	NA	Evaluated as part of TPH	NA
Surface	Heavy Oil-Range Hydrocarbons	13	92.3	12	12	42	131.8	87.5	430	NA	Evaluated as part of TPH	Evaluated as part of TPH	NA	Evaluated as part of TPH	NA
Surface	Total Petroleum Hydrocarbons	13	92.3	12	12	54	160.8	89.5	650	NA	15.4	2.5	NA	260 mg/kg	NA
Surface	Total Dioxin/Furan TEQ (ND=0.5DL) - Human/Mammal	32	100	NA	NA	9.49	52.2	31.1	200.8	NA	100	13.4	NA	15 ng/kg	NA
Surface	1-Methylnaphthalene	5	60	20	20	15	22.0	25.0	26	NA	No screening level	No screening level	No screening level	No screening level	No screening level
Surface	Total cPAH TEQ (ND=0.5RL)	36	100	NA	NA	8.28	386.5	173.0	3494	NA	83.3	166	NA	21 µg/kg	NA
Surface	1,2,4-Trichlorobenzene	28	0	2	88	NA	NA	28.8	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Surface	1,3-Dichlorobenzene (m-Dichlorobenzene)	28	0	2	88	NA	NA	29.8	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Surface	Hexachloroethane	10	0	19	88	NA	NA	38.8	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Surface	Hexachlorobutadiene	27	0	3.6	88	NA	NA	26.1	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Surface	N-Nitrosodiphenylamine (as diphenylamine)	28	0	3.6	88	NA	NA	29.1	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Surface	Benzoic Acid	28	14.3	190	1800	110	337.5	370.0	500	NA	0	<1	NA	650 µg/kg	NA
Surface	Benzyl Alcohol	28	10.7	19	130	37	55.0	50.0	78	NA	3.6	1.4	NA	57 µg/kg	NA
Surface	2,4-Dimethylphenol	28	17.9	4.2	440	19	41.8	42.0	82	NA	10.7	2.8	NA	29 µg/kg	NA
Surface	2-methylphenol (o-Cresol)	27	14.8	4.2	88	24	35.5	35.5	47	NA	0	<1	NA	63 µg/kg	NA
Surface	4-methylphenol (p-Cresol)	28	35.7	19	88	24	207.1	176.0	450	NA	0	<1	NA	670 µg/kg	NA
Surface	Pentachlorophenol	33	69.7	93	510	12	240.6	180.0	580	NA	42.4	5.8	NA	100 µg/kg	NA
Surface	Phenol	28	32.1	15	270	30	168.0	170.0	410	NA	0	<1	NA	420 µg/kg	NA
Surface	Mercury	14	100	NA	NA	0.05	0.3	0.3	0.45	NA	7.1	1.1	NA	0.41 mg/kg	NA
Sub-surface	Diesel-range hydrocarbons	82	67.1	6.4	37	8.3	1224.4	130.0	37000	NA	Evaluated as part of TPH	Evaluated as part of TPH	NA	Evaluated as part of TPH	NA
Sub-surface	Heavy Oil-Range Hydrocarbons	82	80.5	13	44	22	1199.5	190.0	27000	NA	Evaluated as part of TPH	Evaluated as part of TPH	NA	Evaluated as part of TPH	NA
Sub-surface	Total Petroleum Hydrocarbons	82	84.1	13	44	8.3	2099.3	260.0	50000	NA	42.7	192	NA	260 mg/kg	NA
Sub-surface	Total Dioxin/Furan TEQ (ND=0.5DL) - Human/Mammal	57	100	NA	NA	0.468	130.2	50.1	608	NA	86	40	NA	15 ng/kg	NA
Sub-surface	1-Methylnaphthalene	35	68.6	19	150	9.5	260.3	46.5	4700	NA	No screening level	No screening level	No screening level	No screening level	No screening level
Sub-surface	Total cPAH TEQ (ND=0.5RL)	97	81.4	1.058	1613	4.45	680.9	290.0	12080	NA	74.2	575	NA	21 µg/kg	NA
Sub-surface	1,2,4-Trichlorobenzene	75	0	0.93	490	NA	NA	27.1	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Sub-surface	1,2-Dichlorobenzene (o-Dichlorobenzene)	75	0	0.93	490	NA	NA	26.8	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Sub-surface	1,3-Dichlorobenzene (m-Dichlorobenzene)	75	0	0.93	490	NA	NA	26.8	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Sub-surface	Hexachlorobenzene	81	0	1.5	490	NA	NA	25.5	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Sub-surface	Hexachloroethane	38	0	7.6	490	NA	NA	50.4	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Sub-surface	Hexachlorobutadiene	73	0	1.5	490	NA	NA	27.4	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Sub-surface	Benzoic Acid	74	2.7	31	9700	82	166.0	166.0	250	NA	0	<1	NA	650 µg/kg	NA
Sub-surface	Benzyl Alcohol	74	2.7	1.5	490	6.9	12.4	12.5	18	NA	0	<1	NA	57 µg/kg	NA
Sub-surface	2,4,5-Trichlorophenol	5	0	330	1390	NA	NA	703.8	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Sub-surface	2,4,6-Trichlorophenol	5	0	330	1390	NA	NA	703.8	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
Sub-surface	2,4-Dimethylphenol	75	24	1.5	2500	4.1	22.9	16.0	110	NA	5.3	3.8	NA	29 µg/kg	NA
Sub-surface	2-methylphenol (o-Cresol)	75	21.3	1.5	2500	4.6	18.2	8.8	59	NA	0	<1	NA	63 µg/kg	NA
Sub-surface	4-methylphenol (p-Cresol)	75	53.3	1.9	490	1.9	101.0	66.0	440	NA	0	<1	NA	670 µg/kg	NA
Sub-surface	Pentachlorophenol	95	63.2	1.5	1160	5.6	600.5	240.0	4700	NA	45.3	47	NA	100 µg/kg	NA
Sub-surface	Phenol	75	41.3	2.1	490	3.1	80.9	22.0	470	NA	2.7	1.1	NA	420 µg/kg	NA
Sub-surface	Mercury	39	94.9	0.09	0.2	0.05	0.9	0.4	11.3	NA	46.2	28	NA	0.41 mg/kg	NA
All Depth Intervals, Combined	Diesel-range hydrocarbons	95	64.2	6.1	37	8.3	1109.6	110.0	37000	NA	Evaluated as part of TPH	Evaluated as part of TPH	NA	Evaluated as part of TPH	NA
All Depth Intervals, Combined	Heavy Oil-Range Hydrocarbons	95	82.1	12	44	22	1035.3	160.0	27000	NA	Evaluated as part of TPH	Evaluated as part of TPH	NA	Evaluated as part of TPH	NA
All Depth Intervals, Combined	Total Petroleum Hydrocarbons	95	85.3	12	44	8.3	1812.1	220.0	50000	NA	38.9	192	NA	260 mg/kg	NA
All Depth Intervals, Combined	Total Dioxin/Furan TEQ (ND=0.5DL) - Human/Mammal	89	100	NA	NA	0.468	102.2	44.2	608	NA	91	40	NA	15 ng/kg	NA
All Depth Intervals, Combined	1-Methylnaphthalene	40	67.5	19	150	9.5	233.8	34.0	4700	NA	No screening level	No screening level	No screening level	No screening level	No screening level
All Depth Intervals, Combined	Total cPAH TEQ (ND=0.5RL)	133	86.5	1.058	1613	4.45	588.7	226.5	12080	NA	76.7	575	NA	21 µg/kg	NA
All Depth Intervals, Combined	1,2,4-Trichlorobenzene	103	0	0.93	490	NA	NA	27.6	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
All Depth Intervals, Combined	1,3-Dichlorobenzene (m-Dichlorobenzene)	103	0	0.93	490	NA	NA	27.6	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
All Depth Intervals, Combined	Hexachloroethane	48	0	7.6	490	NA	NA	47.9	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
All Depth Intervals, Combined	Hexachlorobutadiene	100	0	1.5	490	NA	NA	27.0	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
All Depth Intervals, Combined	Benzoic Acid	102	5.9	31	9700	82	280.3	300.0	500	NA	0	<1	NA	650 µg/kg	NA
All Depth Intervals, Combined	Benzyl Alcohol	102	4.9	1.5	490	6.9	38.0	37.0	78	NA	1	1.4	NA	57 µg/kg	NA
All Depth Intervals, Combined	2,4,5-Trichlorophenol	5	0	330	1390	NA	NA	703.8	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC

Sediment Depth Zone	Analyte	Total Samples per Depth Zone	Frequency of Detection (%)	Minimum Detection Limit	Maximum Detection Limit	Minimum Dectected Concentration	Mean Dectected Concentration	Median Detected Concentration	Maximum Detected Concentration	Maximum Concentration - TOC-Normalized	Frequency of Exceedance - Detects Only (%)	Magnitude of Exceedance of Dry-weight Screening Levels	Magnitude of Exceedance of TOC-normalized Screening Levels	Dry-weight Sediment Screening Level	TOC-Normalized Screening Level
All Depth Intervals, Combined	2,4,6-Trichlorophenol	5	0	330	1390	NA	NA	703.8	Not detected	Not detected	Not detected	Not detected	Not detected	Not a COC	Not a COC
All Depth Intervals, Combined	2,4-Dimethylphenol	103	22.3	1.5	2500	4.1	27.0	19.0	110	NA	6.8	3.8	NA	29 µg/kg	NA
All Depth Intervals, Combined	2-methylphenol (o-Cresol)	102	19.6	1.5	2500	4.6	21.7	18.5	59	NA	0	<1	NA	63 µg/kg	NA
All Depth Intervals, Combined	4-methylphenol (p-Cresol)	103	48.5	1.9	490	1.9	122.2	73.5	450	NA	0	<1	NA	670 µg/kg	NA
All Depth Intervals, Combined	Pentachlorophenol	128	64.8	1.5	1160	5.6	500.8	230.0	4700	NA	44.5	47	NA	100 µg/kg	NA
All Depth Intervals, Combined	Phenol	103	38.8	2.1	490	3.1	100.5	31.5	470	NA	1.9	1.1	NA	420 µg/kg	NA
All Depth Intervals, Combined	Mercury	53	96.2	0.09	0.2	0.05	0.7	0.3	11.3	NA	35.8	28	NA	0.41 mg/kg	NA

Notes:

COC = contaminant of concern
cPAH = carcinogenic polycyclic aromatic hydrocarbons
DL = detection limit
HPAH = high molecular weight polycyclic aromatic hydrocarbons
LPAH = low molecular weight polycyclic aromatic hydrocarbons
mg/kg = milligrams per kilogram
NA = not applicable
ND = not detected
ng/kg = nanograms per kilogram
OC = organic carbon
RL = reporting limit
TEQ = toxicity equivalent
TOC = total organic carbon
TPH - total petroleum hydrocarbons
µg/kg = micrograms per kilogram

APPENDIX E
Toxicity Testing Report

RAMBOLL ENVIRON

ENVIRONMENT
& HEALTH

BIOLOGICAL TESTING RESULTS

R. G. HALEY SEDIMENT CHARACTERIZATION

BELLINGHAM, WA

Prepared for:
GeoEngineers, Inc
Redmond, WA

On behalf of:
City of Bellingham
Bellingham, WA

Prepared by:
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Ramboll Environ Report ID: 122315.01

Submittal Date: February 3, 2015

CONTENTS

TABLES

ACRONYMS AND ABBREVIATIONS

AFDW:	Ash-free dry weight
ARI:	Analytical Resources, Inc., Tukwila, WA
cm:	Centimeter
CSL:	Cleanup Screening Level
°C:	Degrees Celsius
EC_{50}:	Effective Concentration that results in a 50% reduction in a sub-lethal endpoint
g:	Grams
LC_{50}:	Lethal Concentration that results in a 50% reduction in survival
L:	Liter
µm:	Micrometer
mg:	Milligram
mg/L:	Milligrams per liter
mL:	Milliliter
mm:	Millimeter
NELAP:	National Environmental Laboratory Accreditation Program
NOEC:	No Observed Effect Concentration
ppt:	parts per thousand
PSEP:	Puget Sound Estuary Protocols (PSEP 1995)
SCO:	Sediment Cleanup Objective
SMS:	Sediment Management Standards
SOP:	Standard operation procedure
SSAPA:	Sediment Sampling and Analysis Plan Appendix (SSAPA; WDOE 2008)
SMARM:	Sediment Management Annual Review Meeting
UIA:	Un-ionized ammonia
USACE:	United States Army Corps of Engineers
USEPA:	United States Environmental Protection Agency
WA:	Washington State
WAC:	Washington Administrative Code
WDOE:	Washington (State) Department of Ecology

All testing reported herein was performed consistent with our laboratory's quality assurance program. All results are intended to be considered in their entirety, and Ramboll Environ is not responsible for use of less than the complete report. The test results summarized in this report apply only to the sample(s) evaluated.

Brian Hester

Brian Hester

Laboratory Director

Authors: Jay Word – Program Coordinator
Bridget Gregg – Quality Assurance
Brian Hester - Laboratory Director

1 INTRODUCTION

Ramboll Environ conducted biological toxicity testing with sediment samples collected by GeoEngineers, Inc. as part of a pre-design investigation being performed at the R. G. Haley Site in Bellingham, Washington. Sediments were evaluated for biological effects following guidance provided by the Washington State Department of Ecology (WDOE) Sediment Management Standards (SMS) under the Washington Administrative Code (WAC) 173-204-315. This report presents the results of the toxicity testing portion of the R. G. Haley sediment investigation.

2 METHODS

This section summarizes the test methods followed for this biological characterization. Test methods followed guidance provided by the Puget Sound Estuary Program (PSEP 1995), the Sediment Cleanup User's Manual II (SCUM II; WDOE 2015), and the various updates presented during the Sediment Management Annual Review Meeting (SMARM). Sediment toxicity was evaluated using three standard PSEP bioassays; the 10-day amphipod test, the 20-day juvenile polychaete survival and growth test, and the 48-hour benthic larval development test.

2.1 Sample Collection Sample and Animal Receipt

Test sediments were collected on October 12, 2015 and three were received at Ramboll Environ on November 30 and December 4, 2015. Reference sediment from Carr Inlet, WA was collected by Ramboll Environ on December 4, 2015 and received on the same day. Sediment samples were stored in a walk-in cold room at 4 ± 2ºC in the dark. The test sediment was not sieved prior to testing. All tests were conducted within the eight week holding time.

Amphipods (*Eohaustorius estuarius*) were supplied by Northwestern Aquatic Sciences in Newport, Oregon. Animals were held in native sediment at 15°C prior to test initiation. Juvenile polychaete worms (*Neanthes arenaceodentata*) were obtained from Aquatic Toxicology Support in Bremerton, Washington. Juvenile polychaetes were held in seawater at 20°C (Neanthes were cultured in water-only and were not held in sediment prior to testing). *Mytilus galloprovincialis* (mussel) broodstock were provided by Taylor Shellfish in Shelton, WA. Broodstock were held in unfiltered seawater at 16°C prior to spawning.

Native *Eohaustorius* sediment from Yaquina Bay, Oregon was also provided by Northwest Aquatic Sciences for use as control sediment treatments for the amphipod and juvenile polychaete tests.

2.2 Sample Grain Size and Reference Comparison

Sediment grain size is one of the characteristics used in selecting the appropriate reference sediment(s) to compare the chemical and biological responses of project sediments. The percent fines value is defined as the amount of sediment that passes through a 62.5-µm sieve, expressed as a percentage of the total sample analyzed. This is also the sum of the silt and clay fraction of sediment. Wet-sieve grain size results for the reference sample was conducted in the field (at the time of collection) by Ramboll Environ. The percent-fines determination of the project sediments are summarized in Table 2-1.

Table 2-1. Sample and Reference Grain Size Comparison.

Treatment	Percent Fines[1]	Treatment Compared To:
CR22 (Reference)	24%	
SS1-SS-03_0-12	26%	CR22
SS1-SS-05_0-12	19%	CR22
SS1-SS-06_0-12	28%	CR22

[1] Wet sieve results

All project samples were compared to the reference CR22.

2.3 Ultra-Violet Light Exposure

Test sediment samples were exposed to ultra-violet (UV) light during the entire test exposure. The UV light regime followed guidance provided by Appendix C of SCUM II (WDOE 2015). UV light was provided by fluorescent light ballast containing one Duro-Test Vita-Lite® (40W, 5500°K, 91 CRI) fluorescent bulb and one standard fluorescent bulb (Phillips F40CW). The UV bulbs were placed within 12" above the sediment surface. All test chambers in the UV exposures were left uncovered to prevent any UV loss. Tests were conducted on water-tables to ensure that the additional lighting did not alter water temperatures in the test chambers. In all other respects, the methods followed the standard testing protocols are summarized below.

2.4 10-day Amphipod Bioassay

The 10-day acute toxicity test with *E. estuarius* was initiated on December 7, 2015. To prepare the test exposures, approximately 175 mL of sediment was placed in clean, acid and solvent-rinsed 1-L glass jars, which were then filled with 775 mL of 0.45-µm filtered seawater at 28 ppt. The control and reference sediment were tested concurrently with the test treatment. Five replicates were used to evaluate sediment toxicity while the remaining two replicates were designated as sacrificial surrogate chambers. One surrogate chamber was sacrificed at test initiation to measure porewater and overlying ammonia and sulfides. The remaining surrogate chamber was used for measuring daily water quality throughout the test, as well as porewater and overlying ammonia and sulfides at test termination. Total ammonia as nitrogen was monitored using an Orion meter fitted with an ammonia ion-specific probe. Total sulfides as S^{2-} were monitored using a HACH DR/2800 Spectrophotometer.

Test chambers were placed in randomly assigned positions in a 15°C water bath and allowed to equilibrate overnight. Trickle-flow aeration was provided to prevent dissolved oxygen concentrations from dropping below acceptable levels.

Immediately prior to test initiation, water quality parameters were measured in the surrogate chamber for each treatment. Dissolved oxygen (DO), temperature, pH, and salinity were then monitored in the surrogate chambers daily until test termination. Target test parameters were:

Dissolved Oxygen:	≥5.1 mg/L
pH:	7 - 9 units
Temperature:	15 ± 1°C
Salinity:	28 ± 1ppt

The tests were initiated by randomly allocating 20 *E. estuarius* into each test chamber, ensuring that each of the amphipods successfully buried into the sediment. Amphipods that did not bury within approximately one hour were replaced with healthy amphipods. The 10-day amphipod bioassay was conducted as a static test with no feeding during the exposure period. At test termination, sediment from each test chamber was sieved through a 0.5-mm screen and all recovered amphipods transferred into a Petri dish. The number of surviving and dead amphipods was then determined under a dissecting microscope.

A water-only, 4-day reference-toxicant test was conducted concurrently with the sediment tests using ammonium chloride. The ammonium chloride reference-toxicant test was used to ensure animals used in the test were healthy and of similar sensitivity to prior tests. This test also provided information on the sensitivity to any ammonia concentrations that might be present in the sediments.

2.5 20-day Juvenile Polychaete Bioassay

The 20-day chronic toxicity test with *N. arenaceodentata* was initiated on December 4, 2015. Test exposures were prepared with approximately 175 mL of sediment placed in clean, acid and solvent-rinsed 1-L glass jars, which were then filled with 775 mL of 0.45-µm filtered seawater at 28 ppt. The control and reference sediment were tested concurrently with the test treatment. Five replicates were used to evaluate sediment toxicity while the remaining two replicates were designated as sacrificial surrogate chambers. One surrogate chamber was sacrificed at test initiation to measure overlying and interstitial ammonia and sulfides. The remaining surrogate chamber was used for measuring daily water quality throughout the test, as well as overlying and interstitial ammonia and sulfides at test termination. Total ammonia as nitrogen was monitored using an Orion meter fitted with an ammonia ion-specific probe. Total sulfides as S^{2-} were monitored using a HACH DR/2800 Spectrophotometer.

Test chambers were placed in randomly assigned positions in a water bath at 20°C and allowed to equilibrate overnight. Trickle-flow aeration was provided to prevent dissolved oxygen concentrations from dropping below acceptable levels.

Immediately prior to test initiation, water quality parameters were measured. Dissolved oxygen, temperature, pH, and salinity were then monitored in the surrogates daily until test termination. Target test parameters were:

Dissolved Oxygen:	≥4.6 mg/L
pH:	7 - 9 units
Temperature:	20 ± 1°C
Salinity:	28 ± 2 ppt

The juvenile polychaete test was initiated by randomly allocating five *N. arenaceodentata* into each test chamber, and observing whether each of the worms successfully buried into the sediment. Worms that did not bury within approximately one hour were replaced with healthy worms. The 20-day test was conducted as a static-renewal test, with exchanges of 300 mL of water occurring every third day. *N. arenaceodentata* were fed every other day with 40 mg of TetraMarin® (approximately 8 mg dry weight per worm). At test termination, sediment from each test chamber was sieved through a 0.5-mm screen and all recovered worms transferred into a Petri dish. The number of surviving and dead worms was determined. All surviving worms were then transferred to pre-weighed, aluminum foil weigh-boats, and dried in a drying oven at 60°C for approximately 24 hours. Each weigh-boat was removed, cooled in a dessicator, and then weighed on a microbalance to 0.01 mg. Each of the weigh boats was then heated to 550°C for 2 hours in order to determine the ashed weight. Ash-free dry weights (AFDW) were calculated to correct for the influence of sediment grain size differences between treatments. The ashed boats were weighed to 0.01 mg and the ashed weight was subtracted from the dry weight to calculate the AFDW. Both dry weight and AFDW were used to determine individual worm weight and growth rates.

A water-only, 4-day reference-toxicant test was conducted concurrently with the sediment tests using ammonium chloride. The ammonium chloride reference-toxicant test was used to ensure animals used in the test were healthy and of similar sensitivity to prior tests. This test also provided information on the sensitivity to any ammonia concentrations that might be present in the sediments.

2.6 Larval Developmental Bioassay

Test sediment was evaluated using the larval benthic toxicity test with the mussel, *M. galloprovincialis*. The mussel larval test was initiated on December 7, 2015. The control and reference sediment were tested with the test treatments. To prepare the test exposures, 18 g (±1 g) of test sediment was placed in clean, acid and solvent-rinsed 1-L glass jars, which were then filled to 900 mL with 0.45-µm filtered seawater. Six replicate chambers were prepared for the test treatment, reference sediment, and the native sediment control treatment. Five of the replicates were used to evaluate the test; the sixth replicate was used as a water quality surrogate. Each chamber was shaken for 10 seconds and then placed in predetermined randomly-assigned positions in a water bath at 16°C.

To collect gametes for each test, mussels were placed in clean seawater and acclimated at 16°C for approximately 20 minutes. The water bath temperature was then increased over a period of 15 minutes to 20°C. Mussels were held at 20°C and monitored for spawning individuals. Spawning females and males were removed from the water bath and placed in individual containers with seawater. These individuals were allowed to spawn until sufficient gametes were available to initiate the test. After the spawning period, eggs are transferred to fresh seawater and filtered through a 0.5 mm Nitex® mesh screen to remove large debris, feces, and excess gonadal matter. A composite was made of the sperm and diluted with fresh seawater. The fertilization process was initiated by adding sperm to the isolated egg containers. Egg-sperm solutions were periodically homogenized with a perforated plunger during the fertilization process and sub-samples observed under the microscope for egg and sperm viability. Approximately one to one and a half hours after fertilization, embryo solutions were checked for fertilization rate. Only those embryo stocks with >90% fertilization were used to initiate the tests. Embryo solutions were rinsed free of excess sperm and then combined to create one embryo stock solution. Density of the embryo stock solution was determined by counting the number of embryos in a subsample of homogenized stock solution. This was used to determine the volume of embryo stock solution to deliver approximately 20,000 to 40,000 embryos to each test chamber.

Dissolved oxygen, temperature, pH, and salinity were monitored in water quality surrogates to prevent loss or transfer of larvae by adhesion to water-quality probes. Ammonia and sulfides in the overlying water were measured on Day 0 and Day 2 (test termination). Total ammonia as nitrogen was monitored using an Orion meter fitted with an ammonia ion-specific probe. Total sulfides as S^{-2} were monitored using a HACH DR/2800V Spectrophotometer. Target test parameters were as follows:

Dissolved Oxygen:	≥4.8 mg/L
pH:	7 - 9 units
Temperature:	16 ± 1°C
Salinity:	28 ± 1ppt

The development test was conducted as a static test without aeration. The protocol calls for test termination when 95% of the embryos in the control have reached the prodissoconch I stage (approximately 48-60 hours). At termination, the overlying seawater was decanted into a clean 1-L jar and mixed with a perforated plunger. From this container, a 10 mL subsample was transferred to a scintillation vial and preserved in 5% buffered formalin. Larvae were subsequently stained with a dilute solution of Rose Bengal in 70% alcohol to help visualization of larvae. The number of normal and abnormal larvae was enumerated on an inverted microscope. Normal larvae included all D-shaped prodissoconch I stage larvae. Abnormal larvae included abnormally shaped prodissoconch I larvae and all early stage larvae.

A water-only reference-toxicant test was conducted concurrently with the sediment tests using ammonium chloride. The ammonium chloride reference-toxicant test was used to ensure animals used in the test were healthy and of similar sensitivity to prior tests. This test also provided information on the sensitivity to ammonia concentrations that would possibly be present in the sediments.

2.7 Data Analysis and QA/QC

All water quality and endpoint data were entered into Excel spreadsheets. Water quality parameters were summarized by calculating the mean, minimum, and maximum values for each test treatment. Endpoint data were calculated for each replicate and the mean values and standard deviations were determined for each test treatment.

All hand-entered data was reviewed for data entry errors, which were corrected prior to summary calculations. A minimum of 10% of all calculations and data sorting were reviewed for errors. Review counts were conducted on any apparent outliers.

For the larval test, the percent of normal larvae when compared to the reference was the endpoint used to evaluate the test sediment. This was based on the number of normal larvae in each treatment divided by the number normal in the reference sample, as defined in the SCUM II guidance document (WDOE 2015).

For SMS suitability determinations, comparisons were made according SCUM II (WDOE 2015) and Fox et al. (1998). Data reported as percent mortality or survival were transformed using an arcsine square root transformation prior to statistical analysis. All data were tested for normality using the Wilk-Shapiro test and equality of variance using Levene's test. Determinations of statistical significance were based on one-tailed Student's t-tests with an alpha of 0.05. A comparison of the larval endpoint relative to the reference was made using an alpha level of 0.10. For samples failing to meet assumptions of normality, a Mann-Whitney test was conducted to determine significance. For those samples failing to meet the assumptions of normality and equality of variance, a t-test on rankits was used.

3 RESULTS

The results of the sediment testing, including a summary of test results and water quality observations are presented in this section. Data for each of the replicates, as well as laboratory bench sheets are provided Appendix A and statistical analyses are provided in Appendix B.

3.1 10-day Amphipod Bioassay

The bioassay test with *E. estuarius* was validated with 0% mortality in the native sediment control, which met the performance criterion of ≤10% mortality for SMS evaluations. This result indicates that the test conditions were suitable for adequate amphipod survival. Mean mortality in the reference treatment CR22 was 5% which met the performance criteria (≤25% mortality) and indicated that the reference sediment was acceptable for suitability determination. Mean mortality in the three project samples was 1%. All endpoint results are summarized in Table 3-1.

Summaries of water quality measurements, ammonia and sulfide concentrations, and test conditions are presented in Table 3-2, Table 3-3, Table 3-4, and Table 3-5.

All water quality parameters were within the acceptable limits throughout the duration of the test, with the exception of minor deviations in temperature and salinity. Temperature was recorded slightly above the targeted range of 15±1°C (Max value 16.5°C). The temperature control system was adjusted upon discovery and temperatures returned to the targeted range for the duration of the test. These deviations would not be expected to affect the significance of the test results.

A reference-toxicant test (positive control) was performed on the batch of test organisms utilized for this study. The LC_{50} value was well within control chart limits (±2 standard deviations from the laboratory historical mean). This result indicates that the test organisms used in this study were of similar sensitivity to those previously tested at Ramboll Environ.

Ammonia concentrations observed in the *E. estuarius* test were below the No Observed Effect Concentration (NOEC) value derived from the concurrent ammonia reference-toxicant test (Table 3-3; compare to NOEC of 138 mg/L). Values were also below the published threshold concentration of 15 mg/L total ammonia (Barton 2002). Therefore ammonia concentrations within the sediment samples should not have been a contributor to any adverse biological effects observed in the test treatments. Initial sulfide concentrations in interstitial water were below 0.3 mg/L in all samples except for the reference. Due to the high survival observed in the reference treatment this value was not be expected affect the outcome of the testing.

Table 3-1. Test Results for *Eohaustorius estuarius*.

Treatment	Replicate	Number Initiated	Number Surviving	Percentage Survival	Mean Percentage		Standard Deviation
					Survival	Mortality	
Control	1	20	20	100	100	0	0.0
	2	20	20	100			
	3	20	20	100			
	4	20	20	100			
	5	20	20	100			
CR22 (Reference)	1	20	19	95	95	5	3.5
	2	20	19	95			
	3	20	18	90			
	4	20	20	100			
	5	20	19	95			
SS1-SS-03_0-12	1	20	20	100	99	1	2.2
	2	20	20	100			
	3	20	20	100			
	4	20	19	95			
	5	20	20	100			
SS1-SS-05_0-12	1	20	20	100	99	1	2.2
	2	20	19	95			
	3	20	20	100			
	4	20	20	100			
	5	20	20	100			
SS1-SS-06_0-12	1	20	19	95	99	1	2.2
	2	20	20	100			
	3	20	20	100			
	4	20	20	100			
	5	20	20	100			

Table 3-2. Water Quality Summary for *Eohaustorius estuarius*.

Treatment	Dissolved Oxygen (mg/L)			Temperature (°C)			Salinity (ppt)			pH (units)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Control	8.2	7.7	8.5	15.8	15.6	16.5	28	28	29	8.1	8.0	8.2
CR22 (Reference)	8.2	7.8	8.7	16.0	15.7	16.3	28	28	29	8.1	8.0	8.3
SS1-SS-03_0-12	8.1	7.6	8.5	15.8	15.5	16.2	29	28	30	8.3	8.1	8.5
SS1-SS-05_0-12	8.1	7.5	8.6	15.9	15.7	16.2	28	28	29	8.2	8.0	8.5
SS1-SS-06_0-12	8.1	7.5	8.6	15.8	15.6	16.4	29	28	29	8.3	8.1	8.6

Table 3-3. Ammonia Summary for *Eohaustorius estuarius*.

Treatment	Overlying Ammonia (mg/L Total)		Interstitial Ammonia (mg/L Total)	
	Day 0	Day 10	Day 0	Day 10
Control	0.00	0.00	0.00	0.00
CR22 (Reference)	0.00	0.00	1.83	1.43
SS1-SS-03_0-12	0.342	0.00	5.39	1.73
SS1-SS-05_0-12	0.872	0.00	8.79	4.35
SS1-SS-06_0-12	1.53	0.00	12.3	4.78

NOEC (concurrent reference-toxicant test derived) = 138 mg/L

Table 3-4. Sulfide Summary for *Eohaustorius estuarius*.

Treatment	Overlying Sulfides (mg/L)		Interstitial Sulfides (mg/L)	
	Day 0	Day 10	Day 0	Day 10
Control	0.000	0.000	ND	0.270
CR22 (Reference)	0.024	0.005	1.16	0.310
SS1-SS-03_0-12	0.041	0.000	0.119	0.168
SS1-SS-05_0-12	0.027	0.005	0.142	0.148
SS1-SS-06_0-12	0.002	0.007	0.126	0.154

ND – no data; insufficient volume for analysis.

Table 3-5.Test Condition Summary for *Eohaustorius estuarius*.

Test Conditions: PSEP *E. estuarius*		
Sample Identification	Control, CR22, SS1-SS-03_0-12, SS1-SS-05_0-12, SS1-SS-06_0-12	
Date sampled	October 12, 2015	
Date received	November 30 and December 4, 2015	
Test dates	December 7 – December 17, 2015	
Sample storage conditions	4°C, dark	
Days of holding Recommended: ≤8 weeks (56 days)	56 Days	
Source of control sediment	Yaquina Bay, OR	
Test Species	*E. estuarius*	
Supplier	Northwestern Aquatic Sciences, Newport, OR	
Date acquired	December 4, 2015	
Age class	Mature adult, 3-5 mm	
Test Procedures	PSEP 1995 with SMARM revisions	
Test location	Ramboll Environ Port Gamble Laboratory	
Test type/duration	10-Day static	
Control water	North Hood Canal seawater, 0.45µm filtered	
Test dissolved oxygen	Recommended: > 5.1 mg/L	Observed: 7.5 – 8.7 mg/L
Test temperature	Recommended: 15 ± 1 °C	Observed: 15.5 – 16.5°C
Test Salinity	Recommended: 28 ± 1 ppt	Observed: 28 - 30 ppt
Test pH	Recommended: 7 - 9	Observed: 8.0 – 8.6
Control Performance Standard SMS	Recommended: Control ≤ 10% mortality	Observed: 0% mortality; Pass
Reference Performance Standard SMS	Recommended: Reference ≤ 25% mortality	Observed mortality: 5%; Pass
Reference Toxicant LC_{50} (total ammonia)	LC_{50} = 180.1 mg/L	
Mean; Acceptable Range (total ammonia)	142.1; 35.3 – 248.8 mg/L	
NOEC (total ammonia)	138 mg/L	
NOEC (unionized ammonia)	1.73 mg /L	
Test Lighting	16L:8D with full spectrum lighting per SCUM II Appendix C	
Test chamber	1-Liter Glass Chamber	
Replicates/treatment	5 + 2 surrogates (one used for WQ measurements throughout the test)	
Organisms/replicate	20	
Exposure volume	175 mL sediment/ 775 mL water	
Feeding	None	
Water renewal	None	
Deviations from Test Protocol	Temperature and Salinity	

3.2 20-day Juvenile Polychaete Bioassay

No mortality was observed in the *N. arenaceodentata* control sediment and mean individual growth (MIG) in the control sediment was 0.902 mg/ind/day (dry weight) and 0.577 mg/ind/day (AFDW). These values fall within the test acceptability criteria of <10% mean mortality and ≥0.38 mg/ind/day (WDOE 2015; Kendall 1996) and ≤10% mean mortality and ≥0.38 mg/ind/day mean individual growth (USACE 2015), indicating that the test conditions were suitable for adequate polychaete survival and growth. A summary of the test results for all samples is shown in Table 3-6. Summaries of water quality measurements, ammonia and sulfide concentrations, and test conditions are presented in Table 3-7, Table 3-8, Table 3-9, and Table 3-10.

Mean mortality in the reference treatment CR22 was 0%, meeting the reference performance standard of ≤10% (WDOE 2015; USACE 2015). Mean individual growth for the reference treatment was 0.694 mg/ind/day (dry weight) and 0.527 mg/ind/day (AFDW). When compared to the control, MIG expressed as AFDW was 91%, which met the reference performance standard of ≥80% (WDOE 2015; USACE 2015).

Mortality in all project sediments was 0%. Mean individual growth (as dry weight) in the test treatments ranged from 0.679 to 0.843 mg/ind/day. Mean individual growth in the AFDW assessment, which removes variability caused by gut contents, ranged from 0.567 to 0.687 mg/ind/day as AFDW. The observed mean growth in the project sediments was greater than or similar to the respective endpoints for the reference treatments in all cases.

A reference-toxicant test (positive control) was performed on the batch of test organisms utilized for this study. The LC_{50} value was within control chart limits (±2 standard deviations from the laboratory historical mean). This result indicates that the test organisms used in this study were of similar sensitivity to those previously tested at Ramboll Environ.

All water quality parameters were within the acceptable limits throughout the duration of the test, with the exception of minor deviations in salinity. This deviations would not be expected to affect the significance of the test results.

Ammonia concentrations observed in the *N. arenaceodentata* test were below the No Observed Effect Concentration (NOEC) value derived from the concurrent ammonia reference-toxicant test (Table 3-8; compare to NOEC of 146 mg/L). Initial sulfide concentrations in interstitial water were below the NOEC (3.4 mg/L; Kendall and Barton 2004) for all samples.

Table 3-6. Test Results for *Neanthes arenaceodentata*.

Treatment	Rep	Number Initiated	Survivors	Mean Mortality (%)	Individual Growth (mg/ind/day)					
					Dry Weight	Mean	Std Dev	AFDW	Mean	Std Dev
Control	1	5	5	0	0.785	0.902	0.100	0.485	0.577	0.083
	2	5	5		0.853			0.626		
	3	5	5		0.859			0.489		
	4	5	5		1.002			0.640		
	5	5	5		1.012			0.646		
CR22 (Reference)	1	5	5	0	0.884	0.694	0.108	0.714	0.527	0.110
	2	5	5		0.621			0.496		
	3	5	5		0.670			0.517		
	4	5	5		0.630			0.483		
	5	5	5		0.665			0.427		
SS1-SS-03_0-12	1	5	5	0	0.698	0.843	0.116	0.585	0.687	0.115
	2	5	5		0.909			0.703		
	3	5	5		0.860			0.688		
	4	5	5		0.989			0.870		
	5	5	5		0.761			0.592		
SS1-SS-05_0-12	1	5	5	0	0.751	0.774	0.101	0.653	0.631	0.090
	2	5	5		0.803			0.648		
	3	5	5		0.808			0.662		
	4	5	5		0.890			0.715		
	5	5	5		0.617			0.477		
SS1-SS-06_0-12	1	5	5	0	0.668	0.679	0.064	0.569	0.567	0.044
	2	5	5		0.626			0.537		
	3	5	5		0.738			0.610		
	4	5	5		0.751			0.610		
	5	5	5		0.610			0.511		

Table 3-7. Water Quality Summary for *Neanthes arenaceodentata*.

Treatment	Dissolved Oxygen (mg/L)			Temperature (°C)			Salinity (ppt)			pH (units)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Control	7.2	6.4	7.7	19.9	19.6	20.3	30	28	31	7.9	7.6	8.2
CR22 (Reference)	7.5	6.9	8.1	19.9	19.6	20.2	29	28	31	8.1	7.7	8.6
SS1-SS-03_0-12	7.3	6.8	7.7	19.8	19.5	20.2	30	27	32	8.3	7.9	8.6
SS1-SS-05_0-12	7.4	6.9	8.0	19.9	19.6	20.2	30	28	31	8.4	7.8	8.7
SS1-SS-06_0-12	7.2	6.3	7.8	19.9	19.6	20.2	30	28	31	8.2	7.7	8.6

Table 3-8. Ammonia Summary for *Neanthes arenaceodentata*.

Treatment	Overlying Ammonia (mg/L Total)		Interstitial Ammonia (mg/L Total)	
	Day 0	Day 20	Day 0	Day 20
Control	0.126	3.98	0.638	5.77
CR22 (Reference)	0.000	0.000	1.37	0.760
SS1-SS-03_0-12	0.000	0.000	8.13	0.000
SS1-SS-05_0-12	1.82	0.000	9.64	0.000
SS1-SS-06_0-12	1.84	0.000	12.3	1.11

BOLD= Exceeds NOEC (concurrent reference-toxicant test derived) of 146 mg/L

Table 3-9. Sulfide Summary for *Neanthes arenaceodentata*.

Treatment	Overlying Sulfides (mg/L Total)		Interstitial Sulfides (mg/L Total)	
	Day 0	Day 20	Day 0	Day 20
Control	0.000	0.018	0.200	0.085
CR22 (Reference)	0.006	0.069	0.055	0.305
SS1-SS-03_0-12	0.015	0.020	0.000	0.115
SS1-SS-05_0-12	0.007	0.063	0.170	0.115
SS1-SS-06_0-12	0.002	0.015	0.155	0.225

Table 3-10. Test Condition Summary for *Neanthes arenaceodentata*.

Test Conditions: PSEP *N. arenaceodentata*		
Sample Identification	Control, CR22, SS1-SS-03_0-12, SS1-SS-05_0-12, SS1-SS-06_0-12	
Date sampled	October 12, 2015	
Date received	November 30 and December 4, 2015	
Test dates	December 4 – December 24, 2015	
Sample storage conditions	4°C, dark	
Days of holding Recommended: ≤8 weeks (56 days)	53 Days	
Source of control sediment	Yaquina Bay, OR	
Test Species	*N. arenaceodentata*	
Supplier	Aquatic Toxicology Support	
Date acquired	December 4, 2015	
Age class	Juvenile; 21 – 26 Days post emergence	
Test Procedures	PSEP 1995 with SMARM revisions	
Test location	Ramboll Environ Port Gamble Laboratory	
Test type/duration	20-Day static renewal	
Control water	North Hood Canal seawater, 0.45µm filtered	
Test dissolved oxygen	Recommended: > 4.6 mg/L	Observed: 6.3 – 8.1 mg/L
Test temperature	Recommended: 20 ± 1 °C	Observed: 19.5 – 20.3 °C
Test Salinity	Recommended: 28 ± 2 ppt	Observed: 27 - 32 ppt
Test pH	Recommended: 7 - 9	Observed: 7.6 – 8.7
Initial biomass	Recommended: 0.5 - 1.0 mg Minimum: 0.25 mg	0.331 mg; Acceptable
Control Performance Standard	Recommended: Control ≤ 10% mortality	Observed: 0% Pass
	Recommended: ≥ 0.72 mg/ind/day Minimum: ≥ 0.38 mg/ind/day (as Dry Weight)	Observed: 0.902 mg/ind/day; Pass
Reference performance standard (SMS)	Recommended: Mortality ≤20% $MIG_{Reference}/MIG_{Control}$ (AFDW) ≥ 80%	CR22: 0%; Pass CR22: 91.3%; Pass
Reference Toxicant LC_{50} (total ammonia)	EC_{50} = 169.2 mg/L	
Mean; Acceptable Range (total ammonia)	143.4; 59.8 – 227.1 mg/L	
NOEC (total ammonia)	146 mg/L	
NOEC (unionized ammonia)	1.473 mg /L	
Test Lighting	16L:8D with full spectrum lighting per SCUM II Appendix C	
Test chamber	1-Liter Glass Chamber	
Replicates/treatment	5 + 2 surrogates (one used for WQ measurements throughout the test)	
Organisms/replicate	5	
Exposure volume	175 mL sediment/ 775 mL water	
Feeding	40 mg/jar every other day (8mg/ind every other day)	
Water renewal	Water renewed every third day (1/3 volume of exposure chamber)	
Deviations from Test Protocol	Salinity	

3.3 Larval Development Bioassay

The larval development test with *M. galloprovincialis* was validated by 97.6% normal survivorship, defined as the mean number of normal larvae within the control divided by the stocking density. This value was within both the SMS acceptability criteria of >70%. A summary of the test results for all samples is shown in Table 3-11. Summaries of water quality measurements, ammonia and sulfide concentrations, and test conditions are presented in Table 3-12, Table 3-13, and Table 3-14.

Mean normal survival of the reference sediment CR22 was 87.4%, which met both the SMS reference acceptability criteria of ≥65%. This is defined as the number of normal larvae in the reference sample divided by the number of normal larvae in the control. The test mean chamber stocking density (measured at test initiation) was 28.0 embryos/mL.

A reference-toxicant test (positive control) was performed on the batch of test organisms utilized for this study. The LC_{50} value was within control chart limits (±2 standard deviations from the laboratory historical mean). Therefore the test organisms used in this study were of similar sensitivity to those previously tested at Ramboll Environ.

All water quality parameters were within the acceptable limits throughout the duration of the test.

Ammonia concentrations observed in the *M. galloprovincialis* test were below the No Observed Effect Concentration (NOEC) value derived from the concurrent ammonia reference-toxicant test (Table 3-13; compare to NOEC of 8.03 mg/L). This indicates that ammonia concentrations within the sediment samples should not have been a contributor to any adverse biological effects observed in the test treatments.

Table 3-11. Test Results for *Mytilus galloprovincialis*.

Treatment	Rep	Number Normal	Number Abnormal	Mean # Normal (N)	Std. Dev.	Control Normal Survival N_C / I	Reference Normal Survival Relative to Control N_R / N_C	Performance Standard
Control	1	270	4	273.2	19.2	97.6		>0.70; Meets Criterion
	2	242	6					
	3	291	5					
	4	277	6					
	5	286	8					
CR22 (Reference)	1	206	4	238.8	32.0		87.4	≥0.65; Meets Criterion
	2	256	6					
	3	266	2					
	4	264	5					
	5	202	3					
SS1-SS-03_0-12	1	219	3	229.2	32.8	See Section 4.3 for Larval Test Suitability Determination		
	2	234	5					
	3	183	3					
	4	274	1					
	5	236	2					
SS1-SS-05_0-12	1	226	2	244.6	20.7			
	2	253	3					
	3	233	1					
	4	234	2					
	5	277	2					
SS1-SS-06_0-12	1	246	0	254.0	24.5			
	2	226	2					
	3	288	5					
	4	241	3					
	5	269	1					

I = Mean Initial count (Stocking density); 280.0
N_C = Mean Control Normal
N_R = Mean Reference Normal

Table 3-12. Water Quality Summary for *Mytilus galloprovincialis*.

Treatment	Dissolved Oxygen (mg/L)			Temperature (°C)			Salinity (ppt)			pH (units)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Control	7.6	7.3	7.8	16.5	16.4	16.6	28	28	28	7.8	7.7	8.0
CR22 (Reference)	6.7	6.0	7.4	16.6	16.3	16.8	28	28	28	7.8	7.7	7.9
SS1-SS-03_0-12	6.2	5.6	6.9	16.5	16.3	16.9	28	28	28	7.9	7.8	7.9
SS1-SS-05_0-12	6.5	5.6	7.6	16.7	16.6	16.7	28	28	28	7.9	7.8	8.0
SS1-SS-06_0-12	6.4	5.6	7.5	16.7	16.4	16.9	28	28	28	7.9	7.8	8.0

Table 3-13. Ammonia and Sulfide Summary for *Mytilus galloprovincialis*.

Treatment	Overlying Ammonia (mg/L Total)		Overlying Sulfides (mg/L Total)	
	Day 0	Final (Day 2)	Day 0	Final (Day 2)
Control	0.000	0.000	0.000	0.000
CR22 (Reference)	0.000	0.000	0.134	0.005
SS1-SS-03_0-12	0.000	0.000	0.098	0.000
SS1-SS-05_0-12	0.000	0.139	0.072	0.000
SS1-SS-06_0-12	0.000	0.412	0.050	0.000

NOEC (concurrent reference-toxicant test derived) = 8.03 mg/L

Table 3-14. Test Condition Summary for *Mytilus galloprovincialis*.

Test Conditions: PSEP *M. galloprovincialis*		
Sample Identification	Control, CR22, SS1-SS-03_0-12, SS1-SS-05_0-12, SS1-SS-06_0-12	
Date sampled	October 12, 2015	
Date received	November 30 and December 4, 2015	
Test dates	December 7 – December 9, 2015	
Sample storage conditions	4°C, dark	
Holding time Recommended: < 8 weeks (56 days)	56 Days	
Test Species	*M. galloprovincialis*	
Supplier	Taylor Shellfish, Shelton, Wa	
Date acquired	December 4, 2015	
Age class	<3-h old embryos	
Test Procedures	PSEP 1995 with SMARM revisions	
Test location	Ramboll Environ Port Gamble Laboratory	
Test type/duration	48-60 Hour static test (Actual: 48 hours)	
Control water	North Hood Canal sea water, 0.45µm filtered	
Test dissolved oxygen	Recommended: > 4.8 mg/L	Observed: 5.6 – 7.8 mg/L
Test temperature	Recommended: 16 ± 1 °C	Observed: 16.3 – 16.9 °C
Test Salinity	Recommended: 28 ± 1 ppt	Observed: 28 – 28 ppt
Test pH	Recommended: 7 - 9	Observed: 7.7 – 8.0
Stocking Density	Recommended: 20 – 40 embryos/mL	Observed: 28.0 embryos/mL
Control performance standard (SMS)	Recommended: Control normal survival ≥ 70%	Observed: 97.6%; Pass
Reference performance standard (SMS)	Recommended: Reference normal survival relative to control ≥ 65%	Observed: 87.4%; Pass
Reference Toxicant LC_{50} (total ammonia)	LC_{50} = 10.3 mg/L	
Mean; Acceptable Range (total ammonia)	5.4; 0.22 – 10.5 mg/L	
NOEC Combined proportion normal (total ammonia)	8.03 mg/L	
NOEC Combined proportion normal (unionized ammonia)	0.155 mg /L	
Test Lighting	16L:8D with full spectrum lighting per SCUM II Appendix C	
Test chamber	1-Liter Glass Chamber	
Replicates/treatment	5 + 1 surrogate (used for WQ measurements throughout the test)	
Exposure volume	18 g sediment/ 900 mL water	
Feeding	None	
Water renewal	None	
Deviations from Test Protocol	None	

4 DISCUSSION

Sediments were evaluated based on Sediment Management Standards (SMS) criteria. The biological criteria are based on both statistical significance (a statistical comparison) and the degree of biological response (a numerical comparison). The SMS criteria are derived from the Washington Department of Ecology's Sediment Cleanup User's Manual II (SCUM II; WDOE 2015). Comparisons were made for each treatment against the reference sample. Two numerical comparisons were made under SMS, the Sediment Cleanup Objective (SCO) and the Cleanup Screening Level (CSL).

4.1 Amphipod Test Suitability Determination

Under the SMS program, a treatment will fail SCO if mean mortality in the test sediment is >25% and the difference between mean mortality in the treatment compared to mean mortality in the reference is statistically significant ($p \leq 0.05$). Treatments fail the CSL if mean mortality in the test treatment >30% relative to the reference sediment and the difference is statistically significant.

Project sediments from the R. G. Haley Site do not fail the SCO and CSL criteria for the amphipod test as shown in Table 3-15.

Table 3-15. SMS Comparison for *Eohaustorius estuarius*.

Treatment	Mean Mortality (%)	Compared To:	Statistically Different than Reference? (P=0.05)	Mortality Comparison to Reference M_T-M_R (%)	Fails SCO?[1] > 25 %	Fails CSL?[2] > 30 %
Control	0.0					
CR22	5.0					
SS1-SS-03_0-12	1.0	CR22	No	-4	No	No
SS1-SS-05_0-12	1.0	CR22	No	-4	No	No
SS1-SS-06_0-12	1.0	CR22	No	-4	No	No

[1]SCO: Statistical Significance and MT >25%
[2]CSL: Statistical Significance and MT-MR >30%
M_T = Treatment Mortality
M_R = Reference Mortality

4.2 Juvenile Polychaete Test Suitability Determination

Suitability determinations for the juvenile polychaete test were based on mean individual growth (MIG). A test treatment fails SCO criteria if MIG is statistically lower in the test treatment, relative to the reference, and the ratio of the MIG in the test treatment is <0.70 that of the reference. The treatments will fail CSL criteria if the MIG is significantly lower than the reference treatment and the ratio between the MIG of the treatment and the MIG of the reference is <0.50.

Project sediments from the R. G. Haley Site do not fail the SCO and CSL criteria when evaluated on the dry weight and AFDW basis (Table 3-16).

Table 3-16. SMS Comparison for *Neanthes arenaceodentata*.

Treatment	MIG (mg/ind/day)	Comparison To:	Statistically Less than Reference? (p=0.05)	MIG Relative to Reference MIG_T/MIG_R	Fails SCO?[1] < 0.70	Fails CSL?[2] < 0.50
Dry Weight						
Control	0.902					
CR22	0.694					
SS1-SS-03_0-12	0.843	CR22	No	1.21	No	No
SS1-SS-05_0-12	0.774	CR22	No	1.12	No	No
SS1-SS-06_0-12	0.679	CR22	No	0.98	No	No
Ash-Free Dry Weight						
Control	0.577					
CR22	0.527					
SS1-SS-03_0-12	0.687	CR22	No	1.30	No	No
SS1-SS-05_0-12	0.631	CR22	No	1.20	No	No
SS1-SS-06_0-12	0.567	CR22	No	1.08	No	No

[1]SCO: Statistical Significance and MIG_T/MIG_R <70%

[2]CSL: Statistical Significance and MIG_T/MIG_R <50%

MIG_T = Treatment Mean Individual Growth

MIG_R = Reference Mean Individual Growth

4.3 Larval Test Suitability Determination

Larval test treatments fail SCO criteria if the number of normal larvae in the test treatment is significantly lower than that of the reference and if the ratio between the normal larval development in the test treatment is less than 0.85 of the normal development in the reference. Treatments fail CSL criteria if the number of normal larvae in the test treatment is significantly lower than that of the reference and if the ratio between the normal larval development in the test treatment is less than 0.70 of the normal development in the reference after normalizing to the control.

Project sediments from the R. G. Haley Site do not fail the SCO and CSL criteria for larval development (Table 3-17).

Table 3-17. SMS Comparison for *Mytilus galloprovincialis*.

Treatment	Mean Normal Survival (%)[1]	Mean Number Normal	Compared To:	Statistically Less than Reference? (p=0.10)	Fails SCO?[2] <0.85	Fails CSL?[3] <0.70
Control	96.4	273				
CR22	87.4	239				
SS1-SS-03_0-12	83.8	229	CR22	No	No	No
SS1-SS-05_0-12	89.3	245	CR22	No	No	No
SS1-SS-06_0-12	91.9	254	CR22	No	No	No

[1] Control data is normalized to the stocking density; reference and project treatments are normalized to the control
[2] SCO: Statistical Significance and (N_R-N_T) <0.85
[3] CSL: Statistical Significance and (N_R-N_T) <0.70
N_T =Treatment Mean Number Normal
N_R =Reference Mean Number Normal
N_C =Control Mean Number Normal

5 SUMMARY

A summary of the biological tests conducted on the R. G. Haley Site sediments evaluated under the SMS sediment quality criteria (Table 3-18) are provided below.

All project samples pass the SCO and CSL performance criteria for all tests performed on the R. G. Haley Site sediments.

Table 3-18. Summary of SMS Evaluation.

Treatment	Sediment Cleanup Objectives			Cleanup Screening Levels		
	Amphipod	Polychaete	Larval	Amphipod	Polychaete	Larval
SS1-SS-03_0-12	Pass	Pass	Pass	Pass	Pass	Pass
SS1-SS-05_0-12	Pass	Pass	Pass	Pass	Pass	Pass
SS1-SS-06_0-12	Pass	Pass	Pass	Pass	Pass	Pass

6 REFERENCES

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APPENDICES

A. LABORATORY DOCUMENTS

B. STATISTICAL COMPARISONS

C. CHAIN-OF-CUSTODY FORMS

APPENDIX A

LABORATORY DOCUMENTS

APPENDIX A.1.1

Eohaustorius estuarius

Amphipod Bioassay

Laboratory Data Sheets

ENVIRON

CLIENT	PROJECT	SPECIES	LABORATORY	PROTOCOL
GeoEngineers	RG Haley	*Eohaustorius estuarius*	Port Gamble Bath 7	PSEP 1995
JOB NUMBER	**PROJECT MANAGER**	**TEST START DATE**	**TEST END DATE**	
0	B. Hester	7-Dec-15	17-Dec-15	

N = Normal
#E = Emergence
#M = Mortality or Molts
G = Growth (fungal, bacterial, or algal)
D = No Air Flow (DO?)
F = Floating on Surface
TC = Too Cloudy

			Initial # of Organisms	ENDPOINT DATA AND OBSERVATIONS											
				Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10		
				Date (1) 12/7 12/8	Date (1) 12/8 12/09	Date 12/10	Date 12/11	Date 12/12	Date 12/13	Date 12/14	Date 12/15	Date 12/16	Date 12/17		
Sample ID	**Rep**	**Jar #**	20	Tech.	Tech. JBE JL	Tech.	Tech. JL	Tech. JL	Tech. JL	Tech.	Tech.	Tech.	Tech. MK	**Number Alive**	Number Dead Recovered (if any) / Comments
Control	1			N	N	N	N	N	N	N	N	N	N	20	
	2				N									20	
	3				N									20	
	4				N									20	
	5				N									20	
CR22	1				N		G	G	G	G	G	G	G	19	
	2													19	
	3													18	
	4													20	
	5													19	
SS1-SS-03-0-12	1						N	N					G	20	
	2						L							20	
	3						IF							20	
	4	XF (2)	IF				N							19	
	5		N			IF								20	
SS1-SS-05-0-12	1					N							G	20	
	2													19	
	3													20	
	4													20	
	5													20	

(1) Wrong date ~~JL~~ 12/8 (2) WC. HE 12/08/15.

ENVIRON

CLIENT	PROJECT	SPECIES	LABORATORY	PROTOCOL
GeoEngineers	RG Haley	*Eohaustorius estuarius*	Port Gamble Bath 7	PSEP 1995
JOB NUMBER	**PROJECT MANAGER**	**TEST START DATE**	**TEST END DATE**	
0	B. Hester	7-Dec-15	17-Dec-15	

N = Normal
#E = Emergence
#M = Mortality or Molts
G = Growth
(fungal, bacterial, or algal)
D = No Air Flow (DO?)
F = Floating on Surface
TC = Too Cloudy

Sample ID	Rep	Jar #	Initial # of Organisms	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Number Alive	Number Dead Recovered (if any) / Comments
				ENDPOINT DATA AND OBSERVATIONS											
			20	Date 12/9/15 (1)	Date 12/09	Date 12/10	Date 12/11	Date 12/12	Date 12/13	Date 12/14	Date 12/15	Date 12/16	Date 12/17		
				Tech.	Tech. JL	Tech.	Tech. JL	Tech. JL	Tech. JL	Tech.	Tech.	Tech.	Tech. MK		
SS1-SS-06-0-12	1			N	N	N	N	N	G	G	G	G	G	19	
	2			↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	20	
	3			↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	20	
	4		(2)	IF	↓	↓	↓	↓	↓	↓	↓	↓	↓	20	
	5			IF	IF	↓	↓	IF	↓	↓	↓	↓	↓	20	

(1) WD. HE 12/08/15
(2) WC. HE 12/08/15

ENVIRON

CLIENT	PROJECT
GeoEngineers	RG Haley
JOB NUMBER	PROJECT MANAGER
0	B. Hester

SPECIES		Laboratory / Location	PROTOCOL
Eohaustorius estuarius		Port Gamble / Bath 7	PSEP 1995
TEST START DATE	TIME	TEST END DATE	TIME
7-Dec-15	1520	17-Dec-15	0900

				WATER QUALITY DATA									
				Test Conditions		DO (mg/L) >5.1 mg/L		Temperature (°C) 15±1		Salinity (ppt) 28±1		pH 7 - 9		Tech	Date
Project ID	Day	Rep	Jar#	meter	mg/L	meter	deg C	meter	ppt	meter	unit		
Control	0	WQ	22	8	7.9	8	15.9	8	28	8	8.0	RE	12/7/15
CR22	0	WQ	3		7.9		16.2		28		8.0	RE	12/7/15
SS1-SS-03-0-12	0	WQ	16		8.2		15.8		28		8.1	RE	12/7/15
SS1-SS-05-0-12	0	WQ	1		8.1		15.8		28		8.0	RE	12/7/15
SS1-SS-06-0-12	0	WQ	8		8.1		15.9		28		8.1	RE	12/7/15
Control	1	WQ	22	8	8.0	8	16.5	8	28	8	8.0	BE	12/8/15
CR22	1	WQ	3	8	8.0	8	16.3	8	28	8	8.0	BE	12/8/15
SS1-SS-03-0-12	1	WQ	16	8	①78.1	8	16.2	8	28	8	8.1	BE	12/8/15
SS1-SS-05-0-12	1	WQ	1	8	7.8	8	16.2	8	28	8	8.1	BE	12/8/15
SS1-SS-06-0-12	1	WQ	8	8	7.8	8	16.4	8	28	8	8.1	BE	12/8/15
Control	2	WQ	22	9	8.1	9	15.8	9	28	9	8.1	UL	12/09/15
CR22	2	WQ	3		8.0		15.9		28		8.0		
SS1-SS-03-0-12	2	WQ	16		8.0		15.6		28		8.1		
SS1-SS-05-0-12	2	WQ	1		7.8		15.9		28		8.1		
SS1-SS-06-0-12	2	WQ	8		8.0		15.7		28		8.2		
Control	3	WQ	22	9	②~~7.5~~7.1	9	15.6	9	28	9	②~~8.2~~8.1	AR	12/10/15
CR22	3	WQ	3		7.8		15.8		28		8.0		
SS1-SS-03-0-12	3	WQ	16		7.6		15.7		28		8.1		
SS1-SS-05-0-12	3	WQ	1		7.7		15.7		28		8.1		
SS1-SS-06-0-12	3	WQ	8		7.5		15.6		28		8.1		

① WC AR 12/10/15

② WC AR 12/10/15

ENVIRON

CLIENT	PROJECT
GeoEngineers	RG Haley
JOB NUMBER	PROJECT MANAGER
0	B. Hester

SPECIES		Laboratory / Location	PROTOCOL
Eohaustorius estuarius		Port Gamble / Bath 7	PSEP 1995
TEST START DATE	TIME	TEST END DATE	TIME
7-Dec-15	1520	17-Dec-15	0900

				WATER QUALITY DATA											
				Test Conditions		DO (mg/L) >5.1 mg/L		Temperature (°C) 15±1		Salinity (ppt) 28±1		pH 7 - 9		Tech	Date
Project ID	Day	Rep	Jar#	meter	mg/L	meter	deg C	meter	ppt	meter	unit		
Control	4	WQ	22	9	8.1	9	15.6	9	28	9	8.1	JL	12/11/15
CR22	4	WQ	3		7.9		15.8		28		8.1		
SS1-SS-03-0-12	4	WQ	16		8.0		15.5		29		8.2		
SS1-SS-05-0-12	4	WQ	1		7.5		15.8		28		8.1		
SS1-SS-06-0-12	4	WQ	8		8.0		15.6		28		8.3		
Control	5	WQ	22	9	8.1	9	15.6	9	28	9	8.2	JL	12/12
CR22	5	WQ	3		8.0		15.7		28		8.2		
SS1-SS-03-0-12	5	WQ	16		~~8.5~~ ①		15.7		29		8.3		
SS1-SS-05-0-12	5	WQ	1		8.0		15.7		28		8.2		
SS1-SS-06-0-12	5	WQ	8		7.9		15.7		28		8.3		
Control	6	WQ	22	8	8.3	8	16.0	8	29	8	8.2	JL	12/13
CR22	6	WQ	3		8.3		16.0		28		8.2		
SS1-SS-03-0-12	6	WQ	16		8.2		15.9		29		8.3		
SS1-SS-05-0-12	6	WQ	1		8.2		15.9		28		8.3		
SS1-SS-06-0-12	6	WQ	8		8.2		15.8		29		8.4		
Control	7	WQ	22	8	② ~~8.2~~ 8.4	8	15.8	8	29	8	② ~~8.0~~ 8.1	JL	12/14
CR22	7	WQ	3		8.2		15.8		29		8.0		
SS1-SS-03-0-12	7	WQ	16		8.4		15.7		29		8.3		
SS1-SS-05-0-12	7	WQ	1		8.3		15.9		29		8.2		
SS1-SS-06-0-12	7	WQ	8		8.3		15.8		29		8.4		

① MR. JL 12/12/15.

② WC HL 12/14

ENVIRON

CLIENT	PROJECT
GeoEngineers	RG Haley
JOB NUMBER	PROJECT MANAGER
0	B. Hester

SPECIES		Laboratory / Location	PROTOCOL
Eohaustorius estuarius		Port Gamble / Bath 7	PSEP 1995
TEST START DATE	TIME	TEST END DATE	TIME
7-Dec-15	1520	17-Dec-15	0900

Test Conditions				WATER QUALITY DATA									
				DO (mg/L) >5.1 mg/L		Temperature (°C) 15±1		Salinity (ppt) 28±1		pH 7 - 9		Tech	Date
Project ID	Day	Rep	Jar#	meter	mg/L	meter	deg C	meter	ppt	meter	unit		
Control	8	WQ	22	8	8.5	8	15.9	8	29	8	~~8.2~~ 8.1 ②	HK	12/15
CR22	8	WQ	3		8.7		16.0		29		① ~~8.1~~ 8.2		
SS1-SS-03-0-12	8	WQ	16		8.5		15.9		30		8.4		
SS1-SS-05-0-12	8	WQ	1		8.5		16.0		29		8.3		
SS1-SS-06-0-12	8	WQ	8		8.6		15.9		29		8.5		
Control	9	WQ	22	8	8.4	8	16.0 ③	8	28	8	8.1	HK	12/16
CR22	9	WQ	3		8.7		16.2		28		8.3		
SS1-SS-03-0-12	9	WQ	16		8.4		16.2		29		8.4		
SS1-SS-05-0-12	9	WQ	1		8.5		16.1		28		8.4		
SS1-SS-06-0-12	9	WQ	8		8.6		15.9		29		8.5		
Control	10	WQ	22	8	8.2	8	15.6	8	29	8	8.1	JL	12/17
CR22	10	WQ	3		8.4		15.8		28		8.3		
SS1-SS-03-0-12	10	WQ	16		8.3		15.8		29		8.5		
SS1-SS-05-0-12	10	WQ	1		8.6		16.0		28		8.5		
SS1-SS-06-0-12	10	WQ	8		8.3		15.7		29		8.6		

① Illegible HK 12/15 ② WC HK 12/15 ③ Bath temp ↓ 0.3°C HK 12/16

ENVIRON **Ammonia and Sulfide Analysis Record** Page ____ of ____

Client/Project:	Organism:	Test Duration (days):
Geoengineers RG Italey	Eoh	10

PRETEST / ~~INITIAL~~ → FINAL / OTHER (circle one) DAY of TEST: 0

~~OVERLYING~~ (OV) / ~~POREWATER~~ (PW) (circle one) / Comments: _____

Calibration Standards Temperature		Sample temperature should be within ±1°C of standards temperature at time and date of analysis.
Date:	Temperature:	
~~HE~~ 12/7/15	19.2	

Sample ID or Description	Conc. or Rep	Date of Sampling and Initials	Ammonia Value (mg/L)	Temp °C	Date of Reading and Initials	Sample Preserved (Y/N)	pH	Sal (ppt)	Sample Volume (mL)	Measured Sulf. (mg/L)	Multi-plier	Calc-ulated Sulf. (mg/L)
2 pw	Surf	~~HE~~ 12/7	0.00	~~18.2~~	12/7/15 RE	N	7.5	①20 26.1	③1			
CR-22 pw			1.83	18.7	12/7/15 RE		7.7	28	②10 1	0.116	10	1.16
3 pw			5.39	19.1	12/7/15 RE		7.7	29	② × 10	0.119	②40	
5 pw			8.79	18.9	12/7/15 RE		7.9	29	10	0.142		
6 pw			12.3	19.7	12/7/15 RE		7.9	29		0.126		
0 ov	surf		0.00	19.0	12/7/15 ~~HE~~	N				0.00		
CR-22 ov			0.00							0.024		
3 ov			0.312							0.041		
5 ov			0.872							0.027		
6 ov			1.53							0.002		

① ie RE 12/7/15 ② ~~HE~~ 12/7/15 ③ insufficient pw 12/7/15 ~~HE~~

ENVIRON **Ammonia and Sulfide Analysis Record** Page 1 of 1

Client/Project:	Organism:	Test Duration (days):
GeoEngineers / RG Haley	Eohaustorius estuarius	10

PRETEST / INITIAL / FINAL / OTHER (circle one)

OVERLYING (OV) / POREWATER (PW) (circle one) / Comments: _____

DAY of TEST: 10

Calibration Standards Temperature	
Date: 12/17/15	Temperature: 18.9°C

Sample temperature should be within ±1°C of standards temperature at time and date of analysis.

Sample ID or Description	Conc. or Rep	Date of Sampling and Initials	Ammonia Value (mg/L)	Temp °C	Date of Reading and Initials	Sample Preserved (Y/N)	pH	Sal (ppt)	Sample Volume (mL)	Measured Sulf. (mg/L)	Multi-plier	Calc-ulated Sulf. (mg/L)
OV. Ø	Surv.	12/17/15 JL	0.00	17.9	12/17/15 JL	N			10	0.000	NA	NA
CR 22			0.00							0.005		
3			0.00							0.000		
5			0.00							0.005		
6			0.00							0.007		
PW Ø		12/17/15 JL	0.00	17.9	12/17/15 JL	N	7.6	30	1	0.027	10	0.270
CR 22			1.43				7.7	29	2	0.173	5	0.865 ①
3			1.73				7.7	30	5	0.084	2	0.168
5			4.35				7.9	28	5	0.074	2	0.148
6			9.78				7.8	30	5	0.077	2	0.154

① Re-measured w/ blank, 1mL sample · 0.031 × multiplier (10) = 0.310 JL 12/17/15.

RAMBOLL ENVIRON

ORGANISM RECEIPT LOG

Date:	Time:	Batch No.
12/04/15	1250	NAS 4744

Organism / Project: Eohs / Rb Haley

Source / Supplier: Northwestern Aquatic Sciences

No. Ordered:	No. Received:	Source Batch: Collection date, hatch date, etc.):
850	935	Collected 12/02/15

Condition of Organisms:	Approximate Size or Age: (Days from hatch, life stage, size class, etc.):
Good	3-5 mm
Shipper: Fed Ex	**B of L (Tracking No.)** 8068 0541 4744
Condition of Container:	**Received By:** JL

Container	D.O. (mg/L)	Temp. (°C)	Cond. or Sal. (Include Units)	pH (Units)	# Dead	% Dead*	Tech. (Initials)
1 *	—	7.3	22 ppt	—	—	—	JL

*if >10% contact lab manager

Notes: * Received Dry. Supplier provided Salinity.

Northwestern Aquatic Sciences
3814 Yaquina Bay Rd., P.O. Box 1437, Newport, OR 97365
Tel: 541-265-7225, Fax: 541-265-2799, www.nwaquatic.com

SUBJECT: Animal Collection Data Sheet (shipping)

SOLD TO: Ramboll Environ
Ray
4729 NE View Dr.
P.O. Box 216
Port Gamble WA 98364

FedEx# 5507-1540-6

Brian Hester/Collin
360.297.6044
Mary Bacon
360.297.6058

DATE OF SHIPMENT: 12-3-15

ANIMAL HISTORY

Species	Age/Size	Number Shipped
Eohaustorius estuarius	3-5mm	850 + 10%

WATER QUALITY AT TIME OF SHIPMENT

Temperature (°C): 14.3	pH: 8.0	Salinity (ppt): 22.0	D.O. (mg/L): 8.7
Other:			

PACKAGED BY: K. Nakahara **DATE:** 12-3-15

FIELD COLLECTION/CULTURE NOTES

Collected 12-2-15 from Yaquina Bay, OR.
Interstitial WQ: Temp: 4.0 °C, Salinity 16.0 ppt.; salinity adjusted up ~5 ppt.
Held at 15°C in aerated water.

ADDITIONAL COMMENTS

2-liters of 0.5 mm sieved home sediment included.

PLEASE RETURN ALL SHIPPING MATERIALS thanks gose!

If you have any questions, Please call Gary Buhler or Gerald Irissarri at (541) 265-7225. Thank You.

APPENDIX A.1.2

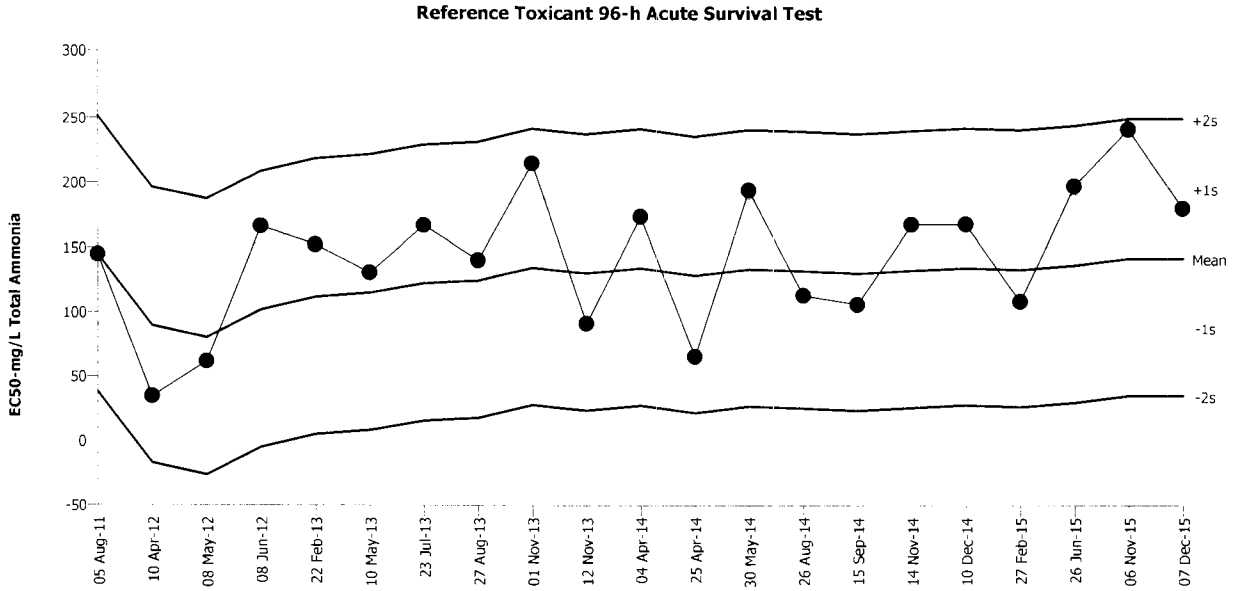
Eohaustorius estuarius

Amphipod Bioassay

Reference Toxicant Test

Reference Toxicant 96-h Acute Survival Test **All Matching Labs**

Test Type: Survival **Organism:** Eohaustorius estuarius (Amphipod) **Material:** Total Ammonia
Protocol: EPA/600/R-94/025 (1994) **Endpoint:** Proportion Survived **Source:** Reference Toxicant-REF



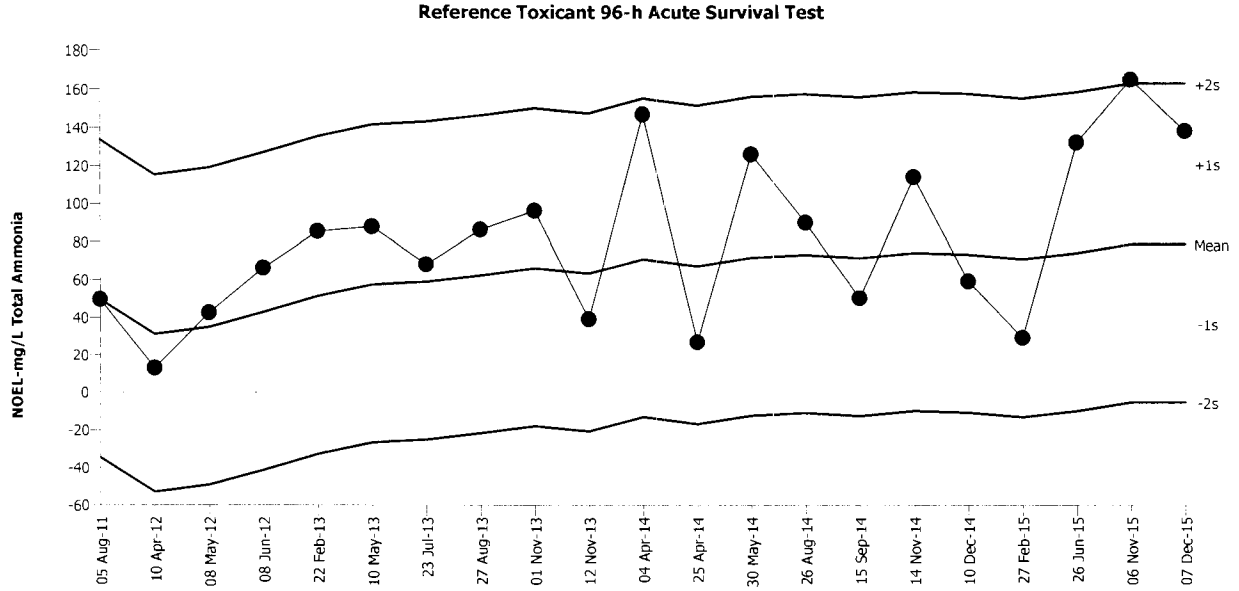
Mean:	142.1	**Count:**	20	**-1s Warning Limit:**	88.67	**-2s Action Limit:**	35.28
Sigma:	53.39	**CV:**	37.60%	**+1s Warning Limit:**	195.4	**+2s Action Limit:**	248.8

Quality Control Data

Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2011	Aug	5	14:35	144.9	2.759	0.05168			05-3970-3796	17-5474-7748	NewFields
2	2012	Apr	10	15:10	34.72	-107.4	-2.011	(-)	(-)	02-5902-8958	20-3951-0452	NewFields
3		May	8	14:30	61.87	-80.23	-1.503	(-)		20-1853-8108	14-9890-9529	NewFields
4		Jun	8	15:30	166.5	24.39	0.4567			03-4756-9479	07-8270-3224	NewFields
5	2013	Feb	22	11:40	152.2	10.12	0.1895			09-9358-3146	14-0757-4516	NewFields
6		May	10	14:20	130.8	-11.34	-0.2125			01-9831-6628	02-4493-3987	NewFields
7		Jul	23	15:10	167.1	25.04	0.469			15-9850-7427	05-2897-2730	NewFields
8		Aug	27	12:10	140.4	-1.707	-0.03197			20-8540-9997	05-1258-2331	NewFields
9		Nov	1	13:30	215	72.91	1.366	(+)		15-9765-5224	08-6656-9431	NewFields
10			12	13:45	91.52	-50.58	-0.9475			12-4327-2465	06-0504-8497	NewFields
11	2014	Apr	4	19:15	173.9	31.75	0.5947			13-5617-0473	14-6315-5154	Port Gamble Environment
12			25	13:00	65.78	-76.32	-1.43	(-)		11-2394-9115	16-6351-0798	Port Gamble Environment
13		May	30	15:30	193.9	51.82	0.9706			11-1744-7543	02-6036-0984	ENVIRON
14		Aug	26	15:45	113.3	-28.78	-0.539			15-5557-5937	00-0529-4993	ENVIRON
15		Sep	15	15:10	106.3	-35.76	-0.6697			07-1282-2061	01-5984-9612	ENVIRON
16		Nov	14	14:25	168	25.9	0.485			09-0717-5355	19-7840-9499	ENVIRON
17		Dec	10	15:50	168.3	26.21	0.4908			19-3485-9112	05-9978-3434	ENVIRON
18	2015	Feb	27	12:35	108.8	-33.3	-0.6237			19-3876-5860	21-0291-4043	ENVIRON
19		Jun	26	13:20	197.1	54.99	1.03	(+)		00-5720-1886	11-7391-9309	ENVIRON
20		Nov	6	15:30	240.8	98.72	1.849	(+)		07-0462-4762	05-5994-4603	ENVIRON
21		Dec	7	15:58	180.1	37.98	0.7114			18-5380-2632	01-5604-1684	ENVIRON

Reference Toxicant 96-h Acute Survival Test **All Matching Labs**

Test Type: Survival **Organism:** Eohaustorius estuarius (Amphipod) **Material:** Total Ammonia
Protocol: EPA/600/R-94/025 (1994) **Endpoint:** Proportion Survived **Source:** Reference Toxicant-REF



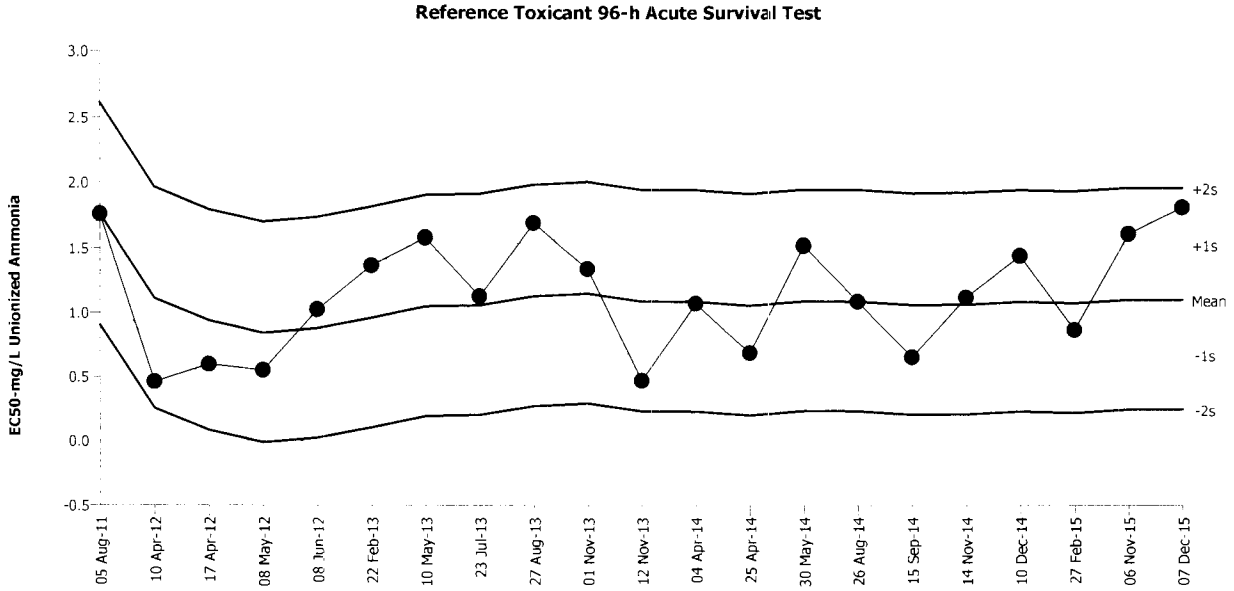
Mean:	78.8	**Count:**	20	**-1s Warning Limit:**	36.72	**-2s Action Limit:**	-5.345
Sigma:	42.07	**CV:**	53.40%	**+1s Warning Limit:**	120.9	**+2s Action Limit:**	162.9

Quality Control Data

Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2011	Aug	5	14:35	49.6	-29.2	-0.6941			05-3970-3796	20-5970-4725	NewFields
2	2012	Apr	10	15:10	13	-65.8	-1.564	(-)		02-5902-8958	03-7154-8292	NewFields
3		May	8	14:30	42.6	-36.2	-0.8605			20-1853-8108	20-5519-2940	NewFields
4		Jun	8	15:30	66.4	-12.4	-0.2947			03-4756-9479	03-6674-9041	NewFields
5	2013	Feb	22	11:40	85.6	6.8	0.1616			09-9358-3146	06-2817-6220	NewFields
6		May	10	14:20	88	9.2	0.2187			01-9831-6628	03-9560-5903	NewFields
7		Jul	23	15:10	68.3	-10.5	-0.2496			15-9850-7427	18-8212-0119	NewFields
8		Aug	27	12:10	86.4	7.6	0.1807			20-8540-9997	03-1133-2124	NewFields
9		Nov	1	13:30	96.4	17.6	0.4184			15-9765-5224	03-3609-7670	NewFields
10			12	13:45	39.3	-39.5	-0.9389			12-4327-2465	09-6874-0351	NewFields
11	2014	Apr	4	19:15	147	68.2	1.621	(+)		13-5617-0473	16-0396-5073	Port Gamble Environment
12			25	13:00	27	-51.8	-1.231	(-)		11-2394-9115	19-2434-9439	Port Gamble Environment
13		May	30	15:30	126	47.2	1.122	(+)		11-1744-7543	06-3985-7474	ENVIRON
14		Aug	26	15:45	90.1	11.3	0.2686			15-5557-5937	08-3094-4388	ENVIRON
15		Sep	15	15:10	50.5	-28.3	-0.6727			07-1282-2061	16-3885-0935	ENVIRON
16		Nov	14	14:25	114	35.2	0.8367			09-0717-5355	07-0500-8008	ENVIRON
17		Dec	10	15:50	59.4	-19.4	-0.4611			19-3485-9112	07-0579-1018	ENVIRON
18	2015	Feb	27	12:35	29.3	-49.5	-1.177	(-)		19-3876-5860	19-7961-3594	ENVIRON
19		Jun	26	13:20	132	53.2	1.265	(+)		00-5720-1886	15-3704-4199	ENVIRON
20		Nov	6	15:30	165	86.2	2.049	(+)	(+)	07-0462-4762	19-7906-3673	ENVIRON
21		Dec	7	15:58	138	59.2	1.407	(+)		18-5380-2632	00-7335-5231	ENVIRON

Reference Toxicant 96-h Acute Survival Test **All Matching Labs**

Test Type: Survival **Organism:** Eohaustorius estuarius (Amphipod) **Material:** Unionized Ammonia
Protocol: EPA/600/R-94/025 (1994) **Endpoint:** Proportion Survived **Source:** Reference Toxicant-REF



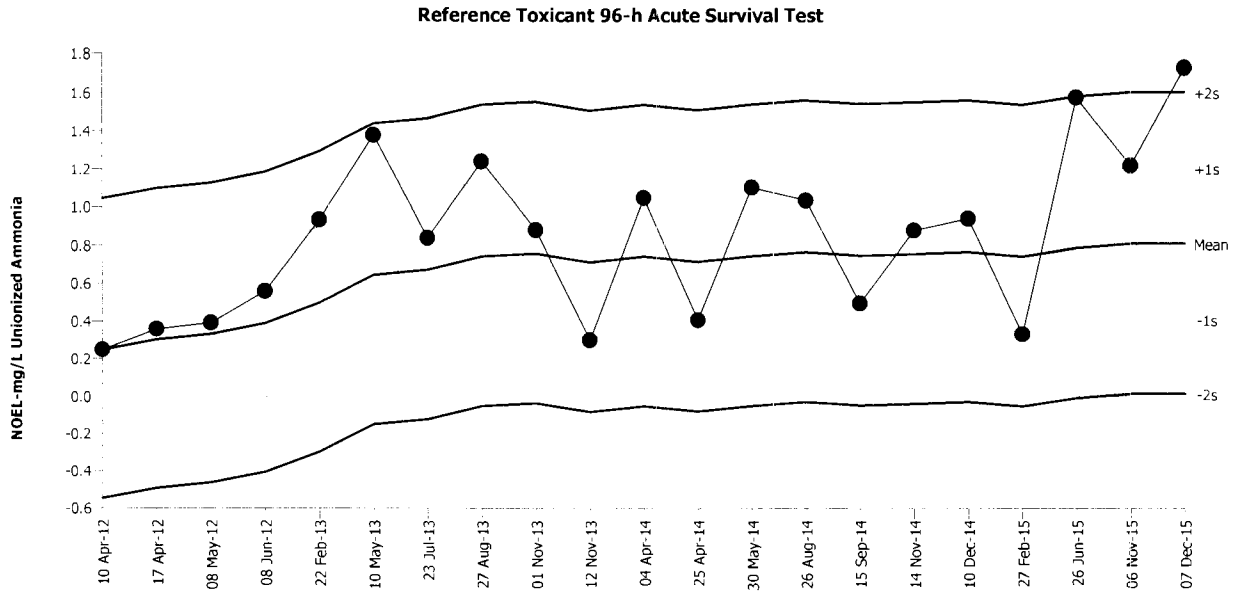
Mean:	1.101	**Count:**	20	**-1s Warning Limit:**	0.6734	**-2s Action Limit:**	0.2462
Sigma:	0.4272	**CV:**	38.80%	**+1s Warning Limit:**	1.528	**+2s Action Limit:**	1.955

Quality Control Data

Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2011	Aug	5	14:35	1.76	0.6592	1.543	(+)		17-9542-0646	06-2792-7024	NewFields
2	2012	Apr	10	15:10	0.4636	-0.6374	-1.492	(-)		18-7283-5013	07-7471-6807	NewFields
3			17	15:45	0.5982	-0.5028	-1.177	(-)		18-5229-3668	10-4921-5938	NewFields
4		May	8	14:30	0.5509	-0.5501	-1.288	(-)		15-4565-2403	06-1396-7211	NewFields
5		Jun	8	15:30	1.024	-0.07673	-0.1796			03-7901-3036	07-6844-7156	NewFields
6	2013	Feb	22	11:40	1.364	0.2632	0.616			10-3861-9695	21-2507-0831	NewFields
7		May	10	14:20	1.578	0.4768	1.116	(+)		05-8857-3753	18-2954-4563	NewFields
8		Jul	23	15:10	1.126	0.02489	0.05826			08-8059-3744	12-6137-6954	NewFields
9		Aug	27	12:10	1.689	0.5883	1.377	(+)		18-3860-3992	18-0374-3993	NewFields
10		Nov	1	13:30	1.339	0.2376	0.5561			01-7225-6737	09-1642-9045	NewFields
11			12	13:45	0.4715	-0.6295	-1.473	(-)		15-7445-3893	06-3812-4989	NewFields
12	2014	Apr	4	19:15	1.072	-0.02935	-0.06871			02-4910-1045	07-9486-3041	NewFields
13			25	13:00	0.6871	-0.4139	-0.9688			05-3931-3196	11-2528-6540	Port Gamble Environment
14		May	30	15:30	1.517	0.4156	0.9728			03-2348-8477	19-6287-3473	ENVIRON
15		Aug	26	15:45	1.087	-0.01396	-0.03268			16-9917-4183	13-7453-5343	ENVIRON
16		Sep	15	15:10	0.6543	-0.4467	-1.046	(-)		04-2286-3837	03-1229-8693	ENVIRON
17		Nov	14	14:25	1.119	0.01813	0.04244			07-5753-6828	00-1415-6148	ENVIRON
18		Dec	10	15:50	1.441	0.3396	0.7949			04-0714-3304	08-0742-5225	ENVIRON
19	2015	Feb	27	12:35	0.8668	-0.2342	-0.5481			10-1977-7129	06-3048-0232	ENVIRON
20		Nov	6	15:30	1.605	0.5043	1.181	(+)		14-1974-2437	14-7486-0204	ENVIRON
21		Dec	7	15:58	1.807	0.7056	1.652	(+)		12-1918-7694	00-1085-2209	ENVIRON

Reference Toxicant 96-h Acute Survival Test **All Matching Labs**

Test Type: Survival **Organism:** Eohaustorius estuarius (Amphipod) **Material:** Unionized Ammonia
Protocol: EPA/600/R-94/025 (1994) **Endpoint:** Proportion Survived **Source:** Reference Toxicant-REF



Mean: 0.8098 **Count:** 20 **-1s Warning Limit:** 0.412 **-2s Action Limit:** 0.0142
Sigma: 0.3978 **CV:** 49.10% **+1s Warning Limit:** 1.208 **+2s Action Limit:** 1.605

Quality Control Data

Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2012	Apr	10	15:10	0.249	-0.5608	-1.41	(-)		18-7283-5013	17-8032-8770	NewFields
2			17	15:45	0.36	-0.4498	-1.131	(-)		18-5229-3668	21-3980-0168	NewFields
3		May	8	14:30	0.393	-0.4168	-1.048	(-)		15-4565-2403	07-1675-0393	NewFields
4		Jun	8	15:30	0.56	-0.2498	-0.628			03-7901-3036	09-3097-7160	NewFields
5	2013	Feb	22	11:40	0.935	0.1252	0.3147			10-3861-9695	14-6175-2687	NewFields
6		May	10	14:20	1.38	0.5702	1.433	(+)		05-8857-3753	12-0577-0060	NewFields
7		Jul	23	15:10	0.839	0.0292	0.0734			08-8059-3744	14-8468-9199	NewFields
8		Aug	27	12:10	1.242	0.4322	1.086	(+)		18-3860-3992	13-4279-2307	NewFields
9		Nov	1	13:30	0.882	0.0722	0.1815			01-7225-6737	17-4499-2761	NewFields
10			12	13:45	0.302	-0.5078	-1.277	(-)		15-7445-3893	14-8429-9092	NewFields
11	2014	Apr	4	19:15	1.05	0.2402	0.6038			02-4910-1045	18-6624-7464	NewFields
12			25	13:00	0.409	-0.4008	-1.008	(-)		05-3931-3196	00-2785-8568	Port Gamble Environment
13		May	30	15:30	1.105	0.2952	0.7421			03-2348-8477	17-7984-3461	ENVIRON
14		Aug	26	15:45	1.037	0.2272	0.5711			16-9917-4183	01-4278-7622	ENVIRON
15		Sep	15	15:10	0.497	-0.3128	-0.7863			04-2286-3837	01-4675-9354	ENVIRON
16		Nov	14	14:25	0.881	0.0712	0.179			07-5753-6828	01-5478-5022	ENVIRON
17		Dec	10	15:50	0.943	0.1332	0.3348			04-0714-3304	12-5251-7122	ENVIRON
18	2015	Feb	27	12:35	0.334	-0.4758	-1.196	(-)		10-1977-7129	04-0485-4050	ENVIRON
19		Jun	26	13:20	1.578	0.7682	1.931	(+)		13-7504-6588	11-4090-1553	ENVIRON
20		Nov	6	15:30	1.22	0.4102	1.031	(+)		14-1974-2437	10-4251-0205	ENVIRON
21		Dec	7	15:58	1.733	0.9232	2.321	(+)	(+)	12-1918-7694	05-5204-9536	ENVIRON

CETIS Summary Report

Reference Toxicant 96-h Acute Survival Test **ENVIRON**

Batch ID:	15-6483-7423	**Test Type:**	Survival	**Analyst:**	
Start Date:	07 Dec-15 15:58	**Protocol:**	EPA/600/R-94/025 (1994)	**Diluent:**	Laboratory Seawater
Ending Date:	11 Dec-15 14:35	**Species:**	Eohaustorius estuarius	**Brine:**	Not Applicable
Duration:	95h	**Source:**	Northwestern Aquatic Science, OR	**Age:**	
Sample ID:	04-1097-4320	**Code:**	187EF870	**Client:**	Internal Lab
Sample Date:	05 May-14	**Material:**	Total Ammonia	**Project:**	Reference Toxicant
Receive Date:	05 May-14	**Source:**	Reference Toxicant		
Sample Age:	581d 16h	**Station:**	p140505.221		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
00-7335-5231	Proportion Survived	138	243	183.1	8.44%		Dunnett Multiple Comparison Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
01-5604-1684	Proportion Survived	EC50	180.1	168.6	192.4		Trimmed Spearman-Kärber

Proportion Survived Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	1	1	1	1	1	0	0	0.0%	0.0%
20.5		3	0.9667	0.8232	1	0.9	1	0.03333	0.05774	5.97%	3.33%
37.4		3	1	1	1	1	1	0	0	0.0%	0.0%
74.2		3	1	1	1	1	1	0	0	0.0%	0.0%
138		3	0.9333	0.7899	1	0.9	1	0.03333	0.05774	6.19%	6.67%
243		3	0.03333	0	0.1768	0	0.1	0.03333	0.05774	173.2%	96.67%

Proportion Survived Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	1	1	1
20.5		1	1	0.9
37.4		1	1	1
74.2		1	1	1
138		1	0.9	0.9
243		0	0.1	0

Proportion Survived Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	10/10	10/10	10/10
20.5		10/10	10/10	9/10
37.4		10/10	10/10	10/10
74.2		10/10	10/10	10/10
138		10/10	9/10	9/10
243		0/10	1/10	0/10

CETIS Test Data Worksheet

Reference Toxicant 96-h Acute Survival Test **ENVIRON**

Start Date:	07 Dec-15 15:58	**Species:**	Eohaustorius estuarius	**Sample Code:**	187EF870
End Date:	11 Dec-15 14:35	**Protocol:**	EPA/600/R-94/025 (1994)	**Sample Source:**	Reference Toxicant
Sample Date:	05 May-14	**Material:**	Total Ammonia	**Sample Station:**	p140505.221

C-mg/L	Code	Rep	Pos	# Exposed	# Survived	Notes
0	D	1	1	10	10	
0	D	2	2	10	10	
0	D	3	3	10	10	
20.5		1	4	10	10	
20.5		2	5	10	10	
20.5		3	6	10	9	
37.4		1	7	10	10	
37.4		2	8	10	10	
37.4		3	9	10	10	
74.2		1	10	10	10	
74.2		2	11	10	10	
74.2		3	12	10	10	
138		1	13	10	10	
138		2	14	10	9	
138		3	15	10	9	
243		1	16	10	0	
243		2	17	10	1	
243		3	18	10	0	

CETIS Summary Report

Reference Toxicant 96-h Acute Survival Test **ENVIRON**

Batch ID:	13-8402-0771	**Test Type:**	Survival	**Analyst:**	
Start Date:	07 Dec-15 15:58	**Protocol:**	EPA/600/R-94/025 (1994)	**Diluent:**	Laboratory Seawater
Ending Date:	11 Dec-15 14:35	**Species:**	Eohaustorius estuarius	**Brine:**	Not Applicable
Duration:	95h	**Source:**	Northwestern Aquatic Science, OR	**Age:**	
Sample ID:	21-0513-7019	**Code:**	7D79D77B	**Client:**	Internal Lab
Sample Date:	05 May-14	**Material:**	Unionized Ammonia	**Project:**	Reference Toxicant
Receive Date:	05 May-14	**Source:**	Reference Toxicant		
Sample Age:	581d 16h	**Station:**	p140505.221		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
05-5204-9536	Proportion Survived	1.733	1.906	1.817	8.44%		Dunnett Multiple Comparison Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
00-1085-2209	Proportion Survived	EC50	1.807	1.757	1.857		Trimmed Spearman-Kärber

Proportion Survived Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	1	1	1	1	1	0	0	0.0%	0.0%
0.399		3	0.9667	0.8232	1	0.9	1	0.03333	0.05774	5.97%	3.33%
0.734		3	1	1	1	1	1	0	0	0.0%	0.0%
1.161		3	1	1	1	1	1	0	0	0.0%	0.0%
1.733		3	0.9333	0.7899	1	0.9	1	0.03333	0.05774	6.19%	6.67%
1.906		3	0.03333	0	0.1768	0	0.1	0.03333	0.05774	173.2%	96.67%

Proportion Survived Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	1	1	1
0.399		1	1	0.9
0.734		1	1	1
1.161		1	1	1
1.733		1	0.9	0.9
1.906		0	0.1	0

Proportion Survived Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	10/10	10/10	10/10
0.399		10/10	10/10	9/10
0.734		10/10	10/10	10/10
1.161		10/10	10/10	10/10
1.733		10/10	9/10	9/10
1.906		0/10	1/10	0/10

CETIS Test Data Worksheet

Reference Toxicant 96-h Acute Survival Test — **ENVIRON**

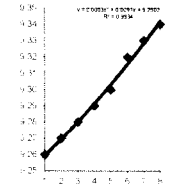
Start Date:	07 Dec-15 15:58	**Species:**	Eohaustorius estuarius	**Sample Code:**	7D79D77B
End Date:	11 Dec-15 14:35	**Protocol:**	EPA/600/R-94/025 (1994)	**Sample Source:**	Reference Toxicant
Sample Date:	05 May-14	**Material:**	Unionized Ammonia	**Sample Station:**	p140505.221

C-mg/L	Code	Rep	Pos	# Exposed	# Survived	Notes
0	D	1	1	10	10	
0	D	2	2	10	10	
0	D	3	3	10	10	
0.399		1	4	10	10	
0.399		2	5	10	10	
0.399		3	6	10	9	
0.734		1	7	10	10	
0.734		2	8	10	10	
0.734		3	9	10	10	
1.161		1	10	10	10	
1.161		2	11	10	10	
1.161		3	12	10	10	
1.733		1	13	10	10	
1.733		2	14	10	9	
1.733		3	15	10	9	
1.906		1	16	10	0	
1.906		2	17	10	1	
1.906		3	18	10	0	

CLIENT:	GeoEngineers	Date of Test:	07-Dec-15
PROJECT:	RG Haley	Test Type:	Eoh RT
COMMENTS:	P140505.221		

To convert Total Ammonia (mg/L) to Free (un-ionized) Ammonia (mg/L) enter the corresponding total ammonia, salinity, temperature, and pH.

Integer:	I-factor
1	9.26
2	9.27
3	9.28
4	9.29
5	9.30
6	9.32
7	9.33
	9.34



	Sample	Mod	NH3T (mg/L)	salinity (ppt)	pH	temp (C)	temp (K)	I-factor	Mod	NH3U (mg/L)
	Target / Sample Name		Actual	22.9	8.0	24.1	297.26	9.3053		#VALUE!
	Example 3.5		2.000	10.0	7.5	5.0	278.16	9.2750		0.008
1										
2										
3										
4	15		20.5	28	7.9	16.1	289.26	9.3187		0.399
5	30		37.4	28	7.9	16.2	289.36	9.3187		0.734
6	60		74.2	28	7.8	16.2	289.36	9.3187		1.161
7	120		138	28	7.7	16.3	289.46	9.3187		1.733
8	240		243	28	7.5	16.1	289.26	9.3187		1.906
9										
10										
11										
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Ammonia Reference Toxicant Test Water Quality Data Sheet

CLIENT	PROJECT		Laboratory	PROTOCOL
GeoEngineers	RG Haley	*Eohaustorius estuarius*	Port Gamble .	PSEP 1995
TEST ID	**LOT #:**	**TEST START DATE** / **TIME**	**4-DAY END DATE**	**TIME**
P140505.221	3244C535	①~~04~~07Dec15 / 1558	①~~08~~11Dec15	1435
CHAMBER SIZE/TYPE	**EXPOSURE VOLUME**			
glass pint jar	250 mL			

WATER QUALITY DATA

TEST CONDITIONS					DO (mg/L)	TEMP(C)	SAL (ppt)	pH	TECHNICIAN	AMMONIA				
					> 5.1	15 ± 1	28 ± 2	7--9						
SAMPLE ID	CONCENTRATION value	CONCENTRATION units	DAY	REP	D.O. meter	D.O. mg/L	TEMP. meter	TEMP. °C	SALINITY meter	SALINITY ppt	pH meter	pH unit	WQ TECH/ DATE	AMMONIA METER	AMMONIA mg/L	Tech
Ref.Tox.-ammonia	0	mg/L	0	Stock	8	7.9	8	②16.2 ~~16.4~~	8	28	8	8.0	RE 12/7/15	3	0.00	
			4	1	9	7.4	9	15.6	9	28	9	7.9	JL 12/11			
Ref.Tox.-ammonia	15	mg/L	0	Stock	8	8.0	8	②16.1 ~~16.5~~	8	28	8	7.9	RE 12/7/15	3	20.5	
			4	1	9	7.5	9	15.3	9	28	9	8.0	JL 12/11			
Ref.Tox.-ammonia	30	mg/L	0	Stock	8	8.0	8	②16.2 ~~16.5~~	8	28	8	7.9	RE 12/7/15	3	37.4	
			4	1	9	7.5	9	15.3	9	28	9	8.0	JL 12/11			
Ref.Tox.-ammonia	60	mg/L	0	Stock	8	8.0	8	②16.2 ~~16.6~~	8	28	8	7.8	RE 12/7/15	3	74.2	
			4	1	9	7.6	9	15.2	9	28	9	7.9	JL 12/11			
Ref.Tox.-ammonia	120	mg/L	0	Stock	8	8.0	8	②16.3 ~~17.1~~	8	28	8	7.7	RE 12/7/15	3	138	
			4	1	9	7.4	9	15.2	9	28	9	7.9	JL 12/11			
Ref.Tox.-ammonia	240	mg/L	0	Stock	8	7.9	8	②16.1 ~~17.0~~	8	28	8	7.5	RE 12/7/15	3	243	
			4	1	9	7.5	9	15.3	9	28	9	7.9	JL 12/11			

① IE. JL 12/06/15
② IE RE 12/7/15

Ammonia Re ence Toxicant Test Water Qu lity Data Sheet

CLIENT	PROJECT	SPECIES	PROJECT MANAGER	LABORATORY	PROTOCOL
GeoEngineers	RG Haley	*Eohaustorius estuarius*	B. Hester	Port Gamble .	PSEP 1995

SURVIVAL & BEHAVIOR DATA

OBSERVATION KEY
N = Normal
LOE = Loss of equilibium
Q = Quinscent
DC = Discoloration
NB = No body
F = Floating on surface

INITIAL # OF ORGANISMS: 10

SAMPLE ID	CONC. value	CONC. units	REP	INITIAL NUMBER	DAY 1 DATE: 12/8/15 TECHNICIAN			DAY 2 DATE: 12/09 TECHNICIAN: JL			DAY 3 DATE: TECHNICIAN			DAY 4 DATE: 12/11 TECHNICIAN: JL		
					#ALIVE	#DEAD	OBS	#ALIVE	#DEAD	OBS	#ALIVE	#DEAD	OBS	#ALIVE	#DEAD	OBS
Ref.Tox.- Ammonia	0	mg/L	1		10	0	3F	10	0	3F	10	0	1F	10	0	1F
			2		10	0	N	10	0	N	10	0		10	0	N
			3		10	0	2F	10	0	3F	10	0	2F	10	0	2F
Ref.Tox.- Ammonia	15	mg/L	1		10	0	2F	10	0	4F	10	0	2F	10	0	1F
			2		10	0	2F	10	0	1F	10	0	1F	10	0	2F
			3		10	0	3F	10	0	3F	10	0	2F	9	1	3F
Ref.Tox.- Ammonia	30	mg/L	1		10	0	1F	10	0	1F	10	0	2F	10	0	N
			2		10	0	3F	10	0	3F	10	0	3F	10	0	1F
			3		10	0	N	10	0	1F	10	0	1F	10	0	1F
Ref.Tox.- Ammonia	60	mg/L	1		10	0	3F	10	0	3F	10	0	1F	10	0	N
			2		10	0	3F	10	0	4F	10	0	5F	10	0	2F
			3		10	0	3F	10	0	2F	10	0	2F	10	0	2F
Ref.Tox.- Ammonia	120	mg/L	1		10	0	3F	10	0	2F	10	0	2F	10	0	2F
			2		10	0	3F	10	0	N	10	0	N	9	1	N
			3		10	0	4F	10	0	4F	10	0	4F	9	1	2F
Ref.Tox.- Ammonia	240	mg/L	1		10	0	3F,Q	6	4	0	4	2	0	0	4	0
			2		10	0	4F,Q	6	4	0	5	1		1	4	
			3		10	0	2F,Q	7	3	0	4	3		0	4	

ENVIRON **Ammonia Reference Toxicant**
Spiking Worksheet

Reference Toxicant ID: P140505.221
Date Prepared: 12/7/15
Technician Initials: HE

Amp/Eoh NH_3 RT

Assumptions in Model
Stock ammonia concentration is 10,000 mg/L = 10 mg/mL

Date: 12/7/2015
Measurement: 9286.6

Test Solutions			Volume of stock to reach desired concentration	
Measured Concentration	**Desired Concentration**	**Volume**		
mg/L	mg/L	mL	mL stock to increase	
			[redacted]	SALT WATER
243 ~~320~~ ①	**240**	750		**29.074**
138	**120**	750		**14.537**
74.2	**60**	750		**7.269**
37.4	**30**	750		**3.634**
20.5	**15**	750		**1.817**
	0	750		**0.000**

① IE HE 12/7

APPENDIX A.2.1

Neanthes arenaceodentata

Juvenile Polychaete Bioassay

Laboratory Data Sheets

RAMBOLL ENVIRON

CLIENT	PROJECT	JOB NO.	PROJECT MANAGER	LABORATORY / LOCATION	PROTOCOL	SPECIES
Geoengineers	RG Hulcy	0	B. Hester	Port Gamble /	PSEP 1995	Neanthes arenaceodentata

ENDPOINT DATA & OBSERVATIONS

S = Normal
AE = Emergence
AB = Mortality
G = Growth
(Behavior, Avoidance, or other)
O = No Air Flow (DO?)
F = Floating on Surface
TC = Tow Crowds
U=Excess Food

Sample Identification	Rep	Rep	Initial # of Animals	Date and Initials	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Number Remaining	Tare Weight (mg)	Total Weight (mg)	Ashed Weight (mg)
Control /	1			12/05 JL	2	2	2	2	2	2	2	2	2	2	U	N	N	N	2	2	N	N	G	G	5	1 191.54	271.70	~~231.93~~ 236.04
	2			12/06 JL	2	2	2	G	2	2	2	2	2	G	G	G	G	G	G	G	G	G			5	2 212.92	299.89	236.09
	3			12/7 MK	2	2	2	G	2	2	2	2	2	G	L										5	3 203.89	291.47	241.38
	4			12/8 MK	2	2	2	G	2	2	2	2	2	G	L										5	4 212.09	31393	248.68
	5			12/9 MK	2	2	2	G	2	2	2	2	2	G	G										5	5 205.64	308.47	242.67
CR22 /	1			12/09 JL	G	G	G	G	G	G	G	G	G	G	G									G	5	6 195.85	285.94	213.34
	2			12/10 MK	G																				5	7 199.38	263.17	212.35
	3			12/11 JL	G																				5	8 216.42	285.09	232.21
	4			12/12 JL	G																				5	9 200.20	264.85	215.35
	5			12/13 JL	G																				5	10 194.97	263.13	219.25
SS1-SS-03-0-12 /	1			12/15 MK	N	2	N	G																G	5	11 184.30	255.71	196.09
	2			12/16 MK	G			G																	5	12 197.80	290.32	218.85
	3			12/17 JL	N			G																	5	13 206.63	294.32	224.35
	4			12/18 MK	G			G																	5	14 168.73	269.29	181.06
	5			12/19 JL	G			G																	5	15 187.87	265.58	205.15

Initial Biomass	Rep	Number	Tare Weight (mg)	Dry Weight (mg)	Ashed Weight (mg)
	1	5	33 51.03	52.88	51.96
	2	5	34 51.00	52.94	51.38
	3	5	35 51.01	52.58	51.54

222.02

DWC #2 12/28

CLIENT	PROJECT	JOB NO.	PROJECT MANAGER	LABORATORY / LOCATION	PROTOCOL	SPECIES
GeoEngineers	RG Haley	0	B. Hester	Port Gamble /	PSEP 1995	*Neanthes arenaceodentata*

N = Normal; AE = Emergence; AM = Mortality; G = Growth (Weight, Ash-free dry weight); R = No Air Flow (SED); F = Floating on Surface; TC = Tube Density; SPLIT = Excess Sed

ENDPOINT DATA & OBSERVATIONS

SAMPLE DESIGNATION	REP	SUB	INITIAL # OF JUVENILES	Date and Initials	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	NUMBER REMAINING	TARE WEIGHT (mg)	TOTAL WEIGHT (mg)	ASHED WEIGHT (mg)
																											261.00	
SS1-SS-05-0-12 /	1			12/05 JL	2	2	N	N	2	5	G	G	G	G	G	G	G	G	G	G	G	G	G	G	5	16 184.26	262 ①	194.53
	2									2	G														5	17 173.51	255.96	189.47
	3									→	G														5	18 191.83	274.29	206.92
	4										G														5	19 204.14	294.75 ① ~~277.96~~	222.05
	5										G														5	20 232.20	295.54	216.65
SS1-SS-06-0-12 /	1			12/06 JL			2			2	G													G	5	21 205.97	274.44	216.32
	2										G														5	22 201.75	265.99	211.11
	3										G														5	23 211.75	287.16	224.98
	4			12/9 AE				5		5	G														5	24 202.00	278.80	216.60
	5									2	G														5	25 201.31	263.99	211.71
				12/8 AE																						26 256.32		
				12/09 JL																						27 242.33		
				12/10 JL																						28 219.89		
				12/11 JL																								
				12/12 JL																								
				12/13 JL																								
				12/14 AE																								
				12/15 AE																								
				12/16 AE																								
				12/17 JL																								
				12/18 AE																								
				12/19 JL																								
				12/20 JL																								
				12/21 AE																								
				12/22 AE																								
				12/23																								
				12/24 AE																								

① MB HE 12/28

RAMBOLL ENVIRON

CLIENT	PROJECT	START TIME/ END TIME	DILUTION WATER BATCH	PROTOCOL	TEST START DATE
GeoEngineers	RG Haley	1505 /	FSW120315.01	PSEP 1995	4-Dec-2015
JOB NUMBER	**PROJECT MANAGER**	**LABORATORY / LOCATION**	**ORGANISM BATCH**	**TEST SPECIES**	**TEST END DATE**
0	B. Hester	Port Gamble / Bath 5	ATS110515	*Neanthes arenaceodentata*	24-Dec-2015

WATER QUALITY DATA

TEST CONDITIONS				DO (mg/L) > 4.6		TEMP (C) 20 ± 1		SALINITY (ppt) 28 ± 2		pH 8.0±1.0				
SAMPLE ID	DAY	REP	JAR	D.O. meter	D.O. mg/L	TEMP meter	TEMP °C	SALINITY meter	SALINITY ppt	pH meter	pH unit	WATER RENEWAL	Feeding	TECH/DATE
Control /	0	Surr	28	8	7.7	8	20.0	8	28	8	7.9		JL	JL 12/04
Control /	1	Surr		8	7.1	8	20.2	8	28	8	7.67 ~~7.7~~ ①			JL 12/05
Control /	2	Surr		8	7.7	8	20.3	8	28	8	8.0		JL	JL 12/06
Control /	3	Surr		8	7.2	8	20.1	8	29	8	7.8	BH		HE 12/7
Control /	4	Surr		8	② ~~6.9~~ (7.3)	8	(20.3) ~~20.2~~	8	~~28~~ (30)	8	~~7.7~~ (6.8)		HE	BE 12/8
Control /	5	Surr		9	7.1	9	19.8	9	29	9	7.7			JL 12/09
Control /	6	Surr		9	6.8	9	19.8	9	29	9	7.8	JL	HE	JL 12/10
Control /	7	Surr		9	6.4	9	19.8	9	29	9	7.7			JL 12/11
Control /	8	Surr		9	7.3	9	19.8	9	30	9	8.0		JL	JL 12/12
Control /	9	Surr		8	7.0	8	19.9	8	30	8	7.8	JL		JL 12/13
Control /	10	Surr		8	7.4	8	19.9	8	30	8	8.0		HE	HE 12/14
Control /	11	Surr		8	7.3	8	19.9	8	30	8	8.0			HE 12/15
Control /	12	Surr		8	7.5	8	19.9	8	30	8	8.0	HE	HE	HE 12/16
Control /	13	Surr		8	7.4	8	19.9	8	30	8	7.9			JL 12/17
Control /	14	Surr		8	7.3	8	20.0	8	31	8	8.0		HE	HE 12/18
Control /	15	Surr		8	6.8	8	19.9	8	31	8	7.9	JL		JL 12/19
Control /	16	Surr		8	7.5	8	20.0	8	30	8	8.2		JL	JL 12/20
Control /	17	Surr		8	6.7	9	19.8	9	30	9	8.1			HE 12/21
Control /	18	Surr		9	7.0	9	19.7	9	30	9	8.0	HE	BG	HE 12/22
Control /	19	Surr		9	7.1	9	19.6	9	29	9	7.9			HE 12/23
Control /	20	Surr		9	7.0	9	19.7	9	30	9	8.0			HE 12/24

① WP. JL 12/05/15. ② wrong date 12.7.15 BH ③ Wrong meter HE 12/21

RAMBOLL ENVIRON

CLIENT	PROJECT	START TIME/ END TIME	DILUTION WATER BATCH	PROTOCOL	TEST START DATE
GeoEngineers	RG Haley	1505 /	FSW120315.01	PSEP 1995	4-Dec-2015
JOB NUMBER	**PROJECT MANAGER**	**LABORATORY / LOCATION**	**ORGANISM BATCH**	**TEST SPECIES**	**TEST END DATE**
0	B. Hester	Port Gamble / Bath 5	ATS110515	*Neanthes arenaceodentata*	24-Dec-2015

WATER QUALITY DATA

TEST CONDITIONS				DO (mg/L) > 4.6		TEMP (C) 20 ± 1		SALINITY (ppt) 28 ± 2		pH 8.0±1.0				
SAMPLE ID	DAY	REP	3RD	D.O. meter	D.O. mg/L	TEMP meter	TEMP °C	SALINITY meter	SALINITY ppt	pH meter	pH unit	WATER RENEWAL	Feeding	TECH/DATE
CR22 /	0	Surr	7	8	7.5	8	19.6	8	28	8	7.9		JL	JL 12/04
CR22 /	1	Surr		8	7.3	8	20.1	8	28	8	7.7			JL 12/05
CR22 /	2	Surr		8	7.6	8	20.2	8	28	8	8.1		JL	JL 12/06
CR22 /	3	Surr		8	7.2	8	20.2	8	28	8	7.9	DM		HE 12/7
CR22 /	4	Surr		8	7.0	8	20.0	8	30	8	7.9		HE	BE 12/8
CR22 /	5	Surr		~~8~~ 9	6.9	~~8~~ 9	20.0	9	29	9	7.9			JL 12/09
CR22 /	6	Surr		9	7.4	9	19.9	9	29	9	8.1	JL	HE	JL 12/10
CR22 /	7	Surr		9	7.5	9	19.8	9	29	9	8.1			JL 12/11
CR22 /	8	Surr		9	7.7	9	19.8	9	29	9	8.5		JL	JL 12/12
CR22 /	9	Surr		8	7.8	8	20.1	8	30	8	8.4	JL		JL 12/13
CR22 /	10	Surr		8	8.1	8	19.7	8	30	8	8.3		HE	HE 12/14
CR22 /	11	Surr		8	~~8.2~~ 7.7	8	19.9	8	30	8	8.2			HE 12/15
CR22 /	12	Surr		8	7.6	8	20.0	8	30	8	8.2	HE	HE	HE 12/16
CR22 /	13	Surr		8	7.6	8	19.9	8	30	8	8.2			JL 12/17
CR22 /	14	Surr		8	7.3	8	20.1	8	30	8	8.2		HE	HE 12/18
CR22 /	15	Surr		8	7.4	8	20.0	8	31	8	8.2	JL		JL 12/19
CR22 /	16	Surr		8	7.7	8	20.1	8	30	8	8.3		JL	JL 12/20
CR22 /	17	Surr		9	7.1	9	19.8	9	30	9	8.6			HE 12/21
CR22 /	18	Surr		9	7.4	9	19.6	9	30	9	8.1	HE	BE	HE 12/22
CR22 /	19	Surr		9	7.4	9	19.7	9	29	9	8.1			HE 12/23
CR22 /	20	Surr	✓	9	~~7.0~~ 7.3	9	19.7	9	30	9	~~8.0~~ 8.2			HE 12/24

① wrong meter JL 12/09/15. ② WC HE 12/15 ③ WP HE 12/24

RAMBOLL ENVIRON

CLIENT	PROJECT	START TIME/ END TIME	DILUTION WATER BATCH	PROTOCOL	TEST START DATE
GeoEngineers	RG Haley	1505 /	FSW120315.01	PSEP 1995	4-Dec-2015
JOB NUMBER	**PROJECT MANAGER**	**LABORATORY / LOCATION**	**ORGANISM BATCH**	**TEST SPECIES**	**TEST END DATE**
0	B. Hester	Port Gamble / Bath 5	ATS110515	*Neanthes arenaceodentata*	24-Dec-2015

WATER QUALITY DATA

TEST CONDITIONS				DO (mg/L) > 4.6		TEMP (C) 20 ± 1		SALINITY (ppt) 28 ± 2		pH 8.0±1.0				
				D.O.		TEMP		SALINITY		pH		WATER		
SAMPLE ID	DAY	REP	AM	meter	mg/L	meter	°C	meter	ppt	meter	unit	RENEWAL	Feeding	TECH/DATE
SS1-SS-03-0-12 /	0	Surr	21	8	7.6	8	19.5	8	28	8	7.9		JL	JL 12/04
SS1-SS-03-0-12 /	1	Surr	|	8	7.5	8	20.1	8	28	8	7.9			JL 12/05
SS1-SS-03-0-12 /	2	Surr	|	8	7.6	8	20.1	8	27	8	8.2		JL	JL 12/06
SS1-SS-03-0-12 /	3	Surr	|	8	7.2	8	20.2	8	29	8	8.1	CH		HE 12/7
SS1-SS-03-0-12 /	4	Surr	|	8	7.2	8	20.0	8	29	8	8.1		HE	BE 12/8
SS1-SS-03-0-12 /	5	Surr	|	9	7.1	9	19.8	9	29	9	8.2			JL 12/09
SS1-SS-03-0-12 /	6	Surr	|	9	6.9	9	19.8	9	30	9	8.3	JL	HE	JL 12/10
SS1-SS-03-0-12 /	7	Surr	|	9	7.1	9	19.6	9	30	9	8.2			JL 12/11
SS1-SS-03-0-12 /	8	Surr	|	9	7.3	9	19.6	9	30	9	8.4		JL	JL 12/12
SS1-SS-03-0-12 /	9	Surr	|	8	7.4	8	19.9	8	31	8	8.4	JL		JL 12/13
SS1-SS-03-0-12 /	10	Surr	|	8	7.6	8	19.7	8	31~~30~~ ①	8	8.4		HE	HE 12/14
SS1-SS-03-0-12 /	11	Surr	|	8	7.7	8 ②	19.9 MR	8	31~~30~~ ⑥	8	8.4			HE 12/15
SS1-SS-03-0-12 /	12	Surr	|	8	7.6	8	19.8	8	32	8	8.4	HE	HE	HE 12/16
SS1-SS-03-0-12 /	13	Surr	|	8	7.5	8	19.8	8	31	8	8.3			JL 12/~~17~~ ③
SS1-SS-03-0-12 /	14	Surr	|	8	7.3	8	20.0	8	31	8	8.3		HE	HE 12/18
SS1-SS-03-0-12 /	15	Surr	|	8	7.4	8	20.0	8	31	8	8.3	JL		JL 12/19
SS1-SS-03-0-12 /	16	Surr	|	8	7.6	8	19.9	8	30~~24~~ ④	8	8.4		JL	JL 12/20
SS1-SS-03-0-12 /	17	Surr	|	9	6.8	9	19.7	9	30	9	8.6			HE 12/21
SS1-SS-03-0-12 /	18	Surr	|	9	7.0	9	19.6	9	31	9	8.4	HE	BE	HE 12/22
SS1-SS-03-0-12 /	19	Surr	|	9	7.0	9	19.6	9	30	9	8.2			HE 12/23
SS1-SS-03-0-12 /	20	Surr	|	9	7.0	9	19.6	9	30	9	8.3			HE 12/24

① JL HE 12/14 ② WD HE 12/15 ③ WD. JL 12/17/15. ④ MR. JL 12/24/15.

CLIENT	PROJECT	START TIME/ END TIME	DILUTION WATER BATCH	PROTOCOL	TEST START DATE
GeoEngineers	RG Halley	1505 /	FSW120315.01	PSEP 1995	4-Dec-2015
JOB NUMBER	**PROJECT MANAGER**	**LABORATORY / LOCATION**	**ORGANISM BATCH**	**TEST SPECIES**	**TEST END DATE**
0	B. Hester	Port Gamble / Bath 5	ATS110515	*Neanthes arenaceodentata*	24-Dec-2015

WATER QUALITY DATA

TEST CONDITIONS				DO (mg/L) > 4.6		TEMP (C) 20 ± 1		SALINITY (ppt) 28 ± 2		pH 8.0±1.0				
				D.O.		TEMP		SALINITY		pH		WATER		
SAMPLE ID	DAY	REP	JAR	meter	mg/L	meter	°C	meter	ppt	meter	unit	RENEWAL	Feeding	TECH/DATE
SS1-SS-05-0-12 /	0	Surr	14	8	7.6	8	20.0	8	28	8	8.0		JL	JL 12/04
SS1-SS-05-0-12 /	1	Surr		8	7.4	8	20.2	8	28	8	7.8			JL 12/05
SS1-SS-05-0-12 /	2	Surr		8	7.5	8	20.2	8	28	8	8.2		JL	JL 12/06
SS1-SS-05-0-12 /	3	Surr		8	7.2	8	20.2	8	29	8	8.2	BH		HE 12/07
SS1-SS-05-0-12 /	4	Surr		8	7.1	8	20.2	8	29	8	8.2		HE	BE 12/8
SS1-SS-05-0-12 /	5	Surr		9	6.9	9	19.9	9	29	9	8.1			JL 12/09
SS1-SS-05-0-12 /	6	Surr		9	7.1	9	19.8	9	30	9	8.3	JL	HE	JL 12/10
SS1-SS-05-0-12 /	7	Surr		9	7.2	9	19.7	9	30	9	8.3			JL 12/11
SS1-SS-05-0-12 /	8	Surr		9	7.5	9	19.7	9	30	9	8.6		JL	JL 12/12
SS1-SS-05-0-12 /	9	Surr		8	7.6	8	20.0	8	30	8	8.6	JL		JL 12/13
SS1-SS-05-0-12 /	10	Surr		8	7.9	8	19.9	8	31	8	8.5		HE	HE 12/14
SS1-SS-05-0-12 /	11	Surr		8	7.6	8	19.8	8	31	8	8.4			HE 12/15
SS1-SS-05-0-12 /	12	Surr		8	7.6	8	19.9	8	31	8	8.4	HE	HE	HE 12/16
SS1-SS-05-0-12 /	13	Surr		8	7.4	8	19.8	8	31	8	8.3			JL 12/17
SS1-SS-05-0-12 /	14	Surr		8	7.3	8	20.0	8	31	8	8.4		HE	HE 12/18
SS1-SS-05-0-12 /	15	Surr		8	7.5	8	20.0	8	31	8	8.5	JL		JL 12/19
SS1-SS-05-0-12 /	16	Surr		8	8.0	8	20.0	8	30	8	8.6		JL	JL 12/20
SS1-SS-05-0-12 /	17	Surr		9	7.4	9	19.8	9	30	9	8.7			HE 12/21
SS1-SS-05-0-12 /	18	Surr		9	7.4	9	19.7	9	30	9	8.5	HE	BE	HE 12/22
SS1-SS-05-0-12 /	19	Surr		9	7.5	9	19.7	9	30	9	8.4			HE 12/23
SS1-SS-05-0-12 /	20	Surr	J	9	② 7.3 7.1	9	19.6	9	30	9	② 8.2 ① 8.4			HE 12/24

① SM HE 12/24 ② WP HE 12/24

RAMBOLL ENVIRON

CLIENT	PROJECT	START TIME/ END TIME	DILUTION WATER BATCH	PROTOCOL	TEST START DATE
GeoEngineers	RG Haley	1505 /	FSW120315.01	PSEP 1995	4-Dec-2015
JOB NUMBER	**PROJECT MANAGER**	**LABORATORY / LOCATION**	**ORGANISM BATCH**	**TEST SPECIES**	**TEST END DATE**
0	B. Hester	Port Gamble / Bath 5	ATS110515	*Neanthes arenaceodentata*	24-Dec-2015

WATER QUALITY DATA

TEST CONDITIONS				DO (mg/L) > 4.6		TEMP (C) 20 ± 1		SALINITY (ppt) 28 ± 2		pH 8.0±1.0				
				D.O.		TEMP		SALINITY		pH		WATER		
SAMPLE ID	DAY	REP	LAB	meter	mg/L	meter	°C	meter	ppt	meter	unit	RENEWAL	Feeding	TECH/DATE
SS1-SS-06-0-12 /	0	Surr	19	8	7.6	8	20.0	8	28	8	8.1		JL	JL 12/04
SS1-SS-06-0-12 /	1	Surr	|	8	7.1	8	20.2	8	28	8	7.7			JL 12/05
SS1-SS-06-0-12 /	2	Surr	|	8	6.8	8	20.2	8	28	8	8.0		JL	JL 12/06
SS1-SS-06-0-12 /	3	Surr	|	8	7.3	8	20.2	8	29	8	8.1	BH		BE 12/07
SS1-SS-06-0-12 /	4	Surr	|	8	7.1	8	20.2	8	29	8	8.2		HE	BE 12/8
SS1-SS-06-0-12 /	5	Surr	|	9	6.6	9	20.0	9	29	9	8.1			JL 12/09
SS1-SS-06-0-12 /	6	Surr	|	9	6.9	9	19.9	9	30	9	8.4	JL	HE	JL 12/10
SS1-SS-06-0-12 /	7	Surr	|	9	7.0	9	19.7	9	30	9	8.3			JL 12/11
SS1-SS-06-0-12 /	8	Surr	|	9	7.4	9	19.7	9	30	9	8.6		JL	JL 12/12
SS1-SS-06-0-12 /	9	Surr	|	8	7.6	8	20.0	8	30	8	8.5	JL		JL 12/13
SS1-SS-06-0-12 /	10	Surr	|	8	7.8	8	19.7	8	30	8	8.5		HE	HE 12/14
SS1-SS-06-0-12 /	11	Surr	|	8	7.7	8	19.9	8	30	8	8.4			HE 12/15
SS1-SS-06-0-12 /	12	Surr	|	8	7.6	8	19.9	8	31	8	8.4	HE	HE	HE 12/16
SS1-SS-06-0-12 /	13	Surr	|	8	7.4	8	19.8	8	31	8	8.3			JL 12/17
SS1-SS-06-0-12 /	14	Surr	|	8	7.3	8	20.0	8	31	8	8.3		HE	HE 12/18
SS1-SS-06-0-12 /	15	Surr	|	8	7.0	8	20.0	8	31	8	8.2	JL		JL 12/19
SS1-SS-06-0-12 /	16	Surr	|	8	7.6	8	20.0	8	30	8	8.4		JL	JL 12/20
SS1-SS-06-0-12 /	17	Surr	|	9	6.7	9	19.8	9	30	9	8.5			HE 12/21
SS1-SS-06-0-12 /	18	Surr	|	9	7.0	9	19.7	9	30	9	8.2	HE	BE	HE 12/22
SS1-SS-06-0-12 /	19	Surr	|	9	7.0	9	19.7	9	29	9	8.1			HE 12/23
SS1-SS-06-0-12 /	20	Surr	↓	9	6.3	9	19.6	9	30	9	7.9			HE 12/24

RAMBOLL ENVIRON

Ammonia and Sulfide Analysis Record

Client/Project: GeoEngineers / RG Haley	Organism: Neanthes arenaceodentata	Test Duration (days): 20

PRETEST / ~~INITIAL~~ / FINAL / OTHER (circle one) DAY of TEST: 0

~~OVERLYING (OV)~~ ~~POREWATER (PW)~~ (circle one) / Comments: _____

Calibration Standards Temperature		
Date: 12/04/15	Temperature: 19.0°C	Sample temperature should be within ±1°C of standards temperature at time and date of analysis.

Sample ID or Description	Conc. or Rep	Date of Sampling and Initials	Ammonia Value (mg/L)	Temp °C	Date of Reading and Initials	Sample Preserved (Y/N)	pH	Sal (ppt)	Sample Volume (mL)	Measured Sulf. (mg/L)	Multi-plier	Calc-ulated Sulf. (mg/L)
OV Control	Surr.	12/04/15 JL	0.126	19.0	12/04/15 JL	N			10	0.00	NA	NA
CR-22			0.00							0.006		
3			0.00							0.015		
5			1.82							0.007		
6			1.84							0.002		
PW Control			0.638	19.6			7.5	27	2	0.040	5	0.20
CR-22			1.37				7.7	29		0.011		0.055
3			8.13				7.8	30		0.00		0.00
5			9.64				7.9	29		0.034		0.17
6			12.3				8.0	29		0.031		0.155

RAMBOLL ENVIRON

Ammonia and Sulfide Analysis Record

Page ____ of ____

Client/Project:	Organism:	Test Duration (days):
Geoengineers RG Haley	Neanthes	20

PRETEST / INITIAL / FINAL / OTHER (circle one)

OVERLYING (OV) / POREWATER (PW) (circle one) / Comments: _____

DAY of TEST: 20

Calibration Standards Temperature		
Date:	Temperature:	Sample temperature should be within ±1°C of standards temperature at time and date of analysis.
12/24/25	17.5	

Sample ID or Description	Conc. or Rep	Date of Sampling and Initials	Ammonia Value (mg/L)	Temp °C	Date of Reading and Initials	Sample Preserved (Y/N)	pH	Sal (ppt)	Sample Volume (mL)	Measured Sulf. (mg/L)	Multi-plier	Calc-ulated Sulf. (mg/L)
OV	R	SURF	HL 12/24	17.5	12/24 HL	N			10	0.018		
	CR-22		0.00							0.069		
	3		0.00							0.020		
	5		0.00							0.063		
	6		0.00							0.015		
PW	R	SURF	HL 12/24	16.5	12/24 HL	N	7.6	29	2	0.017	5	0.085
	CR-22		0.760				7.1	29		0.061		0.305
	3		0.00				7.3	30		0.023		0.115
	5		0.00				7.0	30		0023		0.115
	6		1.11				6.6	29		0.045		0.225

RAMBOLL ENVIRON

ORGANISM RECEIPT LOG

Date:	Time:	Batch No.
12/04/15	1420	ATS 120415

Organism / Project: Neanthes / R&A Haley

Source / Supplier: Aquatic Tox. Support

No. Ordered:	No. Received:	Source Batch: Collection date, hatch date, etc.):
360	396	Emerged Nov. 13-18

Condition of Organisms:	Approximate Size or Age: (Days from hatch, life stage, size class, etc.):
Good	21-26 days
Shipper: Courier	**B of L (Tracking No.)** NA
Condition of Container: Good	**Received By:** JL

Container	D.O. (mg/L)	Temp. (°C)	Cond. or Sal. (Include Units)	pH (Units)	# Dead	% Dead*	Tech. (Initials)
1	11.5	18.5	29 ppt	7.5	—	—	JL

*if >10% contact lab manager

Notes: NA

Aquatic Toxicology Support
1849 Charleston Beach Road West
Bremerton, Washington 98312
(360) 813-1202

Order Summary

Species: *Neanthes arenaceodentata**	Emerge Date: 13-18 Nov '15
Number Ordered: 360	Number Shipped: 360 + 10%
Date Shipped: 4 Dec '15	Salinity (ppt): 30

*Smith 1964. CSU Long Beach strain. Feed upon arrival.

APPENDIX A.2.2

Neanthes arenaceodentata

Juvenile Polychaete Bioassay

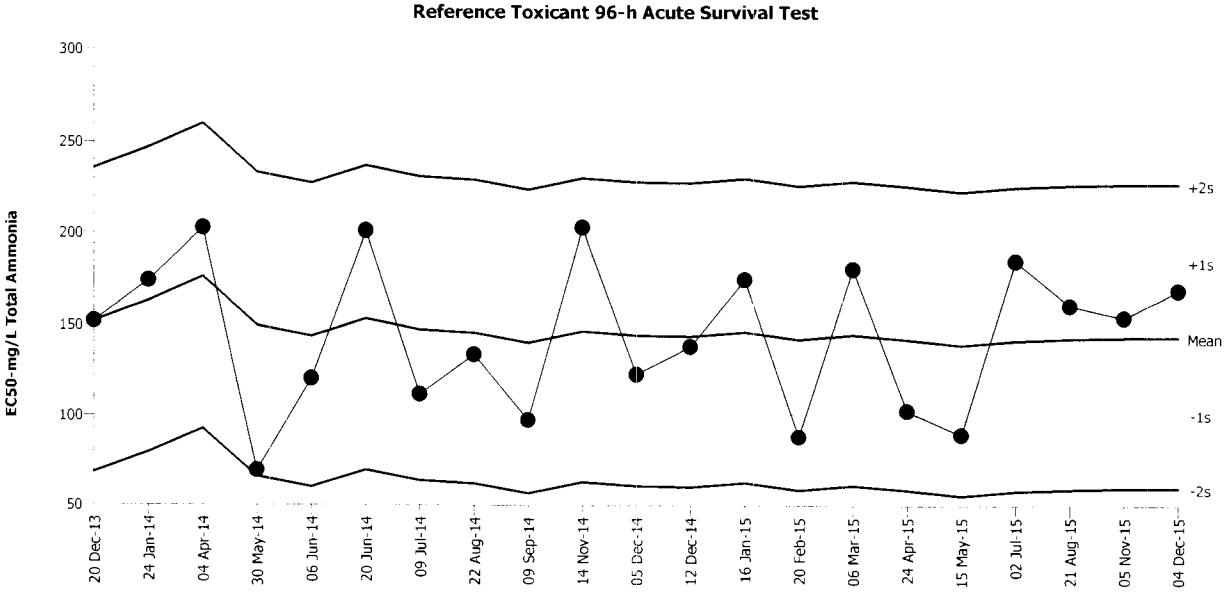
Reference Toxicant Test

CETIS QC Plot

Report Date: 09 Dec-15 14:23 (1 of 1)

Reference Toxicant 96-h Acute Survival Test — **All Matching Labs**

Test Type:	Survival	**Organism:**	Neanthes arenaceodentata (Polycha	**Material:**	Total Ammonia
Protocol:	PSEP (1995)	**Endpoint:**	Proportion Survived	**Source:**	Reference Toxicant-REF



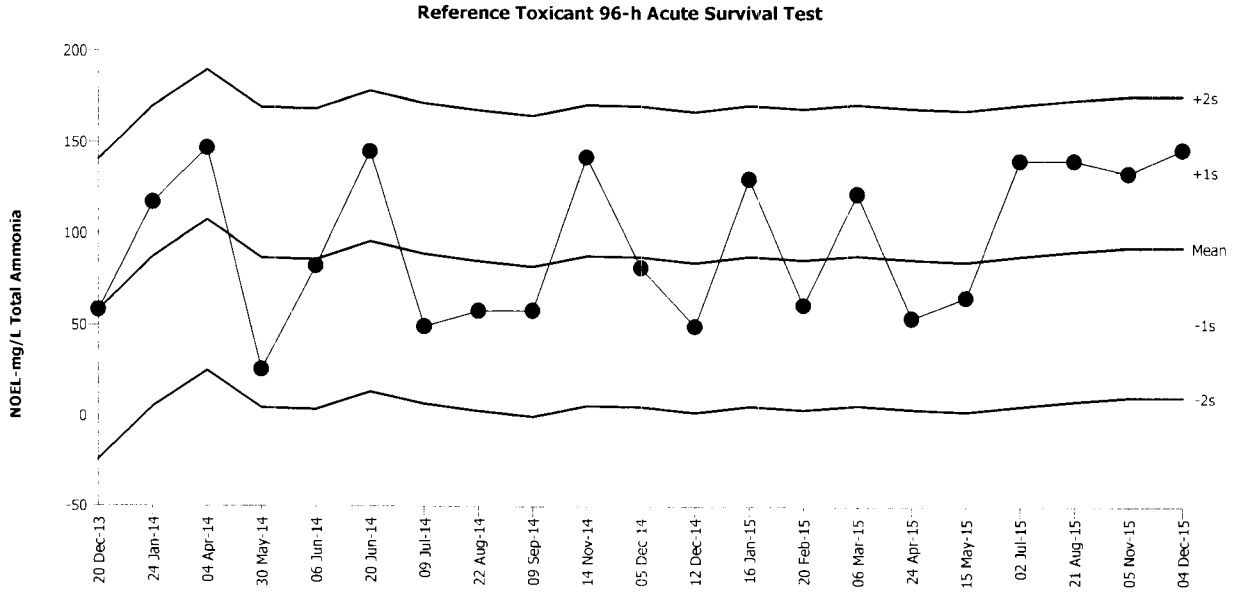
Mean:	143.4	**Count:**	20	**-1s Warning Limit:**	101.6	**-2s Action Limit:**	59.76
Sigma:	41.83	**CV:**	29.20%	**+1s Warning Limit:**	185.3	**+2s Action Limit:**	227.1

Quality Control Data

Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2013	Dec	20	14:00	152.2	8.771	0.2097			08-9922-1254	05-5343-6267	NewFields
2	2014	Jan	24	13:20	174.5	31.12	0.7441			20-9603-7883	05-6245-5381	NewFields
3		Apr	4	15:40	202.9	59.48	1.422	(+)		09-1443-8374	04-8864-2138	ENVIRON
4		May	30	16:25	69.43	-73.97	-1.768	(-)		18-4751-2702	06-4812-5268	ENVIRON
5		Jun	6	14:00	120.6	-22.83	-0.5457			02-4901-6395	02-6665-3375	ENVIRON
6			20	13:20	201.3	57.95	1.385	(+)		04-8899-1061	18-6388-8462	ENVIRON
7		Jul	9	15:30	112	-31.38	-0.7501			00-3047-6484	19-8550-4064	ENVIRON
8		Aug	22	12:30	133.9	-9.533	-0.2279			19-3698-7324	19-8424-2994	ENVIRON
9		Sep	9	15:00	97.87	-45.53	-1.089	(-)		04-0379-7898	08-6657-8417	ENVIRON
10		Nov	14	11:11	203.3	59.88	1.431	(+)		09-0815-7159	21-3147-5839	ENVIRON
11		Dec	5	11:50	123.1	-20.31	-0.4855			14-5288-4655	12-0797-2995	ENVIRON
12			12	11:45	138.4	-4.956	-0.1185			04-7774-5498	11-0912-6539	ENVIRON
13	2015	Jan	16	11:15	175.3	31.89	0.7623			03-9642-9379	19-1724-7286	ENVIRON
14		Feb	20	14:50	88.65	-54.75	-1.309	(-)		12-3560-9864	07-2965-5219	ENVIRON
15		Mar	6	11:50	181.2	37.76	0.9026			09-2159-7453	09-1672-5355	ENVIRON
16		Apr	24	12:50	103.1	-40.32	-0.9639			01-6315-9057	02-6990-5019	ENVIRON
17		May	15	14:00	89.83	-53.57	-1.281	(-)		15-1184-2734	08-8902-1629	ENVIRON
18		Jul	2	14:15	185.6	42.18	1.008	(+)		18-8075-0902	16-6019-0259	ENVIRON
19		Aug	21	16:33	161	17.58	0.4204			18-5704-8732	08-2852-0434	ENVIRON
20		Nov	5	16:00	154.3	10.94	0.2614			15-0871-2744	12-3779-6972	ENVIRON
21		Dec	4	15:55	169.2	25.82	0.6173			15-8650-5167	03-4063-5051	ENVIRON

Reference Toxicant 96-h Acute Survival Test **All Matching Labs**

Test Type: Survival **Organism:** Neanthes arenaceodentata (Polycha **Material:** Total Ammonia
Protocol: PSEP (1995) **Endpoint:** Proportion Survived **Source:** Reference Toxicant-REF



Mean:	93.07	**Count:**	20	**-1s Warning Limit:**	51.89	**-2s Action Limit:**	10.71
Sigma:	41.18	**CV:**	44.20%	**+1s Warning Limit:**	134.3	**+2s Action Limit:**	175.4

Quality Control Data

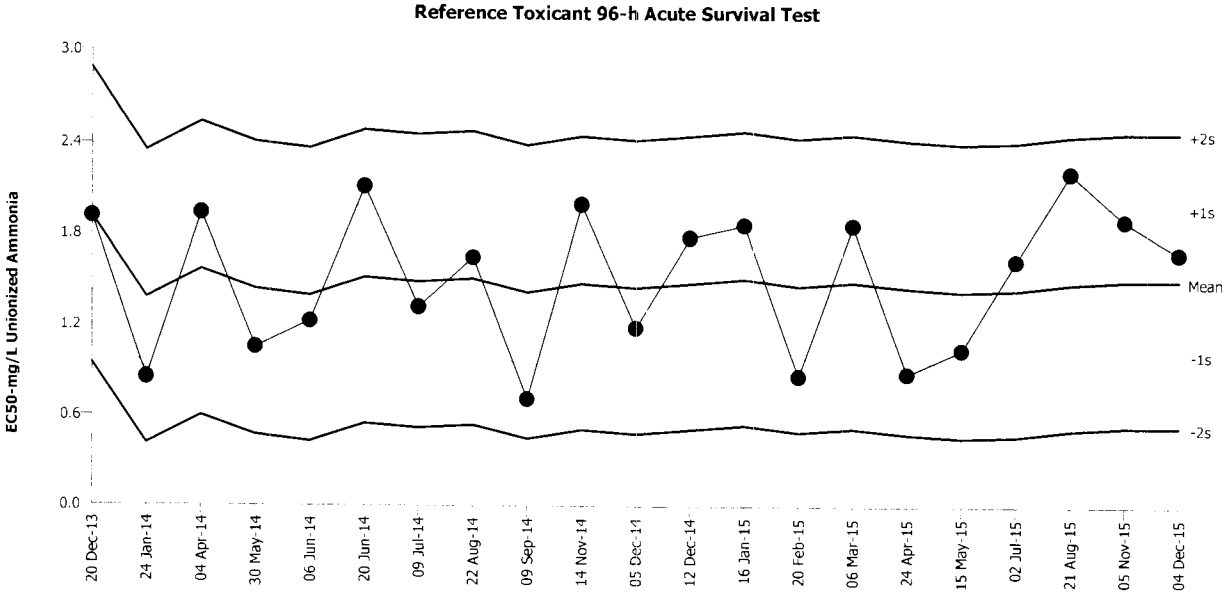
Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2013	Dec	20	14:00	58.3	-34.77	-0.8443			08-9922-1254	11-2068-6689	NewFields
2	2014	Jan	24	13:20	117	23.93	0.5811			20-9603-7883	15-6685-9407	NewFields
3		Apr	4	15:40	147	53.93	1.31	(+)		09-1443-8374	10-8829-6450	ENVIRON
4		May	30	16:25	25.7	-67.37	-1.636	(-)		18-4751-2702	12-3702-5556	ENVIRON
5		Jun	6	14:00	82.6	-10.47	-0.2542			02-4901-6395	20-5404-5146	ENVIRON
6			20	13:20	145	51.93	1.261	(+)		04-8899-1061	10-6019-5810	ENVIRON
7		Jul	9	15:30	49.5	-43.57	-1.058	(-)		00-3047-6484	08-3152-1432	ENVIRON
8		Aug	22	12:30	58.1	-34.97	-0.8492			19-3698-7324	16-9806-3196	ENVIRON
9		Sep	9	15:00	58.3	-34.77	-0.8443			04-0379-7898	19-3535-3112	ENVIRON
10		Nov	14	11:11	142	48.93	1.188	(+)		09-0815-7159	10-8173-5203	ENVIRON
11		Dec	5	11:50	81.9	-11.17	-0.2712			14-5288-4655	20-6606-9579	ENVIRON
12			12	11:45	49.7	-43.37	-1.053	(-)		04-7774-5498	10-4327-6265	ENVIRON
13	2015	Jan	16	11:15	130	36.93	0.8968			03-9642-9379	02-7191-1789	ENVIRON
14		Feb	20	14:50	61.4	-31.67	-0.7691			12-3560-9864	14-9510-1611	ENVIRON
15		Mar	6	11:50	122	28.93	0.7025			09-2159-7453	06-6960-4147	ENVIRON
16		Apr	24	12:50	54.3	-38.77	-0.9415			01-6315-9057	00-4642-5370	ENVIRON
17		May	15	14:00	65.6	-27.47	-0.6671			15-1184-2734	09-3943-6020	ENVIRON
18		Jul	2	14:15	140	46.93	1.14	(+)		18-8075-0902	00-0324-0641	ENVIRON
19		Aug	21	16:33	140	46.93	1.14	(+)		18-5704-8732	12-5806-5521	ENVIRON
20		Nov	5	16:00	133	39.93	0.9696			15-0871-2744	05-8415-3689	ENVIRON
21		Dec	4	15:55	146	52.93	1.285	(+)		15-8650-5167	03-6544-2607	ENVIRON

CETIS QC Plot

Report Date: 09 Dec-15 14:30 (1 of 1)

Reference Toxicant 96-h Acute Survival Test — **All Matching Labs**

Test Type:	Survival	**Organism:**	Neanthes arenaceodentata (Polycha	**Material:**	Unionized Ammonia
Protocol:	PSEP (1995)	**Endpoint:**	Proportion Survived	**Source:**	Reference Toxicant-REF



Mean:	1.5	**Count:**	20	**-1s Warning Limit:**	1.016	**-2s Action Limit:**	0.5312
Sigma:	0.4845	**CV:**	32.30%	**+1s Warning Limit:**	1.985	**+2s Action Limit:**	2.469

Quality Control Data

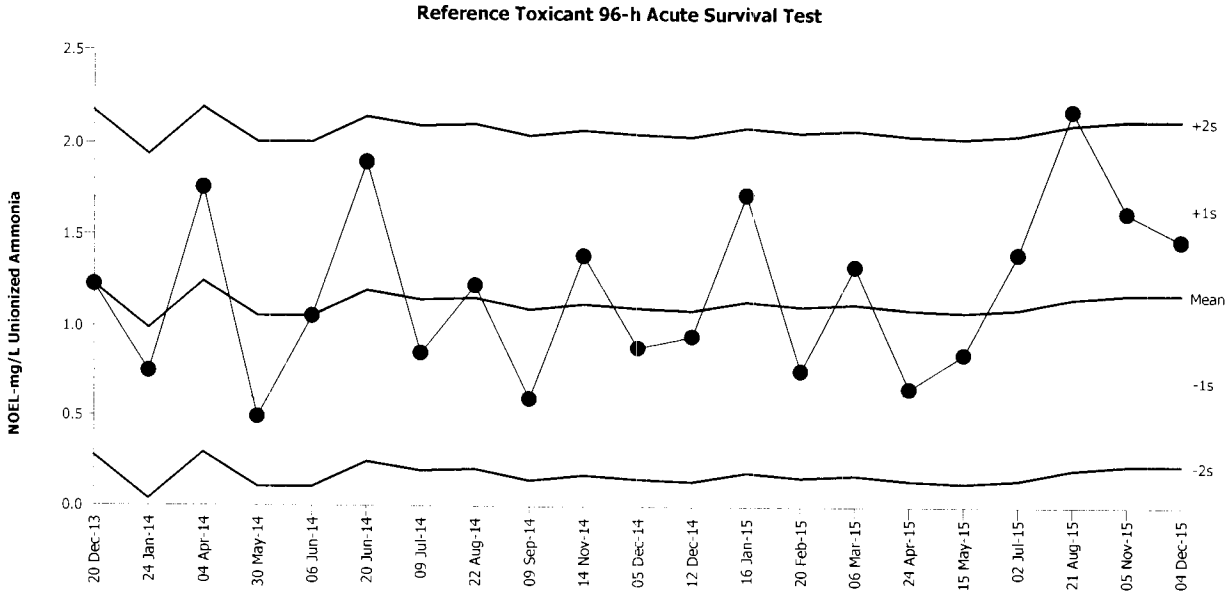
Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2013	Dec	20	14:00	1.916	0.4156	0.8578			01-5055-0133	16-3961-8899	NewFields
2	2014	Jan	24	13:20	0.8517	-0.6483	-1.338	(-)		09-1104-1497	12-8333-6553	NewFields
3		Apr	4	15:40	1.94	0.4397	0.9076			00-6512-2526	06-9520-2408	NewFields
4		May	30	16:25	1.055	-0.4452	-0.9189			04-6747-6619	11-2879-2220	ENVIRON
5		Jun	6	14:00	1.228	-0.2724	-0.5623			19-7971-8908	15-6482-0033	ENVIRON
6			20	13:20	2.113	0.6135	1.266	(+)		01-9511-3585	14-0146-3778	ENVIRON
7		Jul	9	15:30	1.322	-0.1777	-0.3668			09-1500-8488	10-4546-7656	ENVIRON
8		Aug	22	12:30	1.65	0.1498	0.3092			18-5611-8800	16-9514-3424	ENVIRON
9		Sep	9	15:00	0.7125	-0.7875	-1.625	(-)		18-5349-8839	17-4717-4294	ENVIRON
10		Nov	14	11:11	1.998	0.4984	1.029	(+)		17-3054-3443	08-9007-7058	ENVIRON
11		Dec	5	11:50	1.187	-0.3134	-0.6468			14-0275-5265	10-7706-7479	ENVIRON
12			12	11:45	1.782	0.2824	0.583			04-5967-6225	06-1786-3304	ENVIRON
13	2015	Jan	16	11:15	1.864	0.364	0.7513			18-9719-6747	15-5803-7088	ENVIRON
14		Feb	20	14:50	0.866	-0.634	-1.309	(-)		15-6687-7653	15-3894-5718	ENVIRON
15		Mar	6	11:50	1.861	0.3613	0.7457			11-3697-1780	11-9165-3524	ENVIRON
16		Apr	24	12:50	0.8832	-0.6168	-1.273	(-)		01-0867-6874	09-2102-1717	ENVIRON
17		May	15	14:00	1.043	-0.4573	-0.9439			09-1275-9559	04-5482-9783	ENVIRON
18		Jul	2	14:15	1.633	0.1325	0.2736			12-0891-3679	07-1814-7730	ENVIRON
19		Aug	21	16:33	2.206	0.7056	1.456	(+)		12-1645-6634	17-4166-4421	ENVIRON
20		Nov	5	16:00	1.894	0.3937	0.8126			13-9158-6969	12-9319-1772	ENVIRON
21		Dec	4	15:55	1.68	0.1796	0.3708			05-0232-3049	00-1680-9936	ENVIRON

CETIS QC Plot

Report Date: 09 Dec-15 14:30 (1 of 1)

Reference Toxicant 96-h Acute Survival Test — **All Matching Labs**

Test Type: Survival | **Organism:** Neanthes arenaceodentata (Polycha | **Material:** Unionized Ammonia
Protocol: PSEP (1995) | **Endpoint:** Proportion Survived | **Source:** Reference Toxicant-REF



Mean:	1.181	**Count:**	20	**-1s Warning Limit:**	0.706	**-2s Action Limit:**	0.2307
Sigma:	0.4752	**CV:**	40.20%	**+1s Warning Limit:**	1.656	**+2s Action Limit:**	2.132

Quality Control Data

Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2013	Dec	20	14:00	1.228	0.047	0.09891			01-5055-0133	05-3710-3857	NewFields
2	2014	Jan	24	13:20	0.75	-0.431	-0.907			09-1104-1497	11-9980-1624	NewFields
3		Apr	4	15:40	1.759	0.578	1.216	(+)		00-6512-2526	16-4646-7758	NewFields
4		May	30	16:25	0.494	-0.687	-1.446	(-)		04-6747-6619	20-5692-2184	ENVIRON
5		Jun	6	14:00	1.056	-0.125	-0.263			19-7971-8908	15-9945-9119	ENVIRON
6			20	13:20	1.898	0.717	1.509	(+)		01-9511-3585	21-4292-7262	ENVIRON
7		Jul	9	15:30	0.853	-0.328	-0.6902			09-1500-8488	15-2291-7760	ENVIRON
8		Aug	22	12:30	1.227	0.046	0.0968			18-5611-8800	02-5634-5468	ENVIRON
9		Sep	9	15:00	0.599	-0.582	-1.225	(-)		18-5349-8839	09-1071-5088	ENVIRON
10		Nov	14	11:11	1.391	0.21	0.4419			17-3054-3443	03-6925-5177	ENVIRON
11		Dec	5	11:50	0.885	-0.296	-0.6229			14-0275-5265	10-6284-3142	ENVIRON
12			12	11:45	0.949	-0.232	-0.4882			04-5967-6225	18-7114-9710	ENVIRON
13	2015	Jan	16	11:15	1.723	0.542	1.141	(+)		18-9719-6747	13-2446-7374	ENVIRON
14		Feb	20	14:50	0.756	-0.425	-0.8944			15-6687-7653	19-8246-2320	ENVIRON
15		Mar	6	11:50	1.333	0.152	0.3199			11-3697-1780	05-2303-0535	ENVIRON
16		Apr	24	12:50	0.659	-0.522	-1.098	(-)		01-0867-6874	18-8094-8803	ENVIRON
17		May	15	14:00	0.85	-0.331	-0.6965			09-1275-9559	12-8836-8785	ENVIRON
18		Jul	2	14:15	1.402	0.221	0.4651			12-0891-3679	17-1059-5211	ENVIRON
19		Aug	21	16:33	2.184	1.003	2.111	(+)	(+)	12-1645-6634	17-2823-4932	ENVIRON
20		Nov	5	16:00	1.627	0.446	0.9386			13-9158-6969	18-5085-3785	ENVIRON
21		Dec	4	15:55	1.473	0.292	0.6145			05-0232-3049	09-1115-6716	ENVIRON

CETIS Summary Report

Reference Toxicant 96-h Acute Survival Test **ENVIRON**

Batch ID:	08-6334-4077	**Test Type:**	Survival	**Analyst:**	
Start Date:	04 Dec-15 15:55	**Protocol:**	PSEP (1995)	**Diluent:**	Laboratory Seawater
Ending Date:	08 Dec-15 16:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	4d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	
Sample ID:	07-5789-2667	**Code:**	2D2C863B	**Client:**	Internal Lab
Sample Date:	05 May-14	**Material:**	Total Ammonia	**Project:**	Reference Toxicant
Receive Date:	05 May-14	**Source:**	Reference Toxicant		
Sample Age:	578d 16h	**Station:**	P140505.222		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
03-6544-2607	Proportion Survived	146	185	164.3	NA		Fisher Exact Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
03-4063-5051	Proportion Survived	EC50	169.2	163.9	174.7		Spearman-Kärber

Proportion Survived Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	1	1	1	1	1	0	0	0.0%	0.0%
85.5		3	1	1	1	1	1	0	0	0.0%	0.0%
146		3	1	1	1	1	1	0	0	0.0%	0.0%
185		3	0.1	0	0.3484	0	0.2	0.05774	0.1	100.0%	90.0%
262		3	0	0	0	0	0	0	0		100.0%
325		3	0	0	0	0	0	0	0		100.0%

Proportion Survived Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	1	1	1
85.5		1	1	1
146		1	1	1
185		0.2	0	0.1
262		0	0	0
325		0	0	0

Proportion Survived Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	10/10	10/10	10/10
85.5		10/10	10/10	10/10
146		10/10	10/10	10/10
185		2/10	0/10	1/10
262		0/10	0/10	0/10
325		0/10	0/10	0/10

CETIS Test Data Worksheet

Reference Toxicant 96-h Acute Survival Test — **ENVIRON**

Start Date:	04 Dec-15 15:55	**Species:**	Neanthes arenaceodentata	**Sample Code:**	2D2C863B
End Date:	08 Dec-15 16:00	**Protocol:**	PSEP (1995)	**Sample Source:**	Reference Toxicant
Sample Date:	05 May-14	**Material:**	Total Ammonia	**Sample Station:**	P140505.222

C-mg/L	Code	Rep	Pos	# Exposed	# Survived	Notes
0	D	1	12	10	10	
0	D	2	2	10	10	
0	D	3	10	10	10	
85.5		1	9	10	10	
85.5		2	6	10	10	
85.5		3	18	10	10	
146		1	7	10	10	
146		2	17	10	10	
146		3	11	10	10	
185		1	14	10	2	
185		2	4	10	0	
185		3	5	10	1	
262		1	3	10	0	
262		2	16	10	0	
262		3	13	10	0	
325		1	15	10	0	
325		2	1	10	0	
325		3	8	10	0	

CETIS Summary Report

Reference Toxicant 96-h Acute Survival Test **ENVIRON**

Batch ID:	04-3678-3581	**Test Type:**	Survival	**Analyst:**	
Start Date:	04 Dec-15 15:55	**Protocol:**	PSEP (1995)	**Diluent:**	Laboratory Seawater
Ending Date:	08 Dec-15 16:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	4d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	
Sample ID:	05-6447-2130	**Code:**	21A52942	**Client:**	Internal Lab
Sample Date:	05 May-14	**Material:**	Unionized Ammonia	**Project:**	Reference Toxicant
Receive Date:	05 May-14	**Source:**	Reference Toxicant		
Sample Age:	578d 16h	**Station:**	P140505.222		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
09-1115-6716	Proportion Survived	1.473	1.852	1.652	NA		Fisher Exact Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
00-1680-9936	Proportion Survived	EC50	1.68	1.649	1.711		Spearman-Kärber

Proportion Survived Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	1	1	1	1	1	0	0	0.0%	0.0%
1.357		3	1	1	1	1	1	0	0	0.0%	0.0%
1.473		3	1	1	1	1	1	0	0	0.0%	0.0%
1.852		3	0.1	0	0.3484	0	0.2	0.05774	0.1	100.0%	90.0%
2.061		3	0	0	0	0	0	0	0		100.0%
2.104		3	0	0	0	0	0	0	0		100.0%

Proportion Survived Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	1	1	1
1.357		1	1	1
1.473		1	1	1
1.852		0.2	0	0.1
2.061		0	0	0
2.104		0	0	0

Proportion Survived Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	10/10	10/10	10/10
1.357		10/10	10/10	10/10
1.473		10/10	10/10	10/10
1.852		2/10	0/10	1/10
2.061		0/10	0/10	0/10
2.104		0/10	0/10	0/10

CETIS Test Data Worksheet

Reference Toxicant 96-h Acute Survival Test — **ENVIRON**

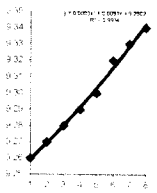
Start Date:	04 Dec-15 15:55	**Species:**	Neanthes arenaceodentata	**Sample Code:**	21A52942
End Date:	08 Dec-15 16:00	**Protocol:**	PSEP (1995)	**Sample Source:**	Reference Toxicant
Sample Date:	05 May-14	**Material:**	Unionized Ammonia	**Sample Station:**	P140505.222

C-mg/L	Code	Rep	Pos	# Exposed	# Survived	Notes
0	D	1	10	10	10	
0	D	2	8	10	10	
0	D	3	5	10	10	
1.357		1	1	10	10	
1.357		2	2	10	10	
1.357		3	4	10	10	
1.473		1	11	10	10	
1.473		2	6	10	10	
1.473		3	18	10	10	
1.852		1	13	10	2	
1.852		2	7	10	0	
1.852		3	12	10	1	
2.061		1	17	10	0	
2.061		2	9	10	0	
2.061		3	15	10	0	
2.104		1	3	10	0	
2.104		2	14	10	0	
2.104		3	16	10	0	

CLIENT:	GeoEngineers	Date of Test:	04-Dec-15
PROJECT:	RG Haley	Test Type:	Neanthes RT
COMMENTS:	P140505.222		

To convert Total Ammonia (mg/L) to Free (un-ionized) Ammonia (mg/L) enter the corresponding total ammonia, salinity, temperature, and pH.

Integer: I-factor	
1	9.26
2	9.27
3	9.28
4	9.29
5	9.30
6	9.32
7	9.33
	9.34



	Sample	Mod	*NH3T (mg/L)*	*salinity (ppt)*	*pH*	*temp (C)*	temp (K)	i-factor	Mod	**NH3U (mg/L)**
	Target / Sample Name		Actual	22.9	8.0	24.1	297.26	9.3053		**#VALUE!**
	Example 3.5		2.000	10.0	7.5	5.0	278.16	9.2750		**0.008**
1										
2										
3										
4	60		85.5	27	7.7	19.4	292.56	9.3160		**1.357**
5	100		146	28	7.5	19.5	292.66	9.3187		**1.473**
6	140		185	28	7.5	19.4	292.56	9.3187		**1.852**
7	180		262	28	7.4	19.5	292.66	9.3187		**2.104**
8	220		325	28	7.3	19.4	292.56	9.3187		**2.061**
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ENVIRON

CLIENT	PROJECT	SPECIES	LABORATORY	PROTOCOL
GeoEngineers	RG Haley	*Neanthes arenaceodentata*	Port Gamble	PSEP 1995

JOB NUMBER	PROJECT MANAGER	TEST START DATE:	TIME	TEST END DATE	TIME
0	B. Hester	04Dec15	1555	08Dec15	1600

Test ID	LOT #:
P190505. ~~210~~ 222 ①	32946535

WATER QUALITY DATA

DILTIN.WAT.BATCH	TEMP REC#	REFERENCE TOX. MATERIAL	REFERENCE TOXICANT
FSW120315.01		ammonium chloride	ammonia - TAN

TEST CONDITIONS	DO (mg/L)	TEMP(C)	SAL (ppt)	pH	TECHNICIAN
	> 4.6	20 ± 1	28 ± 2	7 - 9	

CLIENT/ ENVIRON ID		CONCENTRATION value	CONCENTRATION units	DAY	REP	D.O. meter	D.O. mg/L	TEMP. meter	TEMP. °C	SALINITY meter	SALINITY ppt	pH meter	pH unit	WQ TECH
Ref.Tox.-ammonia - TAN	Target:	0	mg/L	0	Stock	8	8.1	8	19.4	8	27	8	7.9	JL 12/04
	Actual:			4	Rep I	8	7.4	8	20.0	8	28	8	7.8	BE 12/8
Ref.Tox.-ammonia - TAN	Target:	60	mg/L	0	Stock	8	8.1	8	19.4	8	27	8	7.7	JL 12/04
	Actual:			4	Rep I	8	7.4	8	20.1	8	28	8	7.9	BE 12/8
Ref.Tox.-ammonia - TAN	Target:	100	mg/L	0	Stock	8	8.2	8	19.5	8	28	8	7.5	JL 12/04
	Actual:			4	Rep I	8	7.2	8	20.1	8	28	8	7.9	BE 12/8
Ref.Tox.-ammonia - TAN	Target:	140	mg/L	0	Stock	8	8.2	8	19.4	8	28	8	7.5	JL 12/04
	Actual:			4	Rep I	8	7.1	8	20.0	8	28	8	7.8	BE 12/8
Ref.Tox.-ammonia - TAN	Target:	180	mg/L	0	Stock	8	8.2	8	19.5	8	28	8	7.4	JL 12/04
	Actual:			4	Rep I	8	6.7	8	20.0	8	29	8	7.8	BE 12/8
Ref.Tox.-ammonia - TAN	Target:	220	mg/L	0	Stock	8	8.2	8	19.4	8	28	8	7.3	JL 12/04
	Actual:			4	Rep I	8	7.1	8	20.1	8	29	8	7.8	BE 12/8

CLIENT	PROJECT	JOB NUMBER	SPECIES		
			Neanthes arenaceodentata		
GeoEngineers	RG Haley	0	PROJECT MANAGER: B. Hester	LABORATORY: Port Gamble	PROTOCOL: PSEP 1995

SURVIVAL & BEHAVIOR DATA

OBSERVATIONS KEY
N = normal
Q = quiescent
F = Fascicled
P = Floating on surface

INITIAL # OF ORGANISMS: 10

CLIENT/ ENVIRON ID	CONC. value	CONC. units	REP	INITIAL # if differs	DAY 1 DATE: 12/05/15			DAY 2 DATE: 12/06			DAY 3 DATE: 12/7			DAY 4 DATE: 12/8/15		
					TECHNICIAN: JL			TECHNICIAN: JL			TECHNICIAN: AE			TECHNICIAN: (1) ~~BC~~ AE		
					#ALIVE	#DEAD	OBS	#ALIVE	#DEAD	OBS	#ALIVE	#DEAD	OBS	#ALIVE	#DEAD	OBS
Ref.Tox.- ammonia - TAN	0	mg/L	1		10	0	N	10	0	N	10	0	N	10	0	N
			2		10	0	"	10	0	"	10	0	"	10	0	"
			3		10	0	"	10	0	"	10	0	"	10	0	"
Ref.Tox.- ammonia - TAN	60	mg/L	1		10	0	N	10	0	N	10	0	N	10	0	N
			2		10	0	"	10	0	"	10	0	"	10	0	"
			3		10	0	"	10	0	"	10	0	"	10	0	"
Ref.Tox.- ammonia - TAN	100	mg/L	1		10	0	N	10	0	Q	10	0	Q	10	0	Q
			2		10	0	"	10	0	"	10	0	"	10	0	"
			3		10	0	"	10	0	"	10	0	"	10	0	"
Ref.Tox.- ammonia - TAN	140	mg/L	1		10	0	N	10	0	Q	10	0	Q	7	8	Q
			2		10	0	"	10	0	"	10	0	"	0	10	"
			3		10	0	"	10	0	"	10	0	"	1	9	"
Ref.Tox.- ammonia - TAN	180	mg/L	1		10	0	N	10	0	Q	10	0	Q	0	10	"
			2		10	0	"	10	0	"	6	4	"	0	6	"
			3		10	0	"	10	0	"	5	5	"	0	5	"
Ref.Tox.- ammonia - TAN	220	mg/L	1		10	0	Q	10	0	Q	4	6	Q	0	~~4~~ (2)	/
			2		10	0	"	10	0	"	0	10	"			
			3		10	0	"	10	0	"	0	10	"			

(1) TL2 AE 12/8

(2) Illegible 2 AE 12/8

ENVIRON **Ammonia Reference Toxicant**
Spiking Worksheet

Reference Toxicant ID: P140505.~~218~~(1) 222
Date Prepared: 12/04/15
Technician Initials: JL

Neanthes NH_3 RT

Assumptions in Model
Stock ammonia concentration is 10,000 mg/L = 10 mg/mL

Date: 11/18/2015
Measurement: 8443.3

Test Solutions			Volume of stock to reach desired concentration	
Measured Concentration	**Desired Concentration**	**Volume**		
mg/L	mg/L	mL	mL stock to increase	
0.00	0		[redacted]	SALT WATER (mL)
85.5	**60**	750		7.99
146	**100**	750		13.32
185	**140**	750		18.65
262	**180**	750		23.98
325	**220**	750		29.31

(1) IE. JL 12/09/15.

APPENDIX A.3.1

Mytilus galloprovincialis

Benthic Larval Bioassay

Laboratory Data Sheets

SPECIES					
Mytilus galloprovincialis					
CLIENT	PROJECT	JOB NUMBER	PROJECT MANAGER	LAB / LOCATION	PROTOCOL
GeoEngineers	RG Haley	0	B. Hester	Port Gamble /	PSEP (1995)

ORGANISM BATCH	TEST START DATE:	TIME	TEST END DATE:	TIME
	07 Dec. 15	1749	09 Dec. 15	1550

LARVAL OBSERVATION DATA

CLIENT/ ID	REP	NUMBER NORMAL	NUMBER	DATE	TECHNICIAN	COMMENTS
STOCKING DENSITY	1		265	12/17/15	MARK	
	2		281			
	3		268			
	4		297			
	5		289			
Control /	1	270	4			
	2	242	6			
	3	291	5			
	4	277	6			
	5	286	8			
CR22 /	1	206	4			
	2	256	6			
	3	266	2			
	4	264	5			
	5	202	3			
SS1-SS-03-0-12 /	1	219	3			
	2	234	5			
	3	183	3			
	4	274	1			
	5	236	2			

CLIENT	PROJECT	JOB NUMBER	SPECIES		
GeoEngineers	RG Haley	0	*Mytilus galloprovincialis*		
			PROJECT MANAGER	LAB / LOCATION	PROTOCOL
			B. Hester	Port Gamble /	PSEP (1995)

ORGANISM BATCH	TEST START DATE:	TIME	TEST END DATE:	TIME
TS 120415	07 Dec 15	1749	09 Dec 15	1550

LARVAL OBSERVATION DATA

CLIENT/ ID	REP	NUMBER NORMAL	NUMBER	DATE	TECHNICIAN	COMMENTS
SS1-SS-05-0-12 /	1	226	2	12/17/15	MARH	
	2	253	3			
	3	233	1			
	4	234	2			
	5	277	2			
SS1-SS-06-0-12 /	1	246	0			
	2	226	2			
	3	288	5			
	4	241	3			
	5	269	1			

CLIENT	PROJECT	SPECIES		LAB / LOCATION	PROTOCOL
GeoEngineers	RG Haley	*Mytilus galloprovincialis*		Port Gamble /	PSEP (1995)
JOB NUMBER	**PROJECT MANAGER**	**TEST START DATE**	**TIME**	**TEST END DATE**	**TIME**
0	B. Hester	07Dec15	1749	09Dec15	1550

* Day 3&4 observations needed only if development endpoint not met by day 2

WATER QUALITY DATA

TEST CONDITIONS				DO (mg/L) >5.0		Temp (°C) 16 ± 1		Sal (ppt) 28 ± 1		pH 7 - 9		Ammonia NA		Sulfide NA		TECH	DATE
SAMPLE ID	DAY	Random #	REP	D.O.		TEMP.		SALINITY		pH		AMMONIA		SULFIDE			
				meter	mg/L	meter	°C	meter	ppt	meter	unit	Techn.	mg/L (total)	Techn.	mg/L (Total)		
Control /	0		WQ Surr	8	7.8	8	16.6	8	28	8	7.8	JL	0.00	JL	0.00	RE	12/7/15
Control /	1		WQ Surr	8	7.7	8	16.5	8	28	8	7.7					BE	12/8/15
Control /	2		WQ Surr	9	7.3	9	16.4	9	28	9	8.0	JL	0.00	JL	0.00	JL	12/09
Control /	3		WQ Surr														
Control /	4		WQ Surr														
CR22 /	0		WQ Surr	8	7.4	8	16.8	8	28	8	7.9	JL	0.00	JL	0.134	RE	12/7/15
CR22 /	1		WQ Surr	8	6.6	8	16.7	8	28	8	7.7					BE	12/8/15
CR22 /	2		WQ Surr	9	6.0	9	16.3	9	28	9	7.8	JL	0.00	JL	0.005	JL	12/09
CR22 /	3		WQ Surr														
CR22 /	4		WQ Surr														
SS1-SS-03-0-12 /	0		WQ Surr	8	6.9	8	16.9	8	28	8	7.9	JL	0.00	JL	0.098	RE	12/7/15
SS1-SS-03-0-12 /	1		WQ Surr	8	5.6	8	16.3	8	28	8	7.9					BE	12/8/15
SS1-SS-03-0-12 /	2		WQ Surr	9	6.1	9	16.4	9	28	9	7.8	JL	0.00	JL	0.00	JL	12/09
SS1-SS-03-0-12 /	3		WQ Surr														
SS1-SS-03-0-12 /	4		WQ Surr														

CLIENT	PROJECT	SPECIES		LAB / LOCATION	PROTOCOL
GeoEngineers	RG Haley	*Mytilus galloprovincialis*		Port Gamble /	PSEP (1995)
JOB NUMBER	**PROJECT MANAGER**	**TEST START DATE**	**TIME**	**TEST END DATE**	**TIME**
0	B. Hester	07Dec15	1749	09Dec15	1550

* Day 3&4 observations needed only if development endpoint not met by day 2

WATER QUALITY DATA

TEST CONDITIONS				DO (mg/L) >5.0		Temp (°C) 16 ± 1		Sal (ppt) 28 ± 1		pH 7 - 9		Ammonia NA		Sulfide NA		TECH	DATE
SAMPLE ID	DAY	Random #	REP	D.O.		TEMP.		SALINITY		pH		AMMONIA		SULFIDE			
				meter	mg/L	meter	°C	meter	ppt	meter	unit	Techn.	mg/L (total)	Techn.	mg/L (Total)		
SS1-SS-05-0-12 /	0		WQ Surr	8	7.6	8	16.7	8	28	8	8.0	~~JL~~	0.00	~~JL~~	0.07	RE	12/7/15
SS1-SS-05-0-12 /	1		WQ Surr	8	6.3	8	16.6	8	28	8	7.9					BE	12/8/15
SS1-SS-05-0-12 /	2		WQ Surr	9	5.6	9	16.7	9	28	9	7.8	JL	0.139	JL	0.00	JL	12/09
SS1-SS-05-0-12 /	3		WQ Surr														
SS1-SS-05-0-12 /	4		WQ Surr														
SS1-SS-06-0-12 /	0		WQ Surr	8	7.5	8	16.8	8	28	8	8.0	~~JL~~	0.00	~~JL~~	0.00	RE	12/7/15
SS1-SS-06-0-12 /	1		WQ Surr	8	5.6	8	16.9	8	28	8	7.9					BE	12/8/15
SS1-SS-06-0-12 /	2		WQ Surr	9	6.2	9	16.4	9	28	9	7.8	JL	0.412	JL	0.00	JL	12/09
SS1-SS-06-0-12 /	3		WQ Surr														
SS1-SS-06-0-12 /	4		WQ Surr														

CLIENT	PROJECT	JOB NUMBER	PROJECT MANAGER	LABORATORY	PROTOCOL
GeoEngineers	RG Haley	0	B. Hester	Port Gamble	PSEP (1995)

TEST ORGANISM SPAWNING DATA

SPECIES			SAMPLE STORAGE
Mytilus galloprovincialis			4 Degrees Celsius - dark
SUPPLIER: Taylor Shellfish		ORGANISM BATCH: TS120415	SEDIMENT TREATMENT: none
DATE RECEIVED: 12.04.15	TIME RECEIVED: 1420	DATE USED: 12.7.15	TEST CHAMBERS: 1 L Mason Jars
SPAWNING METHOD: feed/ heat shock	INITIAL SPAWNING TIME: 1435	FINAL SPAWNING TIME: 1500	EXPOSURE VOLUME: 900mL seawater / 18g Sediment
MALES: 3 / FEMALES: 3	SPERM VIABILITY: ✓	EGG CONDITION: Good	TIME OF SHAKE: 1212
BEGIN FERTILIZATION: 1500	END FERTILIZATION: 1749	CONDITION OF EMBRYOS: >90% dev	TIME OF INITIATION: 1749

SPECIAL CONDITIONS

UV LIGHT EXPOSURE (YES/NO)	AERATION FROM TEST INITIATION (YES/NO)
Yes	NO
SCREEN TUBE TEST (YES/NO)	**OTHER (EXPLAIN)**
NO	

EMBRYO DENSITY CALCULATIONS

$27 \times 100 = 2700$

$\frac{28000}{7500} = 3.7$ deliver

KT

$\frac{2700}{7500} = 0.36$

100mL · 0.36 = 36mL egg stock

64mL seawater

deliver 0.100mL

RAMBOLL ENVIRON

ORGANISM RECEIPT LOG

Date:	Time:	Batch No.
12/04/15	1420	TS120415

Organism / Project: Mytilus / RG Haley

Source / Supplier: Taylor Shellfish

No. Ordered:	No. Received:	Source Batch: Collection date, hatch date, etc.):
12.15 16	12.15 16	

Condition of Organisms:	Approximate Size or Age: (Days from hatch, life stage, size class, etc.):
Good	Adult
Shipper: Courier	**B of L (Tracking No.)** NA
Condition of Container: Good	**Received By:** JL

Container	D.O. (mg/L)	Temp. (°C)	Cond. or Sal. (Include Units)	pH (Units)	# Dead	% Dead*	Tech. (Initials)
*							JL

*if >10% contact lab manager

Notes: * Received Dry.

INVOICE DUE

Taylor Shellfish Farms

130 SE Lynch Rd
Shelton WA 98584
WA Cert.# 0046 SP

BRIAN HESTER	SHIP DATE 12/4/15	Name of Carrier: PICK UP AT RETAIL

	Description of product being shipped	
	12.15 LB UNPROCESSED MUSSELS	60.14
	STYRO	5.75
		0
	Thank You	
Total		Total
	Balance Due	65.89

our to less than 45° F prior to shipping.

Time:_____ Date:_____ Temp_____

APPENDIX A.3.2

Mytilus galloprovincialis

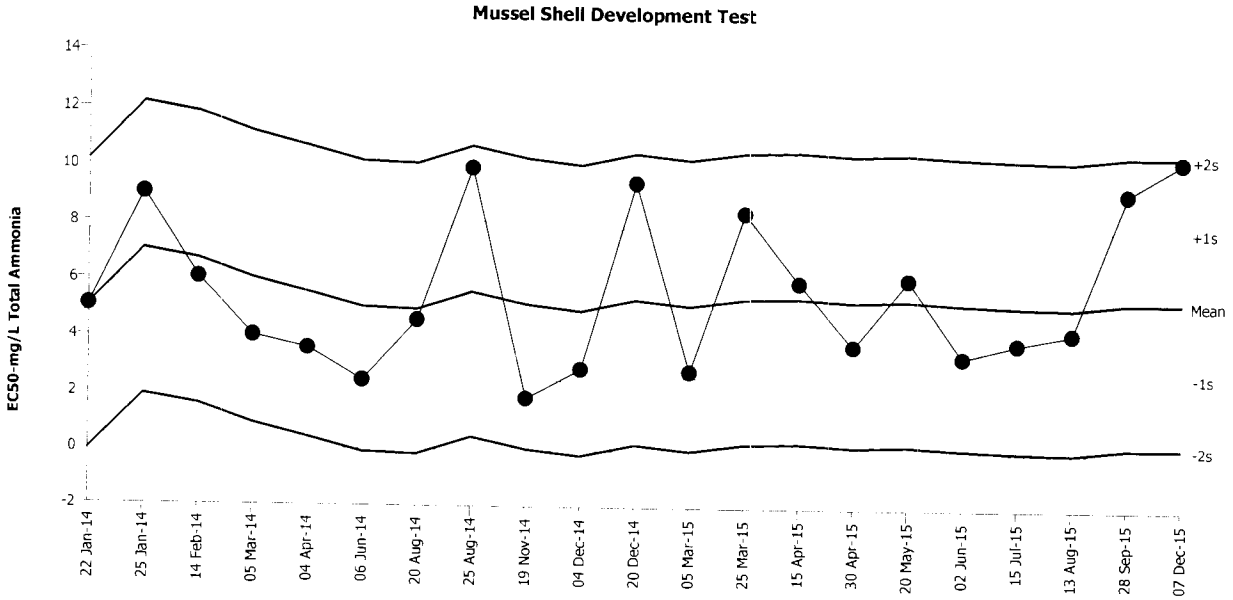
Benthic Larval Bioassay

Reference Toxicant Test

CETIS QC Plot

Mussel Shell Development Test — **All Matching Labs**

Test Type:	Development-Survival	**Organism:**	Mytilus galloprovincialis (Bay Mussel	**Material:**	Total Ammonia
Protocol:	EPA/600/R-95/136 (1995)	**Endpoint:**	Combined Proportion Normal	**Source:**	Reference Toxicant-REF



Mean:	5.348	**Count:**	20	**-1s Warning Limit:**	2.783	**-2s Action Limit:**	0.2176
Sigma:	2.565	**CV:**	48.00%	**+1s Warning Limit:**	7.913	**+2s Action Limit:**	10.48

Quality Control Data

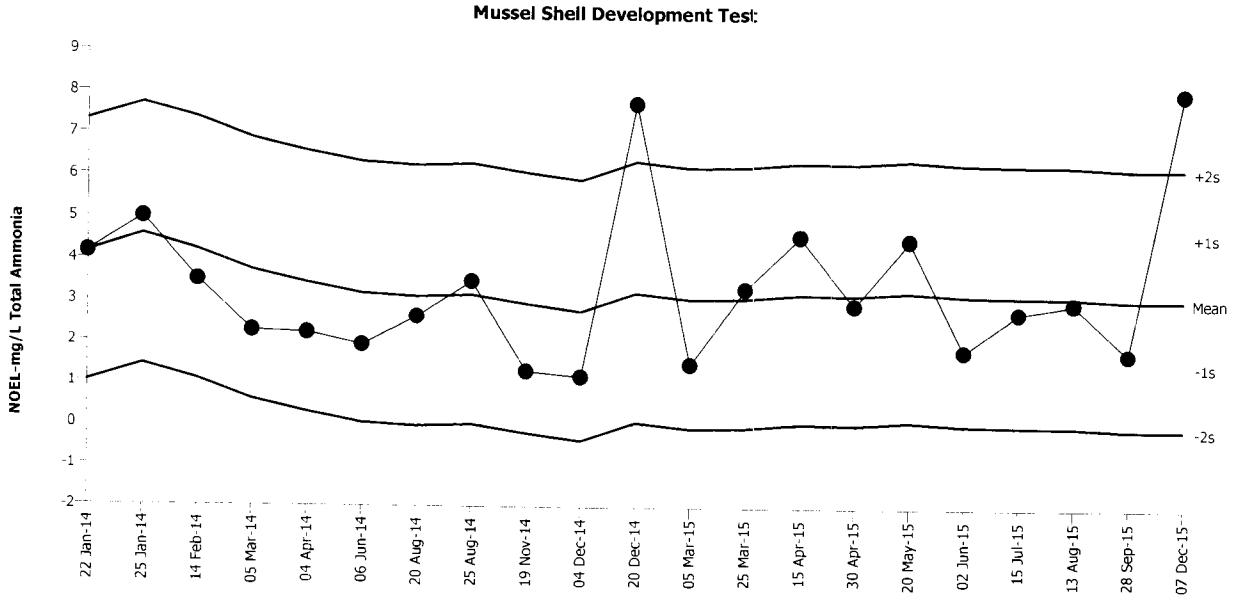
Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2014	Jan	22	18:47	5.072	-0.2759	-0.1076			13-2808-9359	13-2338-2483	NewFields
2			25	20:20	9.018	3.67	1.431	(+)		14-2680-8854	01-2301-1257	NewFields
3		Feb	14	15:45	6.063	0.715	0.2788			00-9581-0604	10-3047-2486	NewFields
4		Mar	5	19:35	4.03	-1.318	-0.5138			00-1473-4954	06-0848-4308	NewFields
5		Apr	4	19:30	3.594	-1.754	-0.6838			00-0374-9463	01-3815-4471	Port Gamble Environment
6		Jun	6	18:15	2.465	-2.883	-1.124	(-)		06-9491-1560	12-3152-8677	ENVIRON
7		Aug	20	18:55	4.595	-0.7527	-0.2934			03-3666-4351	12-9663-9075	ENVIRON
8			25	19:45	9.954	4.606	1.796	(+)		18-5120-4553	05-8275-9550	ENVIRON
9		Nov	19	17:40	1.863	-3.485	-1.359	(-)		16-6497-0143	19-4546-4847	ENVIRON
10		Dec	4	17:10	2.911	-2.437	-0.95			16-3776-3251	02-2399-5582	ENVIRON
11			20	14:48	9.463	4.115	1.604	(+)		18-9022-1075	07-2923-3003	ENVIRON
12	2015	Mar	5	17:00	2.844	-2.504	-0.9762			19-9854-1539	03-8736-8673	ENVIRON
13			25	17:44	8.428	3.08	1.201	(+)		14-7108-3803	03-4995-0478	ENVIRON
14		Apr	15	19:10	5.993	0.6452	0.2515			13-8932-4228	19-6133-3160	ENVIRON
15			30	18:04	3.781	-1.567	-0.611			20-6119-4159	02-4196-3961	ENVIRON
16		May	20	17:25	6.135	0.7868	0.3067			09-2578-9028	09-4770-1274	ENVIRON
17		Jun	2	17:40	3.4	-1.948	-0.7595			17-1514-2545	13-6694-9114	ENVIRON
18		Jul	15	17:28	3.896	-1.452	-0.5659			03-2854-6295	19-5139-2675	ENVIRON
19		Aug	13	17:12	4.263	-1.085	-0.423			11-0008-2350	17-0708-6345	ENVIRON
20		Sep	28	19:46	9.184	3.836	1.495	(+)		13-4113-2133	05-9076-7384	ENVIRON
21		Dec	7	18:00	10.31	4.964	1.935	(+)		08-2168-6467	19-8560-0099	ENVIRON

CETIS QC Plot

Report Date: 20 Dec-15 18:19 (1 of 1)

Mussel Shell Development Test — **All Matching Labs**

Test Type: Development-Survival | **Organism:** Mytilus galloprovincialis (Bay Mussel | **Material:** Total Ammonia
Protocol: EPA/600/R-95/136 (1995) | **Endpoint:** Combined Proportion Normal | **Source:** Reference Toxicant-REF



Mean:	3.079	**Count:**	20	**-1s Warning Limit:**	1.507	**-2s Action Limit:**	-0.0645
Sigma:	1.572	**CV:**	51.10%	**+1s Warning Limit:**	4.651	**+2s Action Limit:**	6.223

Quality Control Data

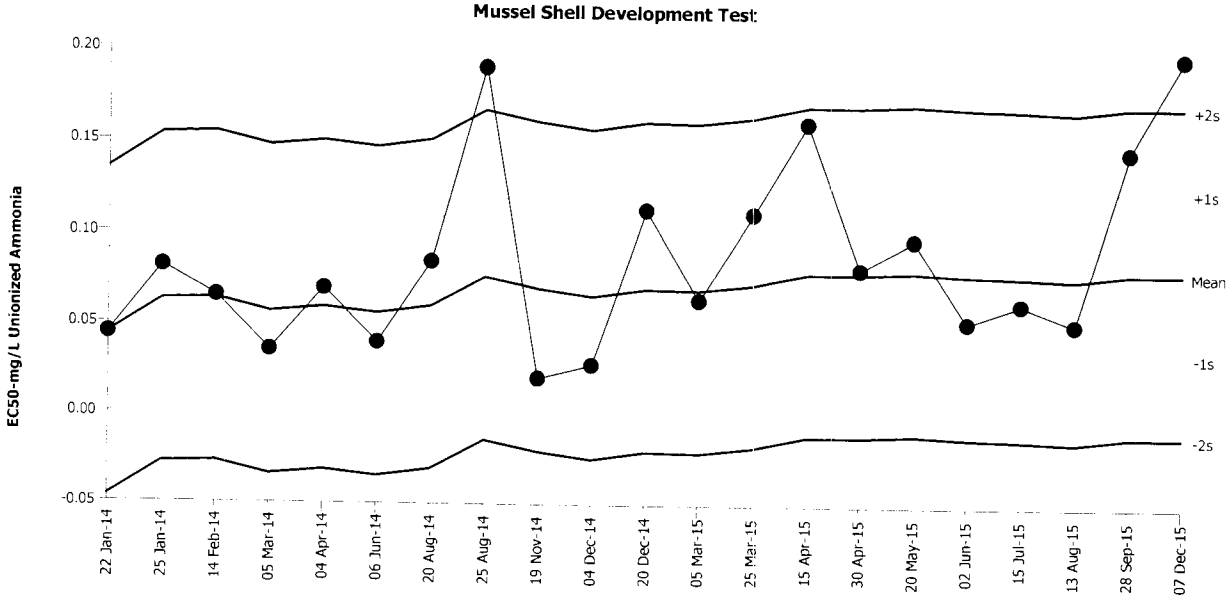
Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2014	Jan	22	18:47	4.16	1.081	0.6877			13-2808-9359	09-9457-8825	NewFields
2			25	20:20	4.99	1.911	1.216	(+)		14-2680-8854	19-4144-0794	NewFields
3		Feb	14	15:45	3.5	0.421	0.2678			00-9581-0604	14-2175-7836	NewFields
4		Mar	5	19:35	2.27	-0.809	-0.5146			00-1473-4954	06-9188-5839	NewFields
5		Apr	4	19:30	2.22	-0.859	-0.5464			00-0374-9463	13-5593-8276	Port Gamble Environment
6		Jun	6	18:15	1.93	-1.149	-0.7309			06-9491-1560	15-1591-7876	ENVIRON
7		Aug	20	18:55	2.62	-0.459	-0.292			03-3666-4351	02-5771-3266	ENVIRON
8			25	19:45	3.48	0.401	0.2551			18-5120-4553	02-0328-1110	ENVIRON
9		Nov	19	17:40	1.3	-1.779	-1.132	(-)		16-6497-0143	01-0463-0999	ENVIRON
10		Dec	4	17:10	1.17	-1.909	-1.214	(-)		16-3776-3251	12-6094-6851	ENVIRON
11			20	14:48	7.74	4.661	2.965	(+)	(+)	18-9022-1075	16-5805-5458	ENVIRON
12	2015	Mar	5	17:00	1.48	-1.599	-1.017	(-)		19-9854-1539	01-8753-6379	ENVIRON
13			25	17:44	3.32	0.241	0.1533			14-7108-3803	13-7995-1182	ENVIRON
14		Apr	15	19:10	4.59	1.511	0.9612			13-8932-4228	17-9791-4217	ENVIRON
15			30	18:04	2.94	-0.139	-0.08842			20-6119-4159	17-0732-0588	ENVIRON
16		May	20	17:25	4.51	1.431	0.9103			09-2578-9028	13-7558-2393	ENVIRON
17		Jun	2	17:40	1.83	-1.249	-0.7945			17-1514-2545	16-3284-8954	ENVIRON
18		Jul	15	17:28	2.77	-0.309	-0.1966			03-2854-6295	02-6331-6633	ENVIRON
19		Aug	13	17:12	3	-0.079	-0.05025			11-0008-2350	11-0317-1423	ENVIRON
20		Sep	28	19:46	1.77	-1.309	-0.8327			13-4113-2133	01-4448-6063	ENVIRON
21		Dec	7	18:00	8.03	4.951	3.149	(+)	(+)	08-2168-6467	11-6893-5917	ENVIRON

CETIS QC Plot

Report Date: 20 Dec-15 18:23 (1 of 1)

Mussel Shell Development Test — **All Matching Labs**

Test Type: Development-Survival | **Organism:** Mytilus galloprovincialis (Bay Mussel | **Material:** Unionized Ammonia
Protocol: EPA/600/R-95/136 (1995) | **Endpoint:** Combined Proportion Normal | **Source:** Reference Toxicant-REF



Mean:	0.08023	**Count:**	20	**-1s Warning Limit:**	0.03485	**-2s Action Limit:**	-0.0105
Sigma:	0.04538	**CV:**	56.60%	**+1s Warning Limit:**	0.1256	**+2s Action Limit:**	0.171

Quality Control Data

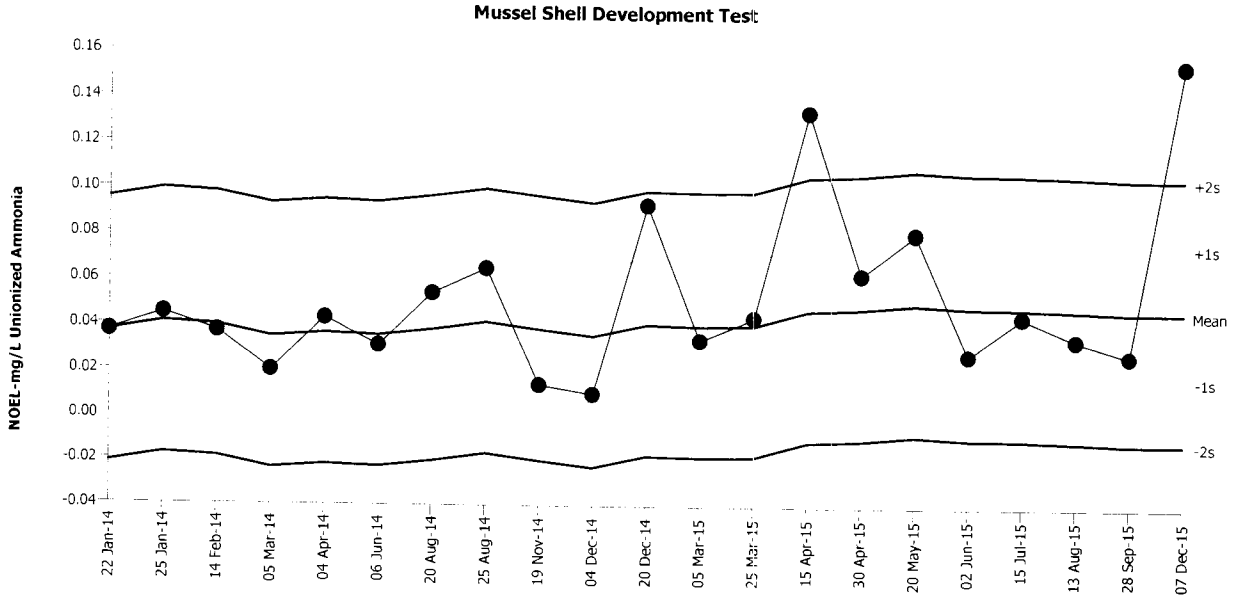
Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2014	Jan	22	18:47	0.04434	-0.03589	-0.7909			15-7285-0453	02-5494-3481	NewFields
2			25	20:20	0.08179	0.001555	0.03427			04-0859-3739	09-7301-2928	NewFields
3		Feb	14	15:45	0.0653	-0.01493	-0.329			15-0233-5150	16-5673-1462	NewFields
4		Mar	5	19:35	0.03552	-0.04471	-0.9851			02-2074-6026	13-5083-6151	NewFields
5		Apr	4	19:30	0.06967	-0.01056	-0.2326			08-9987-7352	06-2075-5011	Port Gamble Environment
6		Jun	6	18:15	0.03982	-0.04041	-0.8904			20-1079-3686	12-0135-9289	ENVIRON
7		Aug	20	18:55	0.08475	0.004517	0.09953			14-9751-1227	04-1532-7472	ENVIRON
8			25	19:45	0.1905	0.1103	2.43	(+)	(+)	00-8792-7550	08-9753-5531	ENVIRON
9		Nov	19	17:40	0.0203	-0.05993	-1.321	(-)		06-3984-9090	13-7269-9515	ENVIRON
10		Dec	4	17:10	0.02788	-0.05235	-1.154	(-)		12-3986-2462	11-3972-7037	ENVIRON
11			20	14:48	0.1135	0.03323	0.7323			09-9287-5419	07-6460-4486	ENVIRON
12	2015	Mar	5	17:00	0.06436	-0.01587	-0.3496			13-3685-7547	03-1524-4615	ENVIRON
13			25	17:44	0.1116	0.03133	0.6904			08-9075-8262	10-9676-7365	ENVIRON
14		Apr	15	19:10	0.1609	0.08065	1.777	(+)		16-8535-8797	10-1479-4973	ENVIRON
15			30	18:04	0.08192	0.001686	0.03715			03-9240-3383	09-4512-5047	ENVIRON
16		May	20	17:25	0.09802	0.01779	0.3919			02-2718-1762	05-2499-4463	ENVIRON
17		Jun	2	17:40	0.05293	-0.0273	-0.6015			05-0395-8879	02-8689-2030	ENVIRON
18		Jul	15	17:28	0.06313	-0.0171	-0.3768			00-2296-0969	17-0196-9853	ENVIRON
19		Aug	13	17:12	0.05202	-0.02821	-0.6217			20-0843-4308	07-3272-8799	ENVIRON
20		Sep	28	19:46	0.1464	0.06613	1.457	(+)		14-0799-9245	10-1527-0979	ENVIRON
21		Dec	7	18:00	0.1977	0.1175	2.59	(+)	(+)	14-1153-0185	08-9940-5879	ENVIRON

CETIS QC Plot

Report Date: 20 Dec-15 18:23 (1 of 1)

Mussel Shell Development Test — **All Matching Labs**

Test Type: Development-Survival | **Organism:** Mytilus galloprovincialis (Bay Mussel | **Material:** Unionized Ammonia
Protocol: EPA/600/R-95/136 (1995) | **Endpoint:** Combined Proportion Normal | **Source:** Reference Toxicant-REF



Mean:	0.04705	**Count:**	20	**-1s Warning Limit:**	0.01787	**-2s Action Limit:**	-0.0113
Sigma:	0.02918	**CV:**	62.00%	**+1s Warning Limit:**	0.07623	**+2s Action Limit:**	0.1054

Quality Control Data

Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID	Laboratory
1	2014	Jan	22	18:47	0.037	-0.01005	-0.3444			15-7285-0453	12-0010-0113	NewFields
2			25	20:20	0.045	-0.00205	-0.07025			04-0859-3739	20-3446-9116	NewFields
3		Feb	14	15:45	0.037	-0.01005	-0.3444			15-0233-5150	19-2470-0896	NewFields
4		Mar	5	19:35	0.02	-0.02705	-0.927			02-2074-6026	10-8335-1484	NewFields
5		Apr	4	19:30	0.043	-0.00405	-0.1388			08-9987-7352	01-2582-7818	Port Gamble Environment
6		Jun	6	18:15	0.031	-0.01605	-0.55			20-1079-3686	02-2339-8824	ENVIRON
7		Aug	20	18:55	0.054	0.00695	0.2382			14-9751-1227	13-4768-2245	ENVIRON
8			25	19:45	0.065	0.01795	0.6151			00-8792-7550	14-4895-9621	ENVIRON
9		Nov	19	17:40	0.014	-0.03305	-1.133	(-)		06-3984-9090	04-2355-4660	ENVIRON
10		Dec	4	17:10	0.01	-0.03705	-1.27	(-)		12-3986-2462	15-5042-0469	ENVIRON
11			20	14:48	0.093	0.04595	1.575	(+)		09-9287-5419	18-5647-4199	ENVIRON
12	2015	Mar	5	17:00	0.034	-0.01305	-0.4472			13-3685-7547	15-2807-2719	ENVIRON
13			25	17:44	0.044	-0.00305	-0.1045			08-9075-8262	05-7869-3859	ENVIRON
14		Apr	15	19:10	0.134	0.08695	2.98	(+)	(+)	16-8535-8797	14-3122-1198	ENVIRON
15			30	18:04	0.063	0.01595	0.5466			03-9240-3383	00-2807-5882	ENVIRON
16		May	20	17:25	0.081	0.03395	1.163	(+)		02-2718-1762	04-5934-5151	ENVIRON
17		Jun	2	17:40	0.028	-0.01905	-0.6528			05-0395-8879	14-7577-7111	ENVIRON
18		Jul	15	17:28	0.045	-0.00205	-0.07025			00-2296-0969	19-0657-0188	ENVIRON
19		Aug	13	17:12	0.035	-0.01205	-0.413			20-0843-4308	02-2615-4019	ENVIRON
20		Sep	28	19:46	0.028	-0.01905	-0.6528			14-0799-9245	09-3291-9362	ENVIRON
21		Dec	7	18:00	0.155	0.108	3.699	(+)	(+)	14-1153-0185	11-3892-1501	ENVIRON

CETIS Summary Report

Mussel Shell Development Test **ENVIRON**

Batch ID:	02-9949-9063	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	07 Dec-15 18:00	**Protocol:**	EPA/600/R-95/136 (1995)	**Diluent:**	Laboratory Seawater
Ending Date:	09 Dec-15 16:00	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	46h	**Source:**	Taylor Shellfish	**Age:**	
Sample ID:	21-4174-5971	**Code:**	7FA87333	**Client:**	Internal Lab
Sample Date:	05 May-14	**Material:**	Total Ammonia	**Project:**	Reference Toxicant
Receive Date:	05 May-14	**Source:**	Reference Toxicant		
Sample Age:	581d 18h	**Station:**	p140505.220		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
11-6893-5917	Combined Proportion Norm	8.03	14.1	10.64	NA		Fisher Exact Test
18-8425-2751	Proportion Normal	2.38	8.03	4.372	NA		Fisher Exact Test
20-9567-7795	Proportion Survived	21	>21	NA	NA		Fisher Exact Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
19-8560-0099	Combined Proportion Norm	EC50	10.31	10.19	10.43		Spearman-Kärber
01-4207-7317	Proportion Normal	EC50	10.45	10.36	10.54		Spearman-Kärber
13-9333-1985	Proportion Survived	EC5	>21	N/A	N/A		Linear Interpolation (ICPIN)
		EC10	>21	N/A	N/A		
		EC15	>21	N/A	N/A		
		EC20	>21	N/A	N/A		
		EC25	>21	N/A	N/A		
		EC40	>21	N/A	N/A		
		EC50	>21	N/A	N/A		

Test Acceptability

Analysis ID	Endpoint	Attribute	Test Stat	TAC Limits	Overlap	Decision
01-4207-7317	Proportion Normal	Control Resp	0.9826	0.9 - NL	Yes	Passes Acceptability Criteria
18-8425-2751	Proportion Normal	Control Resp	0.9826	0.9 - NL	Yes	Passes Acceptability Criteria
13-9333-1985	Proportion Survived	Control Resp	1	0.5 - NL	Yes	Passes Acceptability Criteria
20-9567-7795	Proportion Survived	Control Resp	1	0.5 - NL	Yes	Passes Acceptability Criteria

Mussel Shell Development Test **ENVIRON**

Combined Proportion Normal Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	1	1	1	1	1	0	0	0.0%	0.0%
0.583		3	1	1	1	1	1	0	0	0.0%	0.0%
1.53		3	0.9587	0.7809	1	0.8761	1	0.04131	0.07155	7.46%	4.13%
2.38		3	1	1	1	1	1	0	0	0.0%	0.0%
8.03		3	1	1	1	1	1	0	0	0.0%	0.0%
14.1		3	0	0	0	0	0	0	0		100.0%
21		3	0	0	0	0	0	0	0		100.0%

Proportion Normal Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	0.9826	0.9603	1	0.9746	0.9924	0.005199	0.009005	0.92%	0.0%
0.583		3	0.9766	0.9547	0.9984	0.9686	0.986	0.005074	0.008788	0.9%	0.62%
1.53		3	0.9759	0.9431	1	0.9624	0.9888	0.007615	0.01319	1.35%	0.69%
2.38		3	0.9945	0.9881	1	0.9916	0.9962	0.001494	0.002588	0.26%	-1.21%
8.03		3	0.9631	0.9426	0.9835	0.9539	0.9698	0.004752	0.008231	0.85%	1.99%
14.1		3	0	0	0	0	0	0	0		100.0%
21		3	0	0	0	0	0	0	0		100.0%

Proportion Survived Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	1	1	1	1	1	0	0	0.0%	0.0%
0.583		3	1	1	1	1	1	0	0	0.0%	0.0%
1.53		3	0.9701	0.8414	1	0.9103	1	0.02991	0.05181	5.34%	2.99%
2.38		3	1	1	1	1	1	0	0	0.0%	0.0%
8.03		3	1	1	1	1	1	0	0	0.0%	0.0%
14.1		3	1	1	1	1	1	0	0	0.0%	0.0%
21		3	1	1	1	1	1	0	0	0.0%	0.0%

Mussel Shell Development Test — **ENVIRON**

Combined Proportion Normal Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	1	1	1
0.583		1	1	1
1.53		1	1	0.8761
2.38		1	1	1
8.03		1	1	1
14.1		0	0	0
21		0	0	0

Proportion Normal Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	0.9746	0.9924	0.9809
0.583		0.9751	0.9686	0.986
1.53		0.9888	0.9764	0.9624
2.38		0.9958	0.9916	0.9962
8.03		0.9655	0.9698	0.9539
14.1		0	0	0
21		0	0	0

Proportion Survived Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	1	1	1
0.583		1	1	1
1.53		1	1	0.9103
2.38		1	1	1
8.03		1	1	1
14.1		1	1	1
21		1	1	1

Mussel Shell Development Test **ENVIRON**

Combined Proportion Normal Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	269/269	261/261	257/257
0.583		274/274	247/247	282/282
1.53		265/265	248/248	205/234
2.38		238/238	235/235	265/265
8.03		252/252	257/257	269/269
14.1		0/234	0/234	0/234
21		0/234	0/234	0/234

Proportion Normal Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	269/276	261/263	257/262
0.583		274/281	247/255	282/286
1.53		265/268	248/254	205/213
2.38		238/239	235/237	265/266
8.03		252/261	257/265	269/282
14.1		0/264	0/266	0/269
21		0/288	0/240	0/276

Proportion Survived Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	234/234	234/234	234/234
0.583		234/234	234/234	234/234
1.53		234/234	234/234	213/234
2.38		234/234	234/234	234/234
8.03		234/234	234/234	234/234
14.1		234/234	234/234	234/234
21		234/234	234/234	234/234

CETIS Test Data Worksheet

Mussel Shell Development Test — **ENVIRON**

Start Date:	07 Dec-15 18:00	**Species:**	Mytilus galloprovincialis	**Sample Code:**	7FA87333
End Date:	09 Dec-15 16:00	**Protocol:**	EPA/600/R-95/136 (1995)	**Sample Source:**	Reference Toxicant
Sample Date:	05 May-14	**Material:**	Total Ammonia	**Sample Station:**	p140505.220

C-mg/L	Code	Rep	Pos	Initial Density	Final Density	# Counted	# Normal	Notes
0	D	1	1	234	276	276	269	
0	D	2	2	234	263	263	261	
0	D	3	3	234	262	262	257	
0.583		1	4	234	281	281	274	
0.583		2	5	234	255	255	247	
0.583		3	6	234	286	286	282	
1.53		1	7	234	268	268	265	
1.53		2	8	234	254	254	248	
1.53		3	9	234	213	213	205	
2.38		1	10	234	239	239	238	
2.38		2	11	234	237	237	235	
2.38		3	12	234	266	266	265	
8.03		1	13	234	261	261	252	
8.03		2	14	234	265	265	257	
8.03		3	15	234	282	282	269	
14.1		1	16	234	264	264	0	
14.1		2	17	234	266	266	0	
14.1		3	18	234	269	269	0	
21		1	19	234	288	288	0	
21		2	20	234	240	240	0	
21		3	21	234	276	276	0	

CETIS Summary Report

Mussel Shell Development Test **ENVIRON**

Batch ID:	01-8925-9245	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	07 Dec-15 18:00	**Protocol:**	EPA/600/R-95/136 (1995)	**Diluent:**	Laboratory Seawater
Ending Date:	09 Dec-15 16:00	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	46h	**Source:**	Taylor Shellfish	**Age:**	
Sample ID:	17-5692-0473	**Code:**	68B87A99	**Client:**	Internal Lab
Sample Date:	05 May-14	**Material:**	Unionized Ammonia	**Project:**	Reference Toxicant
Receive Date:	05 May-14	**Source:**	Reference Toxicant		
Sample Age:	581d 18h	**Station:**	p140505.220		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
11-3892-1501	Combined Proportion Norm	0.155	0.267	0.2034	NA		Fisher Exact Test
07-7760-7002	Proportion Normal	0.058	0.155	0.09482	NA		Fisher Exact Test
10-4690-5686	Proportion Survived	0.397	>0.397	NA	NA		Fisher Exact Test

Point Estimate Summary

Analysis ID	Endpoint	Level	mg/L	95% LCL	95% UCL	TU	Method
08-9940-5879	Combined Proportion Norm	EC50	0.1977	0.1957	0.1998		Spearman-Kärber
11-4665-5338	Proportion Normal	EC50	0.2003	0.1988	0.2018		Spearman-Kärber
15-9190-5272	Proportion Survived	EC5	>0.397	N/A	N/A		Linear Interpolation (ICPIN)
		EC10	>0.397	N/A	N/A		
		EC15	>0.397	N/A	N/A		
		EC20	>0.397	N/A	N/A		
		EC25	>0.397	N/A	N/A		
		EC40	>0.397	N/A	N/A		
		EC50	>0.397	N/A	N/A		

Test Acceptability

Analysis ID	Endpoint	Attribute	Test Stat	TAC Limits	Overlap	Decision
07-7760-7002	Proportion Normal	Control Resp	0.9826	0.9 - NL	Yes	Passes Acceptability Criteria
11-4665-5338	Proportion Normal	Control Resp	0.9826	0.9 - NL	Yes	Passes Acceptability Criteria
10-4690-5686	Proportion Survived	Control Resp	1	0.5 - NL	Yes	Passes Acceptability Criteria
15-9190-5272	Proportion Survived	Control Resp	1	0.5 - NL	Yes	Passes Acceptability Criteria

Mussel Shell Development Test
ENVIRON

Combined Proportion Normal Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	1	1	1	1	1	0	0	0.0%	0.0%
0.014		3	1	1	1	1	1	0	0	0.0%	0.0%
0.037		3	0.9587	0.7809	1	0.8761	1	0.04131	0.07155	7.46%	4.13%
0.058		3	1	1	1	1	1	0	0	0.0%	0.0%
0.155		3	1	1	1	1	1	0	0	0.0%	0.0%
0.267		3	0	0	0	0	0	0	0		100.0%
0.397		3	0	0	0	0	0	0	0		100.0%

Proportion Normal Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	0.9826	0.9603	1	0.9746	0.9924	0.005199	0.009005	0.92%	0.0%
0.014		3	0.9766	0.9547	0.9984	0.9686	0.986	0.005074	0.008788	0.9%	0.62%
0.037		3	0.9759	0.9431	1	0.9624	0.9888	0.007615	0.01319	1.35%	0.69%
0.058		3	0.9945	0.9881	1	0.9916	0.9962	0.001494	0.002588	0.26%	-1.21%
0.155		3	0.9631	0.9426	0.9835	0.9539	0.9698	0.004752	0.008231	0.85%	1.99%
0.267		3	0	0	0	0	0	0	0		100.0%
0.397		3	0	0	0	0	0	0	0		100.0%

Proportion Survived Summary

C-mg/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Dilution Water	3	1	1	1	1	1	0	0	0.0%	0.0%
0.014		3	1	1	1	1	1	0	0	0.0%	0.0%
0.037		3	0.9701	0.8414	1	0.9103	1	0.02991	0.05181	5.34%	2.99%
0.058		3	1	1	1	1	1	0	0	0.0%	0.0%
0.155		3	1	1	1	1	1	0	0	0.0%	0.0%
0.267		3	1	1	1	1	1	0	0	0.0%	0.0%
0.397		3	1	1	1	1	1	0	0	0.0%	0.0%

Mussel Shell Development Test
ENVIRON

Combined Proportion Normal Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	1	1	1
0.014		1	1	1
0.037		1	1	0.8761
0.058		1	1	1
0.155		1	1	1
0.267		0	0	0
0.397		0	0	0

Proportion Normal Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	0.9746	0.9924	0.9809
0.014		0.9751	0.9686	0.986
0.037		0.9888	0.9764	0.9624
0.058		0.9958	0.9916	0.9962
0.155		0.9655	0.9698	0.9539
0.267		0	0	0
0.397		0	0	0

Proportion Survived Detail

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	1	1	1
0.014		1	1	1
0.037		1	1	0.9103
0.058		1	1	1
0.155		1	1	1
0.267		1	1	1
0.397		1	1	1

Mussel Shell Development Test **ENVIRON**

Combined Proportion Normal Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	269/269	261/261	257/257
0.014		274/274	247/247	282/282
0.037		265/265	248/248	205/234
0.058		238/238	235/235	265/265
0.155		252/252	257/257	269/269
0.267		0/234	0/234	0/234
0.397		0/234	0/234	0/234

Proportion Normal Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	269/276	261/263	257/262
0.014		274/281	247/255	282/286
0.037		265/268	248/254	205/213
0.058		238/239	235/237	265/266
0.155		252/261	257/265	269/282
0.267		0/264	0/266	0/269
0.397		0/288	0/240	0/276

Proportion Survived Binomials

C-mg/L	Control Type	Rep 1	Rep 2	Rep 3
0	Dilution Water	234/234	234/234	234/234
0.014		234/234	234/234	234/234
0.037		234/234	234/234	213/234
0.058		234/234	234/234	234/234
0.155		234/234	234/234	234/234
0.267		234/234	234/234	234/234
0.397		234/234	234/234	234/234

CETIS Test Data Worksheet

Mussel Shell Development Test — **ENVIRON**

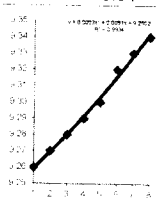
Start Date:	07 Dec-15 18:00	**Species:**	Mytilus galloprovincialis
End Date:	09 Dec-15 16:00	**Protocol:**	EPA/600/R-95/136 (1995)
Sample Date:	05 May-14	**Material:**	Unionized Ammonia
Sample Code:	68B87A99		
Sample Source:	Reference Toxicant		
Sample Station:	p140505.220		

C-mg/L	Code	Rep	Pos	Initial Density	Final Density	# Counted	# Normal	Notes
0	D	1	1	234	276	276	269	
0	D	2	2	234	263	263	261	
0	D	3	3	234	262	262	257	
0.014		1	4	234	281	281	274	
0.014		2	5	234	255	255	247	
0.014		3	6	234	286	286	282	
0.037		1	7	234	268	268	265	
0.037		2	8	234	254	254	248	
0.037		3	9	234	213	213	205	
0.058		1	10	234	239	239	238	
0.058		2	11	234	237	237	235	
0.058		3	12	234	266	266	265	
0.155		1	13	234	261	261	252	
0.155		2	14	234	265	265	257	
0.155		3	15	234	282	282	269	
0.267		1	16	234	264	264	0	
0.267		2	17	234	266	266	0	
0.267		3	18	234	269	269	0	
0.397		1	19	234	288	288	0	
0.397		2	20	234	240	240	0	
0.397		3	21	234	276	276	0	

CLIENT:	GeoEngineers	Date of Test:	07-Dec-15
PROJECT:	RG Haley	Test Type:	Mytilus RT
COMMENTS:	P140505.220		

To convert Total Ammonia (mg/L) to Free (un-ionized) Ammonia (mg/L) enter the corresponding total ammonia, salinity, temperature, and pH.

Integer:	I-factor
1	9.26
2	9.27
3	9.28
4	9.29
5	9.30
6	9.32
7	9.33
	9.34



	Sample	Mod	NH3T (mg/L)	salinity (ppt)	pH	temp (C)	temp (K)	i-factor	Mod	NH3U (mg/L)
	Target / Sample Name		Actual	22.9	8.0	24.1	297.26	9.3053		#VALUE!
	Example 3.5		2.000	10.0	7.5	5.0	278.16	9.2750		0.008
1										
2										
3										
4	0.75		0.583	28	8.0	16.2	289.36	9.3187		0.014
5	1.5		1.53	28	8.0	16.0	289.16	9.3187		0.037
6	3		2.38	28	8.0	16.1	289.26	9.3187		0.058
7	6		8.03	28	7.9	16.0	289.16	9.3187		0.155
8	12		14.1	28	7.9	15.7	288.86	9.3187		0.267
9	18		21.0	28	7.9	15.7	288.86	9.3187		0.397
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ENVIRON

CLIENT	PROJECT	SPECIES	LAB / LOCATION	PROTOCOL
GeoEngineers	RG Haley	*Mytilus galloprovincialis*	Port Gamble / Incubator	PSEP (1995)

JOB NUMBER	PROJECT MANAGER	TEST START DATE:	TIME	TEST END DATE	TIME
0	B. Hester	07Dec15	1800	09 Dec. 15	1600

TEST ID	LOT #:
P140505.220	32449535

WATER QUALITY DATA

DILTIN.WAT.BATCH	ORGANISM BATCH	REFERENCE TOX. MATERIAL	REFERENCE TOXICANT
FSW120715.01		Ammonium chloride	Ammonia - TAN

					DO (mg/L)		TEMP(C)		SAL (ppt)		pH			
					>5.0		16 ± 1		28 ± 1		7 - 9		TECH.	DATE
CLIENT/ ID	CONCENTRATION value	CONCENTRATION units	DAY	REP	D.O. meter	D.O. mg/L	TEMP. meter	TEMP. °C	SALINITY meter	SALINITY ppt	pH meter	pH unit		
Ref.Tox.-Ammonia - TAN	Target: 0	mg/L	0	Stock	8	7.9	8	16.5	8	28	8	8.0	KM	12/7
	Actual:		1	Stock	8	7.5	8	16.5	8	28	8	7.9	BE	12/8
			2	Stock	9	7.4	9	16.8	9	28	9	7.9	JL	12/09
			3	Stock										
			4	Stock										
Ref.Tox.-Ammonia - TAN	Target: 0.75	mg/L	0	Stock	8	8.0	8	16.2	8	28	8	8.0	KM	12/7
	Actual:		1	Stock	8	7.8	8	16.5	8	28	8	8.0	BE	12/8
			2	Stock	9	7.6	9	16.7	9	28	9	8.0	JL	12/09
			3	Stock										
			4	Stock										
Ref.Tox.-Ammonia - TAN	Target: 1.5	mg/L	0	Stock	8	8.0	8	16.0	8	28	8	8.0	KM	12/7
	Actual:		1	Stock	8	8.0	8	16.1	8	28	8	8.0	BE	12/8
			2	Stock	9	7.7	9	16.6	9	28	9	8.0	JL	12/09
			3	Stock										
			4	Stock										
Ref.Tox.-Ammonia - TAN	Target: 3	mg/L	0	Stock	8	8.1	8	16.1	8	28	8	8.0	KM	12/7
	Actual:		1	Stock	8	8.0	8	16.0	8	28	8	8.0	BE	12/8
			2	Stock	9	7.8	9	16.0	9	28	9	8.0	JL	12/09
			3	Stock										
			4	Stock										
Ref.Tox.-Ammonia - TAN	Target: 6	mg/L	0	Stock	8	8.1	8	16.0	8	28	8	7.9	KM	12/7
	Actual:		1	Stock	8	8.0	8	16.2	8	28	8	8.0	BE	12/8
			2	Stock	9	7.8	9	16.1	9	28	9	8.0	JL	12/09
			3	Stock										
			4	Stock										
Ref.Tox.-Ammonia - TAN	Target: 12	mg/L	0	Stock	8	8.1	8	15.7	8	28	8	7.9	KM	12/7
	Actual:		1	Stock	8	8.0	8	15.9	8	28	8	7.9	BE	12/8
			2	Stock	9	7.8	9	16.1	9	28	9	7.9	JL	12/09
			3	Stock										
			4	Stock										
Ref.Tox.-Ammonia - TAN	Target: 18	mg/L	0	Stock	8	8.1	8	15.9	8	28	8	7.9	KM	12/7
	Actual:		1	Stock	8	7.9	8	15.8	8	28	8	7.9	BE	12/8
			2	Stock	9	7.7	9	15.5	9	28	9	7.9	JL	12/09
			3	Stock										
			4	Stock										

ENVIRON

SPECIES					
Mytilus galloprovincialis					
CLIENT	PROJECT	JOB NUMBER	PROJECT MANAGER	LAB / LOCATION	PROTOCOL
GeoEngineers	RG Haley	0	B. Hester	Port Gamble / Incubator	PSEP (1995)
TEST ID	ORGANISM BATCH	TEST START DATE: TIME		TEST END DATE: TIME	
① ~~PTS~~ P140505.220	TS120415	07 Dec.15 1800		09 Dec.15 1600	

LARVAL OBSERVATION DATA

CLIENT/ ID	CONC. value	CONC. units	VIAL NUMBER	REP	NUMBER NORMAL	NUMBER ABNORMAL	DATE	TECHNICIAN	COMMENTS
Ref.Tox. - Ammonia - TAN	0	mg/L		1	269	7	12/17/15	MARY	
				2	261	2			
				3	257	5			
Ref.Tox. - Ammonia - TAN	0.75	mg/L		1	274	7			
				2	247	8			
				3	282	4			
Ref.Tox. - Ammonia - TAN	1.5	mg/L		1	265	3			
				2	248	6			
				3	205	8			
Ref.Tox. - Ammonia - TAN	3	mg/L		1	238	1			
				2	235	2			
				3	265	1			
Ref.Tox. - Ammonia - TAN	6	mg/L		1	252	9			
				2	257	8			
				3	269	13			
Ref.Tox. - Ammonia - TAN	12	mg/L		1	0	264			
				2	0	266			
				3	0	269			
Ref.Tox. - Ammonia - TAN	18	mg/L		1	0	288			
				2	0	240			
				3	0	276			
STOCKING DENSITY				1		245			
				2		267			
				3		189			

① ie. KMR. 12/7/15

mean: 234

ENVIRON **Ammonia Reference Toxicant**
Spiking Worksheet

Reference Toxicant ID: P140505.220
Date Prepared: 12/7/15
Technician Initials: HE

Biv / Echino NH_3 RT

Assumptions in Model
Stock ammonia concentration is 9,000 mg/L = 9 mg/mL

Date: 12/7/2015
Measurement: 9286.6

Test Solutions			Volume of stock to reach desired concentration	
Measured Concentration	**Desired Concentration**	**Volume**		
mg/L	mg/L	mL	mL stock to increase	
			[redacted]	SALT WATER
0.583	**0.75**	250		**0.030**
1.53 ~~2.04~~ ①	**1.5**	250		**0.061**
2.38	**3**	250		**0.121**
6.03	**6**	250		**0.242**
14.1	**12**	250		**0.485**
21.0	**18**	250		**0.727**

① HE 12/7

APPENDIX B

STATISTICAL COMPARISONS

Project Name: R. G. Haley - E. estuarius 10 day - Survival

Sample:	x1
Samp ID:	SS1-SS-03-0-12
Alias:	Sample
Replicates:	5
Mean:	99
SD:	2.236
Tr Mean:	107.089
Trans SD:	16.776

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	95
SD:	3.536
Tr Mean:	83.479
Trans SD:	17.556

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	11.142
SS:	2358.564
K:	5
b:	46.701
Alpha Level:	0.05
Calculated Value:	0.9247
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	12.004
Test Residual SD:	10.066
Ref. Residual Mean:	12.445
Ref. Residual SD:	10.705
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.0671
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	ArcSin
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.05
Calculated Value:	-2.1742
Critical Value:	>= 1.860
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	100	114.592	95	77.079	7.503	6.4			-30.01
2	100	114.592	95	77.079	7.503	6.4			-11.914
3	100	114.592	90	71.565	7.503	11.914			-6.4
4	95	77.079	100	114.592	30.01	31.113			-6.4
5	100	114.592	95	77.079	7.503	6.4			-6.4
6									7.503
7									7.503
8									7.503
9									7.503
10									31.113

Project Name: R. G. Haley - E. estuarius 10 day - Survival

Sample:	x1
Samp ID:	SS1-SS-05-0-12
Alias:	Sample
Replicates:	5
Mean:	99
SD:	2.236
Tr Mean:	107.089
Trans SD:	16.776

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	95
SD:	3.536
Tr Mean:	83.479
Trans SD:	17.556

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	11.142
SS:	2358.564
K:	5
b:	46.701
Alpha Level:	0.05
Calculated Value:	0.9247
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	12.004
Test Residual SD:	10.066
Ref. Residual Mean:	12.445
Ref. Residual SD:	10.705
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.0671
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	ArcSin
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.05
Calculated Value:	-2.1742
Critical Value:	>= 1.860
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	100	114.592	95	77.079	7.503	6.4			-30.01
2	95	77.079	95	77.079	30.01	6.4			-11.914
3	100	114.592	90	71.565	7.503	11.914			-6.4
4	100	114.592	100	114.592	7.503	31.113			-6.4
5	100	114.592	95	77.079	7.503	6.4			-6.4
6									7.503
7									7.503
8									7.503
9									7.503
10									31.113

Project Name: R. G. Haley - E. estuarius 10 day - Survival

Sample:	x1
Samp ID:	SS1-SS-06-0-12
Alias:	Sample
Replicates:	5
Mean:	99
SD:	2.236
Tr Mean:	107.089
Trans SD:	16.776

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	95
SD:	3.536
Tr Mean:	83.479
Trans SD:	17.556

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	11.142
SS:	2358.564
K:	5
b:	46.701
Alpha Level:	0.05
Calculated Value:	0.9247
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	12.004
Test Residual SD:	10.066
Ref. Residual Mean:	12.445
Ref. Residual SD:	10.705
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.0671
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	ArcSin
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.05
Calculated Value:	-2.1742
Critical Value:	>= 1.860
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	95	77.079	95	77.079	30.01	6.4			-30.01
2	100	114.592	95	77.079	7.503	6.4			-11.914
3	100	114.592	90	71.565	7.503	11.914			-6.4
4	100	114.592	100	114.592	7.503	31.113			-6.4
5	100	114.592	95	77.079	7.503	6.4			-6.4
6									7.503
7									7.503
8									7.503
9									7.503
10									31.113

Project Name: R. G. Haley - N. arenaceodentata 20 day - MIG AFDW

Sample:	x1
Samp ID:	SS1-SS-03-0-12
Alias:	Sample
Replicates:	5
Mean:	0.688
SD:	0.115
Tr Mean:	N/A
Trans SD:	N/A

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	0.527
SD:	0.11
Tr Mean:	N/A
Trans SD:	N/A

Shapiro-Wilk Results:		Levene's Results:		Test Results:	
Residual Mean:	0	Test Residual Mean:	0.079	Statistic:	Mann-Whitney
Residual SD:	0.073	Test Residual SD:	0.074	Balanced Design:	Yes
SS:	0.101	Ref. Residual Mean:	0.075	Transformation:	rank-order
K:	5	Ref. Residual SD:	0.071		
b:	0.289	Deg. of Freedom:	8		
				Experimental Hypothesis	
Alpha Level:	0.05	Alpha Level:	0.1	Null:	x1 >= x2
Calculated Value:	0.8265	Calculated Value:	0.1014	Alternate:	x1 < x2
Critical Value:	<= 0.842	Critical Value:	>= 1.860		
				Mann-Whitney N1:	5
				Mann-Whitney N2:	5
Normally		Variances		Degrees of Freedom:	
Distributed:	No	Homogeneous:	Yes	Experimental Alpha Level:	0.05
				Calculated Value:	4
Override Option:	Not Invoked			Critical Value:	>= 21.000
				Accept Null Hypothesis:	Yes
				Power:	
				Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	0.585	5	0.714	9	0.103	0.187	1		-0.103
2	0.703	8	0.496	3	0.015	0.031	2		-0.1
3	0.688	7	0.517	4	0	0.01	3		-0.096
4	0.87	10	0.483	2	0.182	0.044	4		-0.044
5	0.592	6	0.427	1	0.096	0.1	5		-0.031
6							6		-0.01
7							7		0
8							8		0.015
9							9		0.182
10							10		0.187

Project Name: R. G. Haley - N. arenaceodentata 20 day - MIG DW

Sample:	x1
Samp ID:	SS1-SS-03-0-12
Alias:	Sample
Replicates:	5
Mean:	0.843
SD:	0.117
Tr Mean:	0.843
Trans SD:	0.117

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	0.694
SD:	0.108
Tr Mean:	0.694
Trans SD:	0.108

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	0.073
SS:	0.101
K:	5
b:	0.308
Alpha Level:	0.05
Calculated Value:	0.939
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	0.092
Test Residual SD:	0.056
Ref. Residual Mean:	0.076
Ref. Residual SD:	0.067
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.4001
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	No Transformation
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.05
Calculated Value:	-2.0943
Critical Value:	>= 1.860
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	0.696	0.696	0.884	0.884	0.147	0.19			-0.147
2	0.909	0.909	0.621	0.621	0.066	0.073			-0.082
3	0.86	0.86	0.67	0.67	0.017	0.024			-0.073
4	0.989	0.989	0.63	0.63	0.146	0.064			-0.064
5	0.761	0.761	0.665	0.665	0.082	0.029			-0.029
6									-0.024
7									0.017
8									0.066
9									0.146
10									0.19

Project Name: R. G. Haley - N. arenaceodentata 20 day - survival

Sample:	x1
Samp ID:	SS1-SS-03-0-12
Alias:	Sample
Replicates:	5
Mean:	100
SD:	0
Tr Mean:	114.592
Trans SD:	0

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	100
SD:	0
Tr Mean:	114.592
Trans SD:	0

Shapiro-Wilk Results:		Levene's Results:		Test Results:	
Residual Mean:	N/A	Test Residual Mean:	0	Statistic:	1-Sample t-Test
Residual SD:	N/A	Test Residual SD:	0	Balanced Design:	Yes
SS:	0	Ref. Residual Mean:	0	Transformation:	ArcSin
K:	0	Ref. Residual SD:	0		
b:	0	Deg. of Freedom:	0		
				Experimental Hypothesis	
Alpha Level:	N/A	Alpha Level:	N/A	Null:	x1 >= x2
Calculated Value:	N/A	Calculated Value:	N/A	Alternate:	x1 < x2
Critical Value:	N/A	Critical Value:	N/A		
Normally		Variances		Degrees of Freedom:	4
Distributed:	N/A	Homogeneous:	N/A	Experimental Alpha Level:	0.05
				Calculated Value:	0
Override Option:	N/A			Critical Value:	<= -2.132
				Accept Null Hypothesis:	Yes
				Power:	
				Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	100	114.592	100	114.592					
2	100	114.592	100	114.592					
3	100	114.592	100	114.592					
4	100	114.592	100	114.592					
5	100	114.592	100	114.592					
6									
7									
8									
9									
10									

Project Name: R. G. Haley - N. arenaceodentata 20 day - MIG AFDW

Sample:	x1
Samp ID:	SS1-SS-05-0-12
Alias:	Sample
Replicates:	5
Mean:	0.631
SD:	0.09
Tr Mean:	0.631
Trans SD:	0.09

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	0.527
SD:	0.11
Tr Mean:	0.527
Trans SD:	0.11

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	0.065
SS:	0.08
K:	5
b:	0.28
Alpha Level:	0.05
Calculated Value:	0.9738
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	0.062
Test Residual SD:	0.058
Ref. Residual Mean:	0.075
Ref. Residual SD:	0.071
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.3179
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	No Transformation
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.05
Calculated Value:	-1.6333
Critical Value:	>= 1.860
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	0.653	0.653	0.714	0.714	0.022	0.187			-0.154
2	0.648	0.648	0.496	0.496	0.017	0.031			-0.1
3	0.662	0.662	0.517	0.517	0.031	0.01			-0.044
4	0.715	0.715	0.483	0.483	0.084	0.044			-0.031
5	0.477	0.477	0.427	0.427	0.154	0.1			-0.01
6									0.017
7									0.022
8									0.031
9									0.084
10									0.187

Project Name: R. G. Haley - N. arenaceodentata 20 day - MIG DW

Sample:	x1
Samp ID:	SS1-SS-05-0-12
Alias:	Sample
Replicates:	5
Mean:	0.774
SD:	0.101
Tr Mean:	0.774
Trans SD:	0.101

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	0.694
SD:	0.108
Tr Mean:	0.694
Trans SD:	0.108

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	0.068
SS:	0.088
K:	5
b:	0.289
Alpha Level:	0.05
Calculated Value:	0.957
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	0.072
Test Residual SD:	0.061
Ref. Residual Mean:	0.076
Ref. Residual SD:	0.067
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.1026
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	No Transformation
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.05
Calculated Value:	-1.206
Critical Value:	>= 1.860
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	0.751	0.751	0.884	0.884	0.023	0.19			-0.157
2	0.803	0.803	0.621	0.621	0.029	0.073			-0.073
3	0.808	0.808	0.67	0.67	0.034	0.024			-0.064
4	0.89	0.89	0.63	0.63	0.116	0.064			-0.029
5	0.617	0.617	0.665	0.665	0.157	0.029			-0.024
6									-0.023
7									0.029
8									0.034
9									0.116
10									0.19

Project Name: R. G. Haley - N. arenaceodentata 20 day - survival

Sample:	x1
Samp ID:	SS1-SS-05-0-12
Alias:	Sample
Replicates:	5
Mean:	100
SD:	0
Tr Mean:	114.592
Trans SD:	0

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	100
SD:	0
Tr Mean:	114.592
Trans SD:	0

Shapiro-Wilk Results:		Levene's Results:		Test Results:	
Residual Mean:	N/A	Test Residual Mean:	0	Statistic:	1-Sample t-Test
Residual SD:	N/A	Test Residual SD:	0	Balanced Design:	Yes
SS:	0	Ref. Residual Mean:	0	Transformation:	ArcSin
K:	0	Ref. Residual SD:	0		
b:	0	Deg. of Freedom:	0		
				Experimental Hypothesis	
Alpha Level:	N/A	Alpha Level:	N/A	Null:	x1 >= x2
Calculated Value:	N/A	Calculated Value:	N/A	Alternate:	x1 < x2
Critical Value:	N/A	Critical Value:	N/A		
Normally		Variances		Degrees of Freedom:	4
Distributed:	N/A	Homogeneous:	N/A	Experimental Alpha Level:	0.05
				Calculated Value:	0
Override Option:	N/A			Critical Value:	<= -2.132
				Accept Null Hypothesis:	Yes
				Power:	
				Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	100	114.592	100	114.592					
2	100	114.592	100	114.592					
3	100	114.592	100	114.592					
4	100	114.592	100	114.592					
5	100	114.592	100	114.592					
6									
7									
8									
9									
10									

Project Name: R. G. Haley - N. arenaceodentata 20 day - MIG AFDW

Sample:	x1
Samp ID:	SS1-SS-06-0-12
Alias:	Sample
Replicates:	5
Mean:	0.567
SD:	0.044
Tr Mean:	0.567
Trans SD:	0.044

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	0.527
SD:	0.11
Tr Mean:	0.527
Trans SD:	0.11

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	0.054
SS:	0.056
K:	5
b:	0.221
Alpha Level:	0.05
Calculated Value:	0.8749
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	0.035
Test Residual SD:	0.021
Ref. Residual Mean:	0.075
Ref. Residual SD:	0.071
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	1.2086
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	No Transformation
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.05
Calculated Value:	-0.7579
Critical Value:	>= 1.860
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	0.569	0.569	0.714	0.714	0.002	0.187			-0.1
2	0.537	0.537	0.496	0.496	0.03	0.031			-0.056
3	0.61	0.61	0.517	0.517	0.043	0.01			-0.044
4	0.61	0.61	0.483	0.483	0.043	0.044			-0.031
5	0.511	0.511	0.427	0.427	0.056	0.1			-0.03
6									-0.01
7									0.002
8									0.043
9									0.043
10									0.187

Project Name: R. G. Haley - N. arenaceodentata 20 day - MIG DW

Sample:	x1
Samp ID:	SS1-SS-06-0-12
Alias:	Sample
Replicates:	5
Mean:	0.679
SD:	0.064
Tr Mean:	N/A
Trans SD:	N/A

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	0.694
SD:	0.108
Tr Mean:	N/A
Trans SD:	N/A

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	0.058
SS:	0.063
K:	5
b:	0.229
Alpha Level:	0.05
Calculated Value:	0.8292
Critical Value:	<= 0.842
Normally Distributed:	No
Override Option:	Not Invoked

Levene's Results:

Test Residual Mean:	0.053
Test Residual SD:	0.025
Ref. Residual Mean:	0.076
Ref. Residual SD:	0.067
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.7268
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Mann-Whitney
Balanced Design:	Yes
Transformation:	rank-order
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Mann-Whitney N1:	5
Mann-Whitney N2:	5
Degrees of Freedom:	
Experimental Alpha Level:	0.05
Calculated Value:	13
Critical Value:	>= 21.000
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	0.668	6	0.884	10	0.011	0.19	1		-0.073
2	0.626	3	0.621	2	0.053	0.073	2		-0.069
3	0.738	8	0.67	7	0.059	0.024	3		-0.064
4	0.751	9	0.63	4	0.072	0.064	4		-0.053
5	0.61	1	0.665	5	0.069	0.029	5		-0.029
6							6		-0.024
7							7		-0.011
8							8		0.059
9							9		0.072
10							10		0.19

Project Name: R. G. Haley - N. arenaceodentata 20 day - survival

Sample:	x1
Samp ID:	SS1-SS-06-0-12
Alias:	Sample
Replicates:	5
Mean:	100
SD:	0
Tr Mean:	114.592
Trans SD:	0

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	100
SD:	0
Tr Mean:	114.592
Trans SD:	0

Shapiro-Wilk Results:		Levene's Results:		Test Results:	
Residual Mean:	N/A	Test Residual Mean:	0	Statistic:	1-Sample t-Test
Residual SD:	N/A	Test Residual SD:	0	Balanced Design:	Yes
SS:	0	Ref. Residual Mean:	0	Transformation:	ArcSin
K:	0	Ref. Residual SD:	0		
b:	0	Deg. of Freedom:	0		
				Experimental Hypothesis	
Alpha Level:	N/A	Alpha Level:	N/A	Null:	x1 >= x2
Calculated Value:	N/A	Calculated Value:	N/A	Alternate:	x1 < x2
Critical Value:	N/A	Critical Value:	N/A		
Normally Distributed:	N/A	Variances Homogeneous:	N/A	Degrees of Freedom:	4
				Experimental Alpha Level:	0.05
				Calculated Value:	0
Override Option:	N/A			Critical Value:	<= -2.132
				Accept Null Hypothesis:	Yes
				Power:	
				Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	100	114.592	100	114.592					
2	100	114.592	100	114.592					
3	100	114.592	100	114.592					
4	100	114.592	100	114.592					
5	100	114.592	100	114.592					
6									
7									
8									
9									
10									

Project Name: R. G. Haley - M. Galloprovincialis 48 hr - Normalized Combined Survival

Sample:	x1
Samp ID:	SS1-SS-03-0-12
Alias:	Sample
Replicates:	5
Mean:	83.8
SD:	11.925
Tr Mean:	73.804
Trans SD:	23.419

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	87.4
SD:	11.845
Tr Mean:	71.043
Trans SD:	10.524

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	11.781
SS:	2636.85
K:	5
b:	47.183
Alpha Level:	0.05
Calculated Value:	0.8443
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	16.315
Test Residual SD:	14.687
Ref. Residual Mean:	9.097
Ref. Residual SD:	2.704
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	1.0807
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	ArcSin
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.1
Calculated Value:	-0.2404
Critical Value:	>= 1.397
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	80	63.435	75	60	10.369	11.043			-18.865
2	86	68.027	94	75.821	5.777	4.778			-11.7
3	67	54.938	97	80.026	18.865	8.983			-11.043
4	100	114.592	97	80.026	40.788	8.983			-10.369
5	86	68.027	74	59.343	5.777	11.7			-5.777
6									-5.777
7									4.778
8									8.983
9									8.983
10									40.788

Project Name: R. G. Haley - M. Galloprovincialis 48 hr - Normalized Combined Survival

Sample:	x1
Samp ID:	SS1-SS-03-0-12
Alias:	Sample
Replicates:	5
Mean:	98.8
SD:	0.837
Tr Mean:	98.8
Trans SD:	0.837

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	98.4
SD:	0.548
Tr Mean:	98.4
Trans SD:	0.548

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	0.459
SS:	4
K:	5
b:	1.92
Alpha Level:	0.05
Calculated Value:	0.9216
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	0.64
Test Residual SD:	0.434
Ref. Residual Mean:	0.48
Ref. Residual SD:	0.11
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.8
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	No Transformation
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.1
Calculated Value:	-0.8944
Critical Value:	>= 1.397
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	99	99	98	98	0.2	0.4			-0.8
2	98	98	98	98	0.8	0.4			-0.8
3	98	98	99	99	0.8	0.6			-0.4
4	100	100	98	98	1.2	0.4			-0.4
5	99	99	99	99	0.2	0.6			-0.4
6									0.2
7									0.2
8									0.6
9									0.6
10									1.2

Project Name: R. G. Haley - M. Galloprovincialis 48 hr - Normalized Combined Survival

Sample:	x1
Samp ID:	SS1-SS-05-0-12
Alias:	Sample
Replicates:	5
Mean:	89.4
SD:	7.021
Tr Mean:	N/A
Trans SD:	N/A

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	87.4
SD:	11.845
Tr Mean:	N/A
Trans SD:	N/A

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	10.666
SS:	2161.49
K:	5
b:	41.355
Alpha Level:	0.05
Calculated Value:	0.7912
Critical Value:	<= 0.842
Normally Distributed:	No
Override Option:	Not Invoked

Levene's Results:

Test Residual Mean:	14.625
Test Residual SD:	12.737
Ref. Residual Mean:	9.097
Ref. Residual SD:	2.704
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.9493
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Mann-Whitney
Balanced Design:	Yes
Transformation:	rank-order
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Mann-Whitney N1:	5
Mann-Whitney N2:	5
Degrees of Freedom:	
Experimental Alpha Level:	0.1
Calculated Value:	12
Critical Value:	>= 20.000
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	83	3	75	2	12.378	11.043	1		-12.378
2	93	6	94	7	3.37	4.778	2		-11.7
3	85	4	97	8.5	10.815	8.983	3		-11.043
4	86	5	97	8.5	10.001	8.983	4		-10.815
5	100	10	74	1	36.563	11.7	5		-10.001
6							6		-3.37
7							7		4.778
8							8.5		8.983
9							8.5		8.983
10							10		36.563

Project Name: R. G. Haley - M. Galloprovincialis 48 hr - Normalized Combined Survival

Sample:	x1
Samp ID:	SS1-SS-05-0-12
Alias:	Sample
Replicates:	5
Mean:	99.2
SD:	0.447
Tr Mean:	N/A
Trans SD:	N/A

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	98.4
SD:	0.548
Tr Mean:	N/A
Trans SD:	N/A

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	0.324
SS:	2
K:	5
b:	1.232
Alpha Level:	0.05
Calculated Value:	0.7588
Critical Value:	<= 0.842
Normally Distributed:	No
Override Option:	Not Invoked

Levene's Results:

Test Residual Mean:	0.32
Test Residual SD:	0.268
Ref. Residual Mean:	0.48
Ref. Residual SD:	0.11
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	1.2344
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Mann-Whitney
Balanced Design:	Yes
Transformation:	rank-order
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Mann-Whitney N1:	5
Mann-Whitney N2:	5
Degrees of Freedom:	
Experimental Alpha Level:	0.1
Calculated Value:	4
Critical Value:	>= 20.000
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	99	6.5	98	2	0.2	0.4	2		-0.4
2	99	6.5	98	2	0.2	0.4	2		-0.4
3	100	10	99	6.5	0.8	0.6	2		-0.4
4	99	6.5	98	2	0.2	0.4	6.5		-0.2
5	99	6.5	99	6.5	0.2	0.6	6.5		-0.2
6							6.5		-0.2
7							6.5		-0.2
8							6.5		0.6
9							6.5		0.6
10							10		0.8

Project Name: R. G. Haley - M. Galloprovincialis 48 hr - Normalized Combined Survival

Sample:	x1
Samp ID:	SS1-SS-06-0-12
Alias:	Sample
Replicates:	5
Mean:	99.2
SD:	0.837
Tr Mean:	95.915
Trans SD:	17.077

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	98.4
SD:	0.548
Tr Mean:	82.826
Trans SD:	1.31

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	7.859
SS:	1173.392
K:	5
b:	31.856
Alpha Level:	0.05
Calculated Value:	0.8648
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	14.941
Test Residual SD:	3.547
Ref. Residual Mean:	1.148
Ref. Residual SD:	0.262
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	8.6725
Critical Value:	>= 1.860
Variances Homogeneous:	No

Test Results:

Statistic:	Approximate t
Balanced Design:	Yes
Transformation:	ArcSin
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	4
Experimental Alpha Level:	0.1
Calculated Value:	-1.7088
Critical Value:	>= 1.533
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	100	114.592	98	81.87	18.677	0.956			-14.045
2	99	84.261	98	81.87	11.654	0.956			-11.654
3	98	81.87	99	84.261	14.045	1.435			-11.654
4	99	84.261	98	81.87	11.654	0.956			-0.956
5	100	114.592	99	84.261	18.677	1.435			-0.956
6									-0.956
7									1.435
8									1.435
9									18.677
10									18.677

Project Name: R. G. Haley - M. Galloprovincialis 48 hr - Normalized Combined Survival

Sample:	x1
Samp ID:	SS1-SS-06-0-12
Alias:	Sample
Replicates:	5
Mean:	91.8
SD:	7.085
Tr Mean:	80.682
Trans SD:	19.876

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	87.4
SD:	11.845
Tr Mean:	71.043
Trans SD:	10.524

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	10.319
SS:	2023.308
K:	5
b:	41.518
Alpha Level:	0.05
Calculated Value:	0.8519
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	14.039
Test Residual SD:	12.194
Ref. Residual Mean:	9.097
Ref. Residual SD:	2.704
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.8847
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	ArcSin
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.1
Calculated Value:	-0.9583
Critical Value:	>= 1.397
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	90	71.565	75	60	9.117	11.043			-15.032
2	83	65.65	94	75.821	15.032	4.778			-11.7
3	100	114.592	97	80.026	33.91	8.983			-11.043
4	88	69.732	97	80.026	10.95	8.983			-10.95
5	98	81.87	74	59.343	1.188	11.7			-9.117
6									1.188
7									4.778
8									8.983
9									8.983
10									33.91

Project Name: R. G. Haley - M. gallo 48 hr percent normal

Sample:	x1
Samp ID:	SS1-SS-03-0-12
Alias:	Sample
Replicates:	5
Mean:	229.2
SD:	32.844
Tr Mean:	229.2
Trans SD:	32.844

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	238.8
SD:	32.019
Tr Mean:	238.8
Trans SD:	32.019

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	21.046
SS:	8415.6
K:	5
b:	89.139
Alpha Level:	0.05
Calculated Value:	0.9442
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	22.56
Test Residual SD:	21.036
Ref. Residual Mean:	27.84
Ref. Residual SD:	7.508
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	0.5286
Critical Value:	>= 1.860
Variances Homogeneous:	Yes

Test Results:

Statistic:	Student's t
Balanced Design:	Yes
Transformation:	No Transformation
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	8
Experimental Alpha Level:	0.05
Calculated Value:	0.468
Critical Value:	>= 1.860
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	219	219	206	206	10.2	32.8			-46.2
2	234	234	256	256	4.8	17.2			-36.8
3	183	183	266	266	46.2	27.2			-32.8
4	274	274	264	264	44.8	25.2			-10.2
5	236	236	202	202	6.8	36.8			4.8
6									6.8
7									17.2
8									25.2
9									27.2
10									44.8

Project Name: R. G. Haley - M. gallo 48 hr percent normal

Sample:	x1
Samp ID:	SS1-SS-05-0-12
Alias:	Sample
Replicates:	5
Mean:	244.6
SD:	20.695
Tr Mean:	244.6
Trans SD:	20.695

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	238.8
SD:	32.019
Tr Mean:	238.8
Trans SD:	32.019

Shapiro-Wilk Results:

Residual Mean:	0
Residual SD:	17.493
SS:	5814
K:	5
b:	73.121
Alpha Level:	0.05
Calculated Value:	0.9196
Critical Value:	<= 0.842
Normally Distributed:	Yes
Override Option:	N/A

Levene's Results:

Test Residual Mean:	16.32
Test Residual SD:	9.766
Ref. Residual Mean:	27.84
Ref. Residual SD:	7.508
Deg. of Freedom:	8
Alpha Level:	0.1
Calculated Value:	2.0912
Critical Value:	>= 1.860
Variances Homogeneous:	No

Test Results:

Statistic:	Approximate t
Balanced Design:	Yes
Transformation:	No Transformation
Experimental Hypothesis	
Null:	x1 >= x2
Alternate:	x1 < x2
Degrees of Freedom:	7
Experimental Alpha Level:	0.05
Calculated Value:	-0.3402
Critical Value:	>= 1.895
Accept Null Hypothesis:	Yes
Power:	
Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	226	226	206	206	18.6	32.8			-36.8
2	253	253	256	256	8.4	17.2			-32.8
3	233	233	266	266	11.6	27.2			-18.6
4	234	234	264	264	10.6	25.2			-11.6
5	277	277	202	202	32.4	36.8			-10.6
6									8.4
7									17.2
8									25.2
9									27.2
10									32.4

Project Name: R. G. Haley - M. gallo 48 hr percent normal

Sample:	x1
Samp ID:	SS1-SS-06-0-12
Alias:	Sample
Replicates:	5
Mean:	254
SD:	24.485
Tr Mean:	254
Trans SD:	24.485

Ref Samp:	x2
Ref ID:	CR22
Alias:	Reference
Replicates:	5
Mean:	238.8
SD:	32.019
Tr Mean:	238.8
Trans SD:	32.019

Shapiro-Wilk Results:		Levene's Results:		Test Results:	
Residual Mean:	0	Test Residual Mean:	19.6	Statistic:	Student's t
Residual SD:	18.494	Test Residual SD:	10.922	Balanced Design:	Yes
SS:	6498.8	Ref. Residual Mean:	27.84	Transformation:	No Transformation
K:	5	Ref. Residual SD:	7.508		
b:	76.382	Deg. of Freedom:	8		
				Experimental Hypothesis	
Alpha Level:	0.05	Alpha Level:	0.1	Null:	x1 >= x2
Calculated Value:	0.8977	Calculated Value:	1.3902	Alternate:	x1 < x2
Critical Value:	<= 0.842	Critical Value:	>= 1.860		
Normally Distributed:	Yes	Variances Homogeneous:	Yes	Degrees of Freedom:	8
				Experimental Alpha Level:	0.05
				Calculated Value:	-0.8432
Override Option:	N/A			Critical Value:	>= 1.860
				Accept Null Hypothesis:	Yes
				Power:	
				Min. Difference for Power:	

Replicate Number	Test Data	Trans. Test Data	Reference Data	Trans. Reference Data	Levene's Test Residuals	Levene's Reference Residuals	Mann-Whitney Ranks	Rankits	Shipiro-Wilk Residuals
1	246	246	206	206	8	32.8			-36.8
2	226	226	256	256	28	17.2			-32.8
3	288	288	266	266	34	27.2			-28
4	241	241	264	264	13	25.2			-13
5	269	269	202	202	15	36.8			-8
6									15
7									17.2
8									25.2
9									27.2
10									34

APPENDIX C

CHAIN-OF-CUSTODY FORMS

CUSTODY TRANSFER
Printed: 12/03/15
ARI Job No: AOS3

ANALYTICAL RESOURCES INCORPORATED
4611 South 134th Place, Suite 100
Tukwila WA 98168
206-695-6200 206-695-6201 (fax)

ARI Project Manager: Cheronne Oreiro	Client Contact: Dana Carlisle	Sampling Event: 0356-114-06	Samples Received: 10/16/15
	Client: GeoEngineers, Inc.	Project: R.G. Haley	Sample Site: NA

LOGNUM ARI ID	CLIENT ID	MATRIX	# CONTAINERS	ANALYTICAL REQUEST	ANALYTICAL REQUEST	ANALYTICAL REQUEST	COMMENTS
15-19351 AOS3A	SSI-SS-03_0-12	Sediment	1	Biassay			

UPS TRK #
1Z832695035529154 7

Comments/Special Instructions:	Relinquished By:	Received by: (Signature)	Relinquished By:	Received by: (Signature)
	Printed Name: Chris Atwell	Printed Name: Julia Leverfood	Printed Name:	Printed Name:
	Company: ARI	Company: Ramboll	Company:	Company:
	Date/Time: 12-3-15 1320	Date/Time: 12/04/15 1515	Date/Time:	Date/Time:

CUSTODY TRANSFER
Printed: 11/30/15
ARI Job No: AOLI

ANALYTICAL RESOURCES INCORPORATED
4611 South 134th Place, Suite 100
Tukwila WA 98168
206-695-6200 206-695-6201 (fax)

ARI Project Manager: Cheronne Oreiro	Client Contact: Dana Carlisle	Sampling Event: 0356-114-06	Samples Received: 10/13/15
	Client: GeoEngineers, Inc.	Project: R. G. Haley	Sample Site: NA

LOGNUM ARI ID	CLIENT ID	MATRIX	# CONTAINERS	ANALYTICAL REQUEST	ANALYTICAL REQUEST	ANALYTICAL REQUEST	COMMENTS
15-18939 AOLIA	SSI-SS-05_0-12	Sediment	1	Bioassay			
15-18940 AOLIB	SSI-SS-06_0-12	Sediment	1	Bioassay			

Given to Environ per Nancy Musgrove

Comments/Special Instructions:	Relinquished By:	Received by: (Signature)	Relinquished By:	Received by: (Signature)
	Printed Name: Emily Litman	Printed Name: Brian Hester	Printed Name:	Printed Name:
	Company: ARI	Company: Ramboll	Company:	Company:
	Date/Time: 11/30/15 1000	Date/Time: 11.30.15 1000	Date/Time:	Date/Time:

CUSTODY TRANSFER
Printed: 11/30/15
ARI Job No: AOS3

ANALYTICAL RESOURCES INCORPORATED
4611 South 134th Place, Suite 100
Tukwila WA 98168
206-695-6200 206-695-6201 (fax)

ARI Project Manager: Cheronne Oreiro	Client Contact: Dana Carlisle	Sampling Event: 0356-114-06	Samples Received: 10/16/15
	Client: GeoEngineers, Inc.	Project: R.G. Haley	Sample Site: NA

LOGNUM ARI ID	CLIENT ID	MATRIX	# CONTAINERS	ANALYTICAL REQUEST	ANALYTICAL REQUEST	ANALYTICAL REQUEST	COMMENTS
15-19351 AOS3A	SSI-SS-03_0-12	Sediment	1	Bioassay			

Given to Environ per Nancy Musgrove

Comments/Special Instructions:	Relinquished By:	Received by: (Signature)	Relinquished By:	Received by: (Signature)
	Printed Name: Emily Hitchcock	Printed Name: Brian Hester	Printed Name:	Printed Name:
	Company: ARI	Company: Ramboll	Company:	Company:
	Date/Time: 11/30/15 1000	Date/Time: 11.30.15 1000	Date/Time:	Date/Time:

1620

CHAIN OF CUSTODY

ENVIRON

Shipping: 4770 NE View Dr. Mail: P.O. Box 216
Port Gamble, WA. 98364
Tel: (360) 297-6045, Fax: (360)297-6901

Destination: Ramboll	Sample Originator (Organization): Ramboll	Report Results To:	Phone:
Destination Contact: Brian Hoste	PERSON WHO COLLECTED SAMPLE: Brian Hoste	Contact Name:	Fax:
Date: 12.4.15	Address:	Address:	Email:
Turn-Around-Time:			
Project Name: RG Haley	Phone:	Invoicing To:	
	Fax:	Comments or Special Instructions:	
Contract/PO:	E-mail		

No.	Sample ID	Matrix	Volume & Type of Container	Date & Time	Analyses: X Ref Sed	Preservation	Sample Temp Upon Receipt	LAB ID
1	CR-22	Sed	3gal/bag	12.4.15	X	4°C		
2								
3								
4	24% fines							
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Relinquished by:	Recieved by:	Relinquished by:	Recieved by:	Matrix Codes
Print Name: Brian Hoste	Print Name: Jay Ward	Print Name:	Print Name:	FW = Fresh Water
Signature:	Signature:	Signature:	Signature:	SB = Salt & Brackish Water
Affiliation: Ramboll	Affiliation: Ramboll	Affiliation:	Affiliation:	SS = Salt & Sediment
Date/Time: 12.4.15 1400	Date/Time: 12/4/15 1400	Date/Time:	Date/Time:	

...of Custody Record & Laboratory Analysis Request

...Assigned Number:	Turn-around Requested:	Page: 1 of 1	
ARI Client Company: GEI	Phone: 206 818 8646	Date: 10/12/15	Ice Present?
Client Contact: Dena Carlisle / Nancy Musgrove		No. of Coolers:	Cooler Temps:
Client Project Name: R.G. Haley			
Client Project #: 0356-114-06	Samplers: GL/PRICV		

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

	Sample ID	Date	Time	Matrix	No. Containers	TOC	TS	Dx electrical pH	SVOCs	Grain size	PAHs/	Hold for potential analysis	DIF 1613	Notes/Comments
*	SSI-SS-05	10/12/15	12:00	Sed	5	X	X	X	X	X				
*	SSI-SS-06	10/12/15	12:36		5	X	X	No	X	X				Hold for potential Dx
*	SSI-SS-07	10/12/15	13:05		5	X	X	X	X	X				
*	SSI-SS-08	10/12/15	13:50		2	X	X			X				
*	SSI-SS-09	10/12/15	14:10		3	X	X			X	X			
*	SSI-SS-10	10/12/15	14:35		3	X	X			X	X			
*	SSI-SS-11	10/12/15	15:40		3	X	X			X	X			
*	SSI-SS-12	10/12/15	16:00		3	X	X			X	X			
*	SSI-SS-13	10/12/15	16:30		2							X		
*	SSI-SS-DUP-01	10/12/15	-	Sed	2							X		
*	Blank-121012	10/9/15	1720	W	6			X	X			X	X	

Comments/Special Instructions	Relinquished by: (Signature)	Received by: (Signature)	Relinquished by: (Signature)	Received by: (Signature)
	Printed Name: Claudia De La Via	Printed Name: YARED LISANEWORK	Printed Name:	Printed Name:
	Company: GeoEngineers	Company: YL #328	Company:	Company:
	Date & Time: 10/13/15 8:10AM	Date & Time: 10/13/15 8:10AM	Date & Time:	Date & Time:

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

Sample Retention Policy: All samples submitted to ARI will be appropriately discarded no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer, unless alternate retention schedules have been established by work-order or contract.

...ody Record & Laboratory Analysis Request

...Number:	Turn-around Requested: Standard
...Client Company: Geoengineers	Phone: 206-239-3221
Client Contact: Nancy Musgrove	
Client Project Name: R.G. Haley	
Client Project #: 0356-114-06	Samplers: PRD / CVD

Page: 1	of 1
Date: 10/15/15	Ice Present?
No. of Coolers:	Cooler Temps:

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

Sample ID	Date	Time	Matrix	No. Containers	Analysis Requested: TOC / Total Solids	Grain Size	Dx w/ silica gel	SIM SVOCs + SIM SVOCs	SIM PAHs	PCP (8041)	Dioxin/Furans	Bioassay Hold	Notes/Comments
SS1-SS-03_0-12	10/15	1205	Sed	5	X	X	X	X				X	
SS1-SS-01_0-12	"	1315	"	5	X	X		X				X	TPH for archive
SS1-SS-DUP-03	"	—	"	4	X	X		X					TPH for archive
Rinsate-151015	10/15	1535	Water	6			X	X			X		
SS1-SC-04_0-2	"	1455	Sed	4	X	X	X		X	X			
SS1-SC-04_2-4	"	1500	"	5	X	X	X		X	X			
SS1-SC-DUP-03	"	—	"	4	X	X	X		X	X			

Comments/Special Instructions	Relinquished by: (Signature)	Received by: (Signature)	Relinquished by: (Signature)	Received by: (Signature)
	Printed Name: Claudia De La Via	Printed Name: Brian Warren	Printed Name:	Printed Name:
	Company: Geoengineers	Company: ARI	Company:	Company:
	Date & Time: 10/16/2015 8AM	Date & Time: 10/16/15 0800	Date & Time:	Date & Time:

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

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...of Custody Record & Laboratory Analysis Request

...Assigned Number:	Turn-around Requested:	Page: 1 of 1	
ARI Client Company: GEI	Phone: 206 818 8646	Date: 10/12/15	Ice Present?
Client Contact: Dena Carlisle / Nancy Musgrove		No. of Coolers:	Cooler Temps:
Client Project Name: R.G. Haley			
Client Project #: 0356-114-06	Samplers: GL/PRICV		

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

	Sample ID	Date	Time	Matrix	No. Containers	TOC	TS	Dx electrical pH	SVOCs	Grain size	PAHs/	Hold for potential analysis	DIF 1613	Notes/Comments
*	SSI-SS-05	10/12/15	12:00	Sed	5	X	X	X	X	X				
*	SSI-SS-06	10/12/15	12:36		5	X	X	No	X	X				Hold for potential Dx
*	SSI-SS-07	10/12/15	13:05		5	X	X	X	X	X				
*	SSI-SS-08	10/12/15	13:50		2	X	X			X				
*	SSI-SS-09	10/12/15	14:10		3	X	X			X	X			
*	SSI-SS-10	10/12/15	14:35		3	X	X			X	X			
*	SSI-SS-11	10/12/15	15:40		3	X	X			X	X			
*	SSI-SS-12	10/12/15	16:00		3	X	X			X	X			
*	SSI-SS-13	10/12/15	16:30		2							X		
*	SSI-SS-DUP-01	10/12/15	-	Sed	2							X		
*	Blank-121012	10/9/15	1720	W	6			X	X			X	X	

Comments/Special Instructions	Relinquished by: (Signature)	Received by: (Signature)	Relinquished by: (Signature)	Received by: (Signature)
	Printed Name: Claudia De La Via	Printed Name: YARED LISANEWORK	Printed Name:	Printed Name:
	Company: GeoEngineers	Company: YL #328	Company:	Company:
	Date & Time: 10/13/15 8:10AM	Date & Time: 10/13/15 8:10AM	Date & Time:	Date & Time:

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

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...ody Record & Laboratory Analysis Request

...Number:	Turn-around Requested: Standard
...Client Company: Geoengineers	Phone: 206-239-3221
Client Contact: Nancy Musgrove	
Client Project Name: R.G. Haley	
Client Project #: 0356-114-06	Samplers: PRD / CVD

Page: 1	of 1
Date: 10/15/15	Ice Present?
No. of Coolers:	Cooler Temps:

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

Sample ID	Date	Time	Matrix	No. Containers	Analysis Requested: TOC / Total Solids	Grain Size	Dx w/ silica gel	SIM SVOCs + SIM SVOCs	SIM PAHs	PCP (8041)	Dioxin/Furans	Bioassay Hold	Notes/Comments
SS1-SS-03_0-12	10/15	1205	Sed	5	X	X	X	X				X	
SS1-SS-01_0-12	"	1315	"	5	X	X		X				X	TPH for archive
SS1-SS-DUP-03	"	—	"	4	X	X		X					TPH for archive
Rinsate-151015	10/15	1535	Water	6			X	X			X		
SS1-SC-04_0-2	"	1455	Sed	4	X	X	X		X	X			
SS1-SC-04_2-4	"	1500	"	5	X	X	X		X	X			
SS1-SC-DUP-03	"	—	"	4	X	X	X		X	X			

Comments/Special Instructions	Relinquished by: (Signature)	Received by: (Signature)	Relinquished by: (Signature)	Received by: (Signature)
	Printed Name: Claudia De La Via	Printed Name: Brian Warren	Printed Name:	Printed Name:
	Company: Geoengineers	Company: ARI	Company:	Company:
	Date & Time: 10/16/2015 8AM	Date & Time: 10/16/15 0800	Date & Time:	Date & Time:

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

Sample Retention Policy: All samples submitted to ARI will be appropriately discarded no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer, unless alternate retention schedules have been established by work-order or contract.

From: Nancy A. Musgrove
To: Brian Hester
Subject: RE: RG Haley bioassays
Date: Wednesday, December 30, 2015 1:11:12 PM
Attachments: image001.png

Hi there

SS-03 = 25.6% fines
SS-05 = 18.8 %
SS-06 = 28.0 %

Thanks!!

Nancy A. Musgrove
Environmental Scientist | GeoEngineers, Inc.
Telephone: 206.239.3221
Fax: 206.728.2732
Mobile: 206.818.8646
Email: nmusgrove@geoengineers.com

From: Brian Hester [mailto:BHester@ramboll.com]
Sent: Wednesday, December 30, 2015 12:59 PM
To: Nancy A. Musgrove <nmusgrove@geoengineers.com>
Cc: Jay Word <JDWord@ramboll.com>
Subject: RE: RG Haley bioassays

Nancy,

I hope you had a good Holiday.

All tests for RG Haley are complete. The three samples do not appear to exceed SMS or DMMP criteria. We are working through a draft report now.

We had a quick question on the grain sizes for the samples. Do the %fines you provided earlier (email below) correspond to samples 3, 5, and 6, respectively. If not, what % fines correspond to which samples.

Thanks,

Brian

Brian Hester
Laboratory Director

D +1 360 297 6045
M +1 360 461 5784
BHester@ramboll.com

Ramboll Environ: Port Gamble Environmental Laboratory
4770 NE View Drive
PO Box 216
Port Gamble, WA 98364
USA
www.ramboll-environ.com

RAMBOLL ENVIRON

From: Nancy A. Musgrove [mailto:nmusgrove@geoengineers.com]
Sent: Wednesday, November 25, 2015 8:55 AM
To: Brian Hester
Subject: RG Haley bioassays

Hi Brian

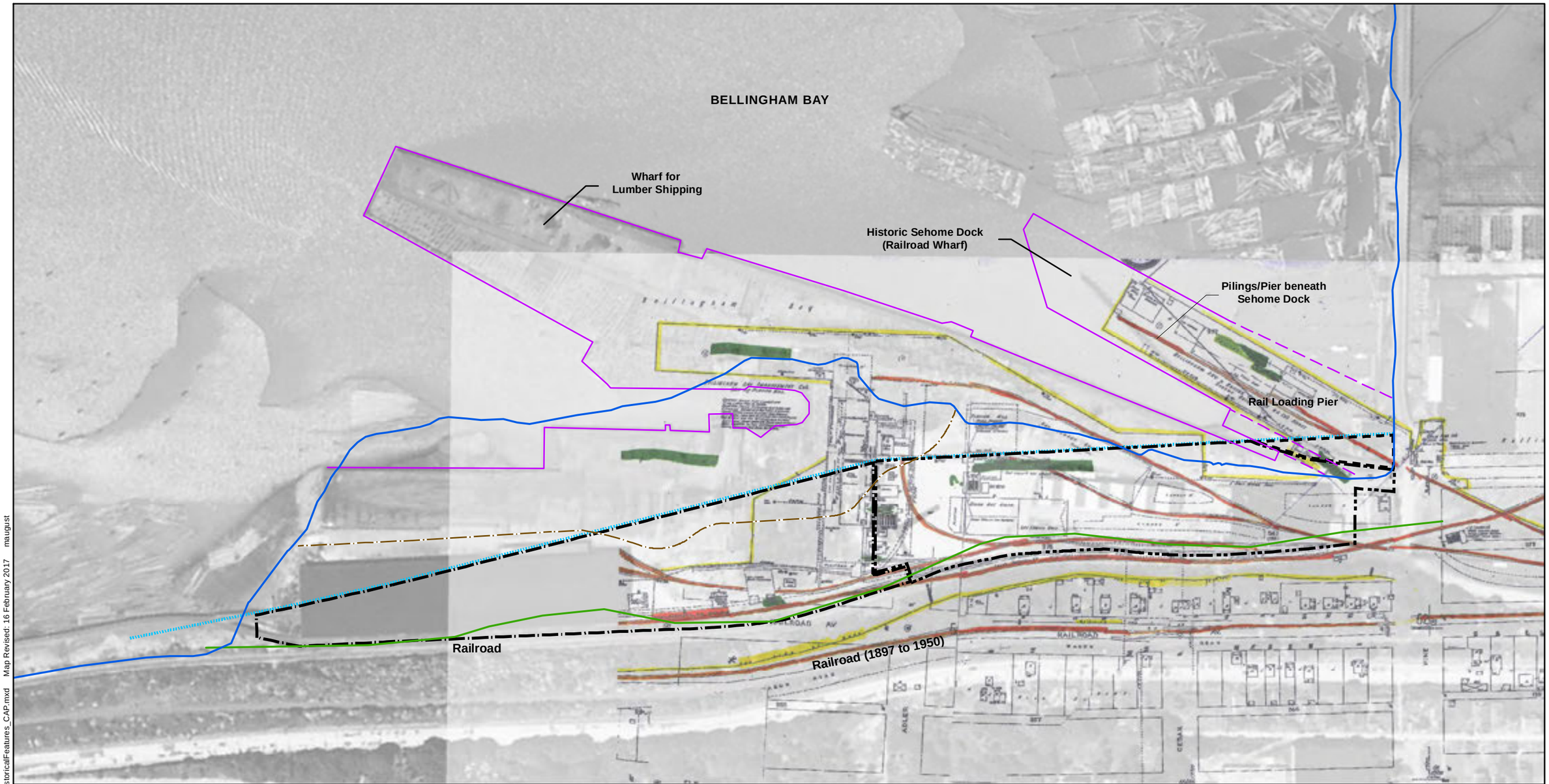
We finally got approval/input from Ecology on what samples they want tested for toxicity at the RG Haley site. We will be sending you three sediment samples to be tested using UV protocol; I will arrange for shipment with Cheronne today. Please let me know when you would be able to accept a shipment (I am assuming the lab is closed tomorrow). With respect to a reference sample—grain sizes for the three samples are 18.8%, 25.6%, and 28% fines. Give me a buzz if you have any questions.

Regards

--NAM
Nancy A. Musgrove
Environmental Scientist | GeoEngineers, Inc.
Telephone: 206.239.3221
Fax: 206.728.2732
Mobile: 206.818.8646
Email: nmusgrove@geoengineers.com

600 Stewart Street, Suite 1700
Seattle, WA 98101
www.geoengineers.com

APPENDIX F
Historical Maps and Photos



Path: \\seap2\projects\0\0356114\GIS\MXDs\Fig_2-3_HistoricalFeatures_CAP.mxd Map Revised: 16 February 2017 maugust

W True North S Project North N E

0 200 400
Feet

Reference: Walker and Associates photograph, 1950. Sanborn Maps, 1904.

Notes:
1. Extent of Cornwall Landfill refuse approximated from Figure 2-1 of Ecology Review Draft, Cornwall Avenue Landfill Remedial Investigation/Feasibility Study, Bellingham WA, Landau Associates Inc, 2013.
2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

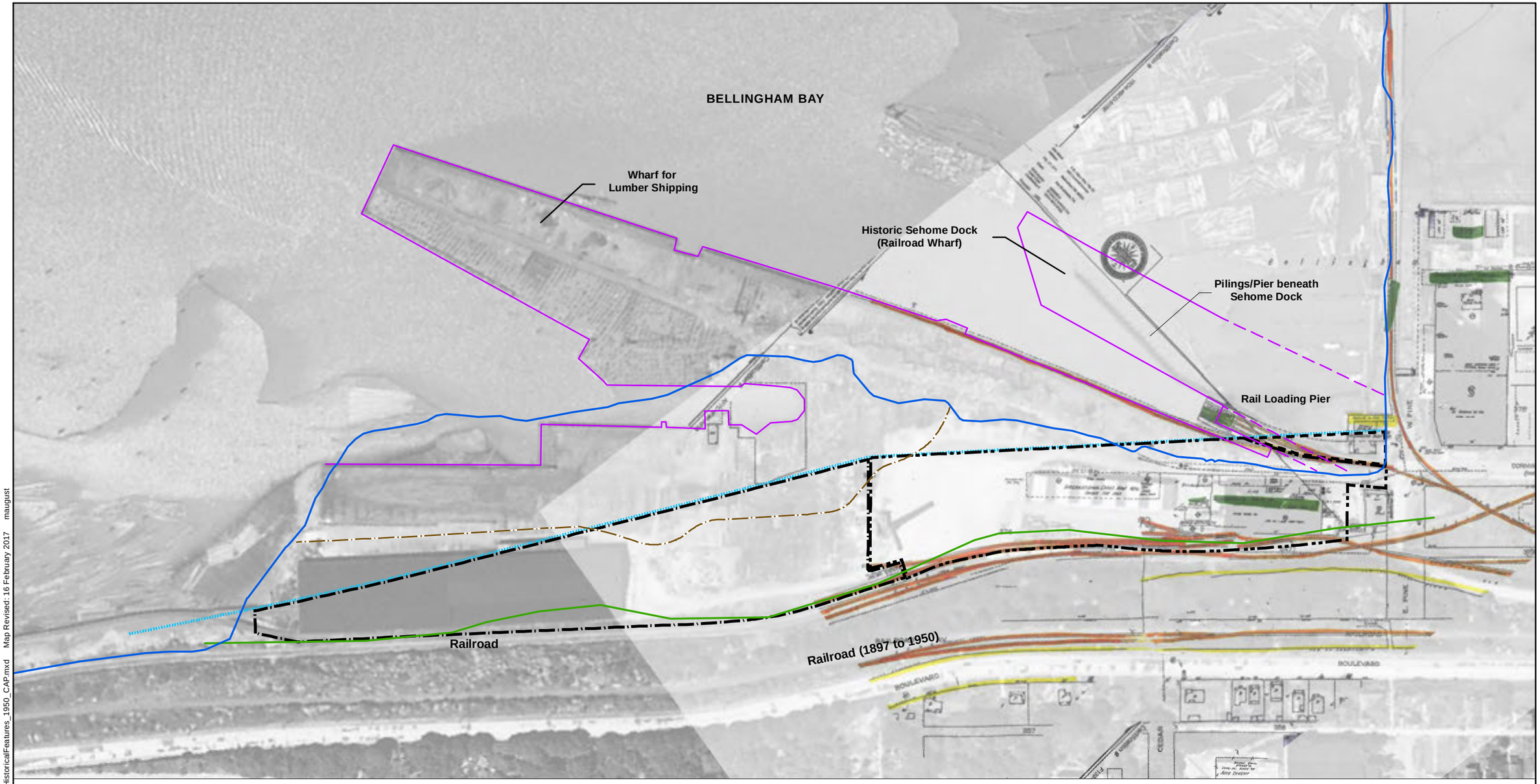
- City-Owned Property, Former R.G. Haley International
- Cornwall Property
- Port of Bellingham Property
- Inner Harbor Line
- Footprint of Historic Over-Water Wharf or Pier
- Current Shoreline
- 1887 Shoreline
- Cornwall Approximate Landward Boundary of Landfill Refuse (Post Lumber Mill)

Historical Over-Water Structures
1904 Sanborn Overlay

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure F-1



W True North S N Project North E

0 200 400

Feet

Reference: Walker and Associates photograph, 1950. Sanborn Maps, 1904.

Notes:
1. Extent of Cornwall Landfill refuse approximated from Figure 2-1 of Ecology Review Draft, Cornwall Avenue Landfill Remedial Investigation/Feasibility Study, Bellingham WA, Landau Associates Inc, 2013.
2. The locations of all features shown are approximate.
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Legend

- City-Owned Property, Former R.G. Haley International
- Cornwall Property
- Port of Bellingham Property
- Inner Harbor Line
- Footprint of Historic Over-Water Wharf or Pier
- Current Shoreline
- 1887 Shoreline
- Cornwall Approximate Landward Boundary of Landfill Refuse (Post Lumber Mill)

Historical Over-Water Structures 1950 Sanborn Overlay

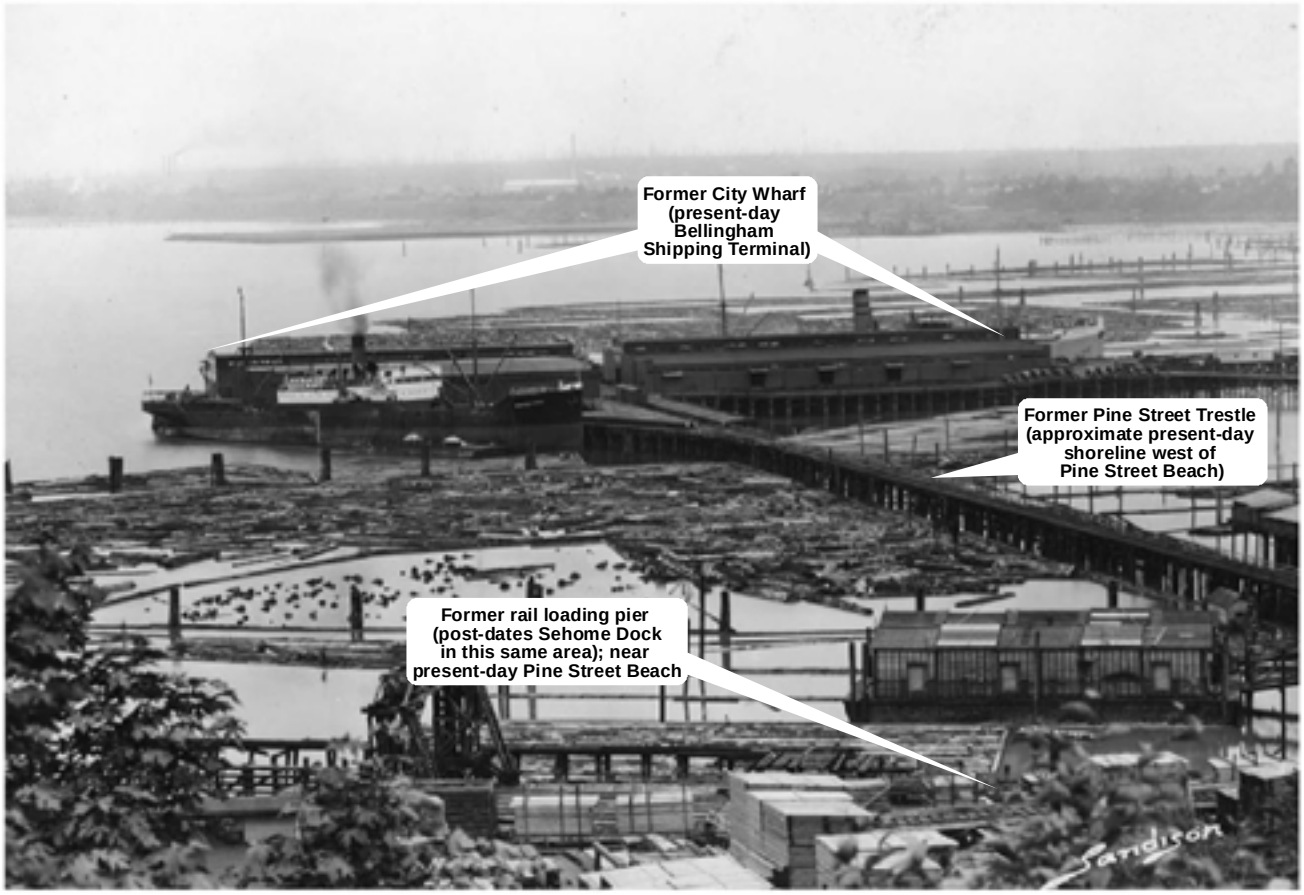
R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure F-2

Path: \\seap2\Projects\0\0356114\GIS\MXDs\Fig_2-3_HistoricalFeatures_1950_CAP.mxd Map Revised: 16 February 2017 maugust

1930



Data Source: Western Washington University - Center for Pacific NW Studies (Galen Biery Collection #1196). Port of Bellingham (P-BBN-0353)

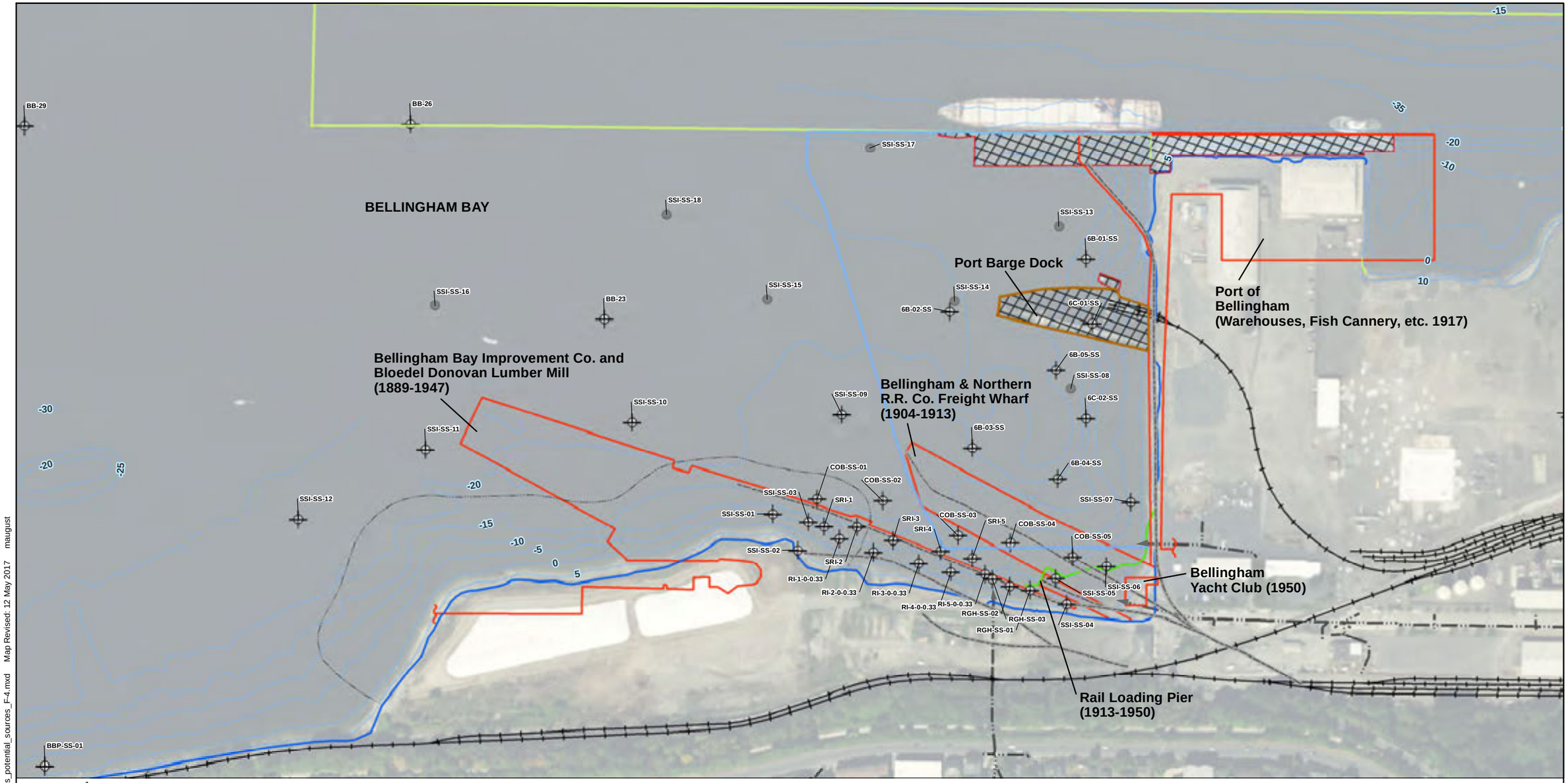
P:\0\0356114\GIS\MXDs\035611406_Fig_F03_HistPhoto_CAP.mxd Date Exported: 02/15/17 by maugust

Historic Over-Water Structures (circa 1930)

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure F-3



Sediment Sample

Archived Sample

Current

- Storm Drain Pipe
- BNSF Railroad
- Present-day Over-water Structure
- Current Shoreline
- Contour (5-ft interval)

Historic

- Footprint of Historical Over-water Structure (Maximum Composite Footprint Over Years Shown)
- Former Railroad Tracks (G.N.R.R., G.M. & S.P., B.B. & B.C.)
- Apparent intertidal/subtidal fill (1950 aerial photo)

Proposed Remedies

- Proposed Cornwall Thin-Layer Cap
- Whatcom Waterway MNR Sediment Site Units
- Whatcom Waterway Dredging or Capping Site Units
- Whatcom Waterway Capping w/Armoring

Reference: Aerial from Google Earth, August 2011.
Contour elevation displayed is referenced to NAVD88 vertical datum.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Historical overwater structures in the Site area are shown in Figure 2-3 of Draft RI Report

Historical Nearshore and Over-water Features

R.G. Haley Site
Bellingham, Washington

GeoEngineers

Figure F-4

Path: P:\0\0356114\GIS\MXD\0356114O6_cPAH_HeatMaps_potential_sources_F-4.mxd Map Revised: 12 May 2017 maugust

APPENDIX G
PAH Profiles

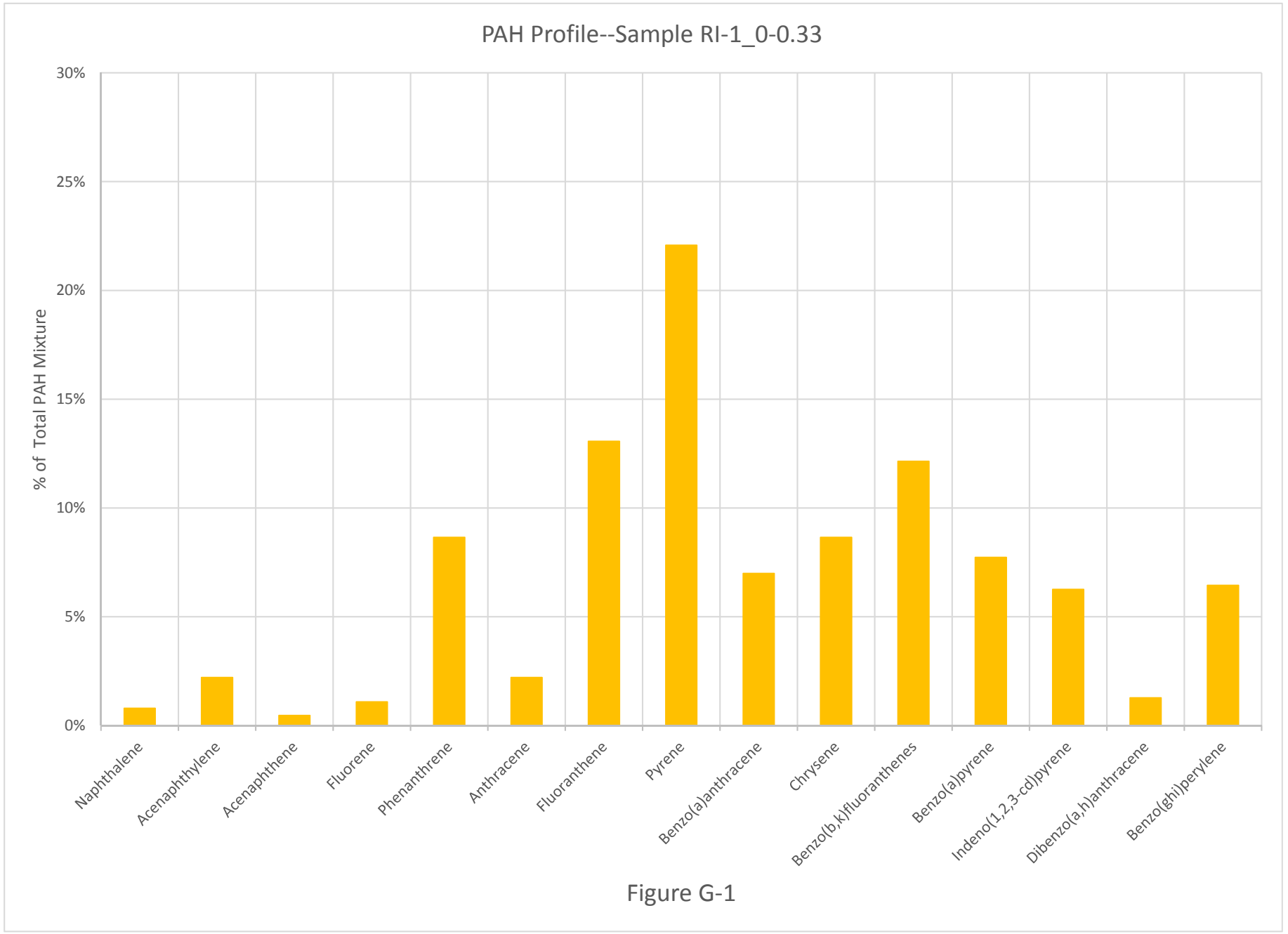

PAH Profile--Sample RI-1_0-0.33
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-1

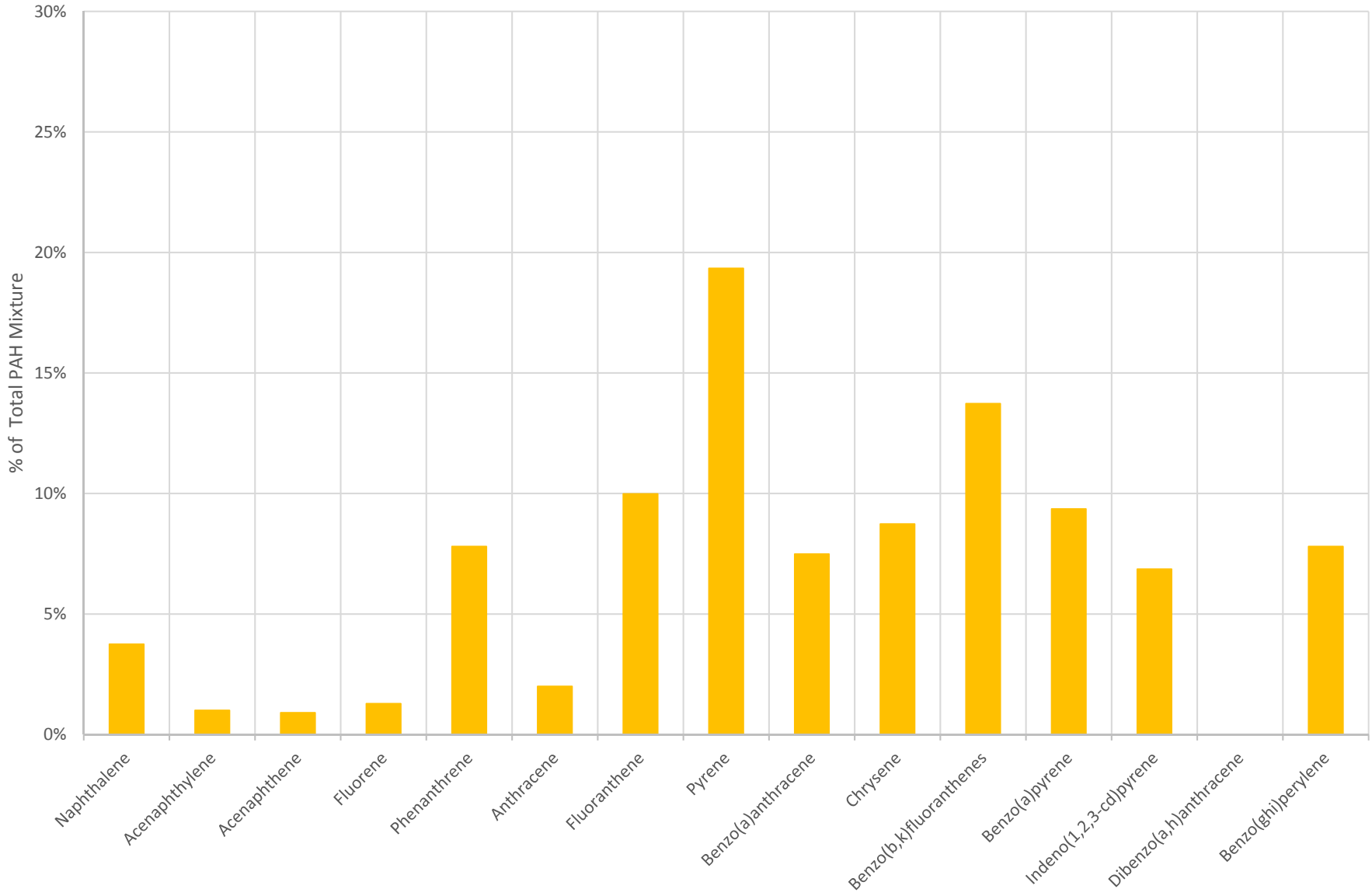

PAH Profile--Sample RI-2_0-0.33
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-2

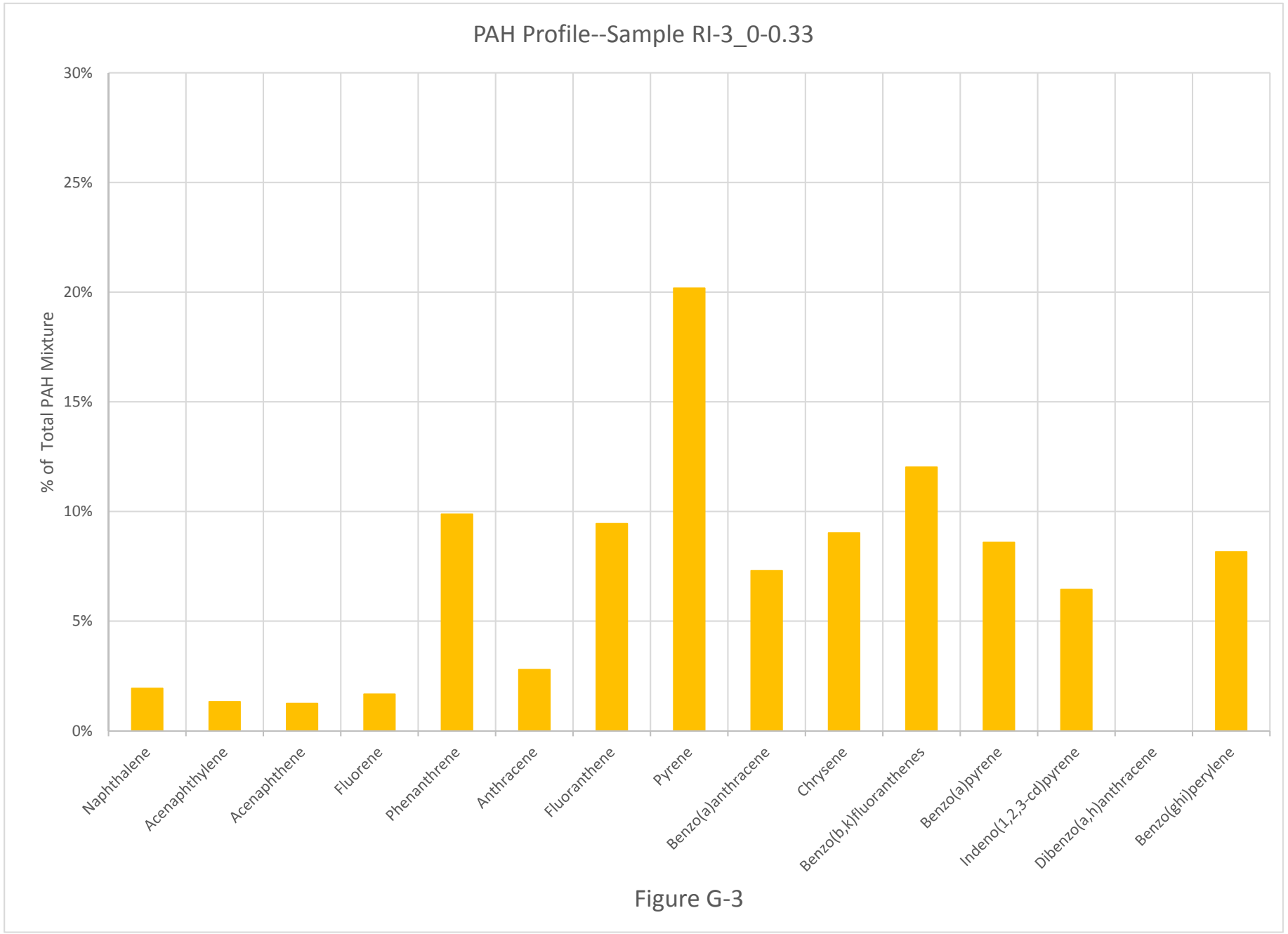

PAH Profile--Sample RI-3_0-0.33
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-3

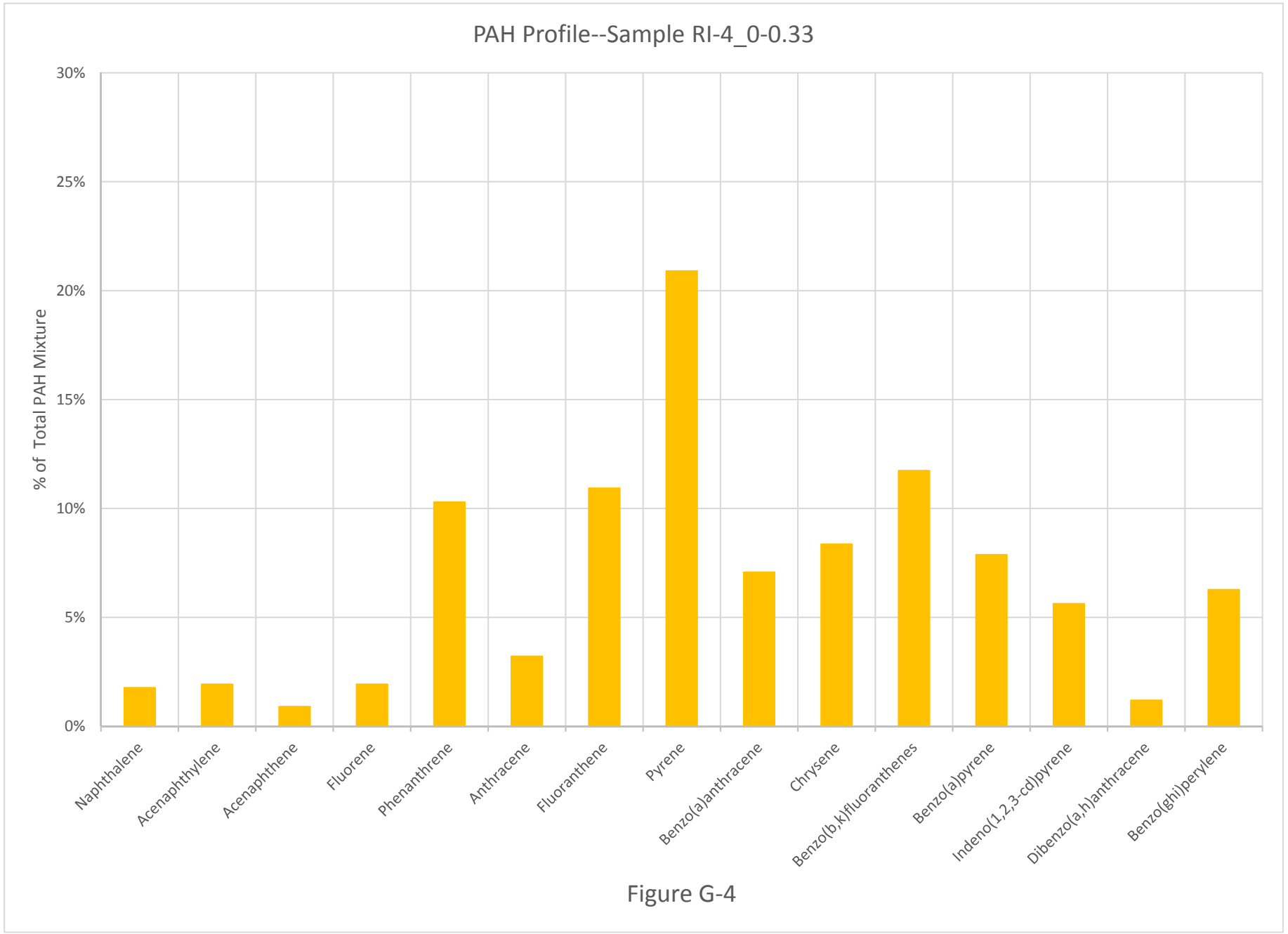

PAH Profile--Sample RI-4_0-0.33
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-4

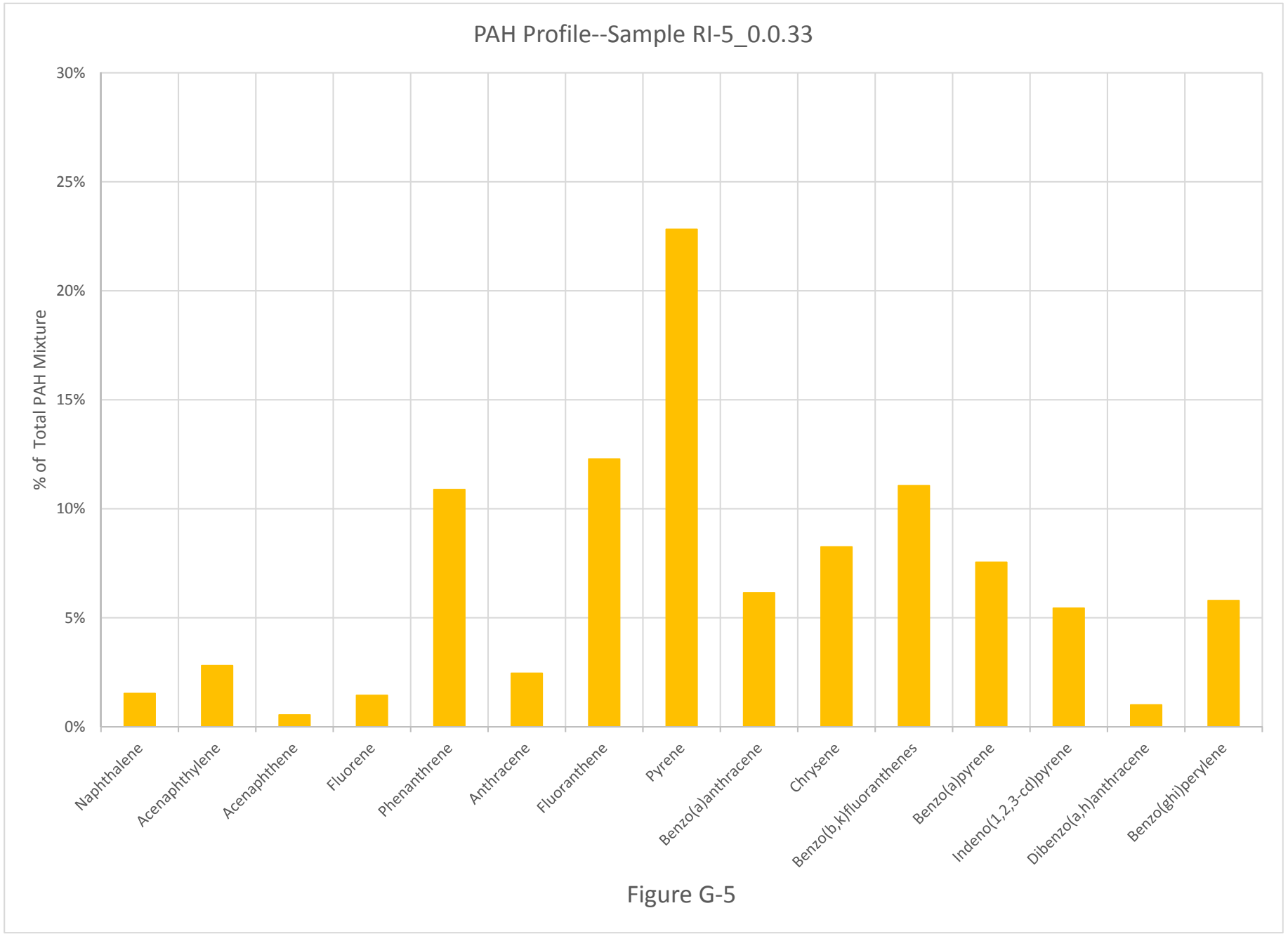

PAH Profile--Sample RI-5_0.0.33
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-5

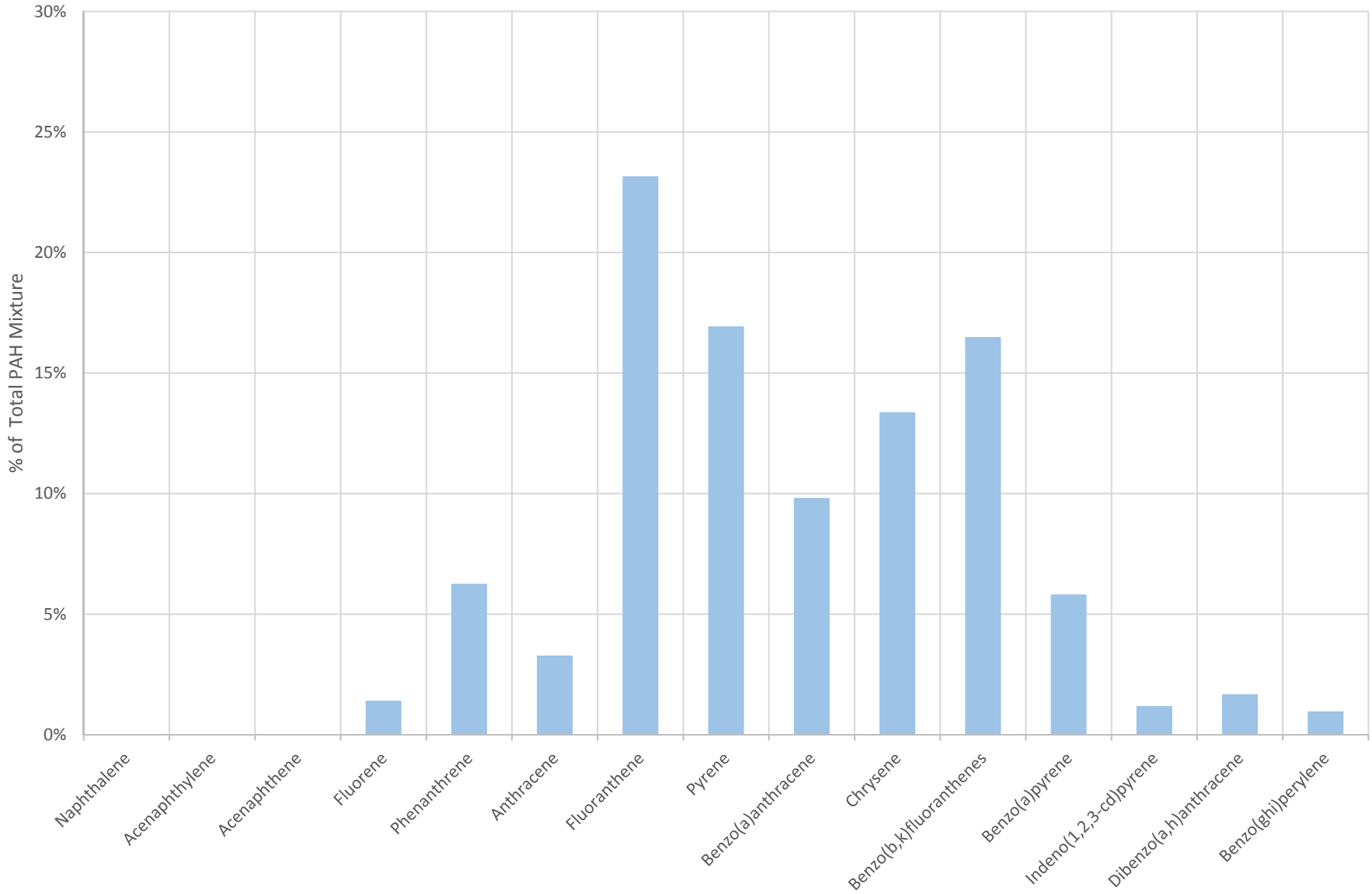

PAH Profile--Sample 6B-01-SS
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-6

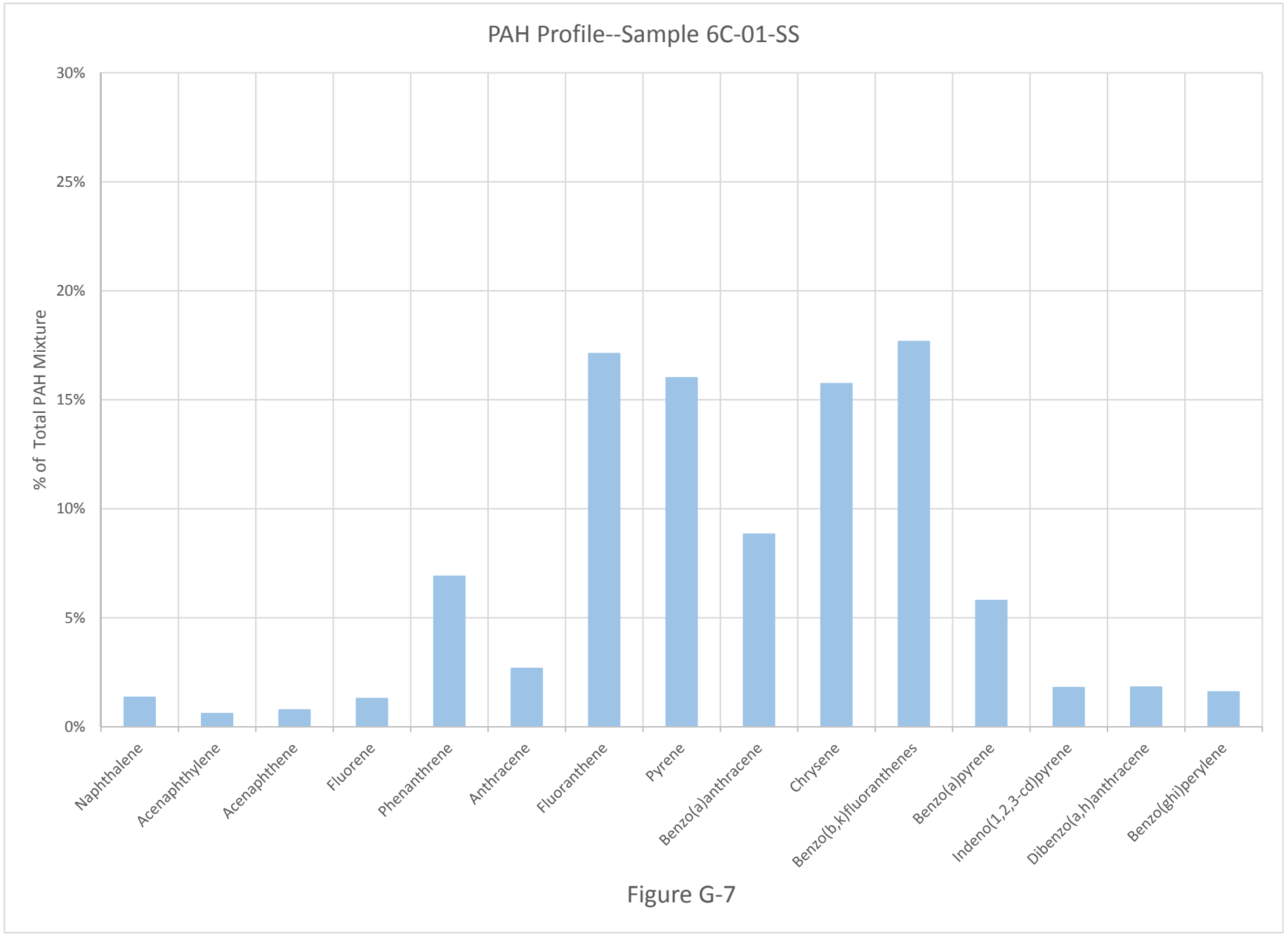

PAH Profile--Sample 6C-01-SS
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-7

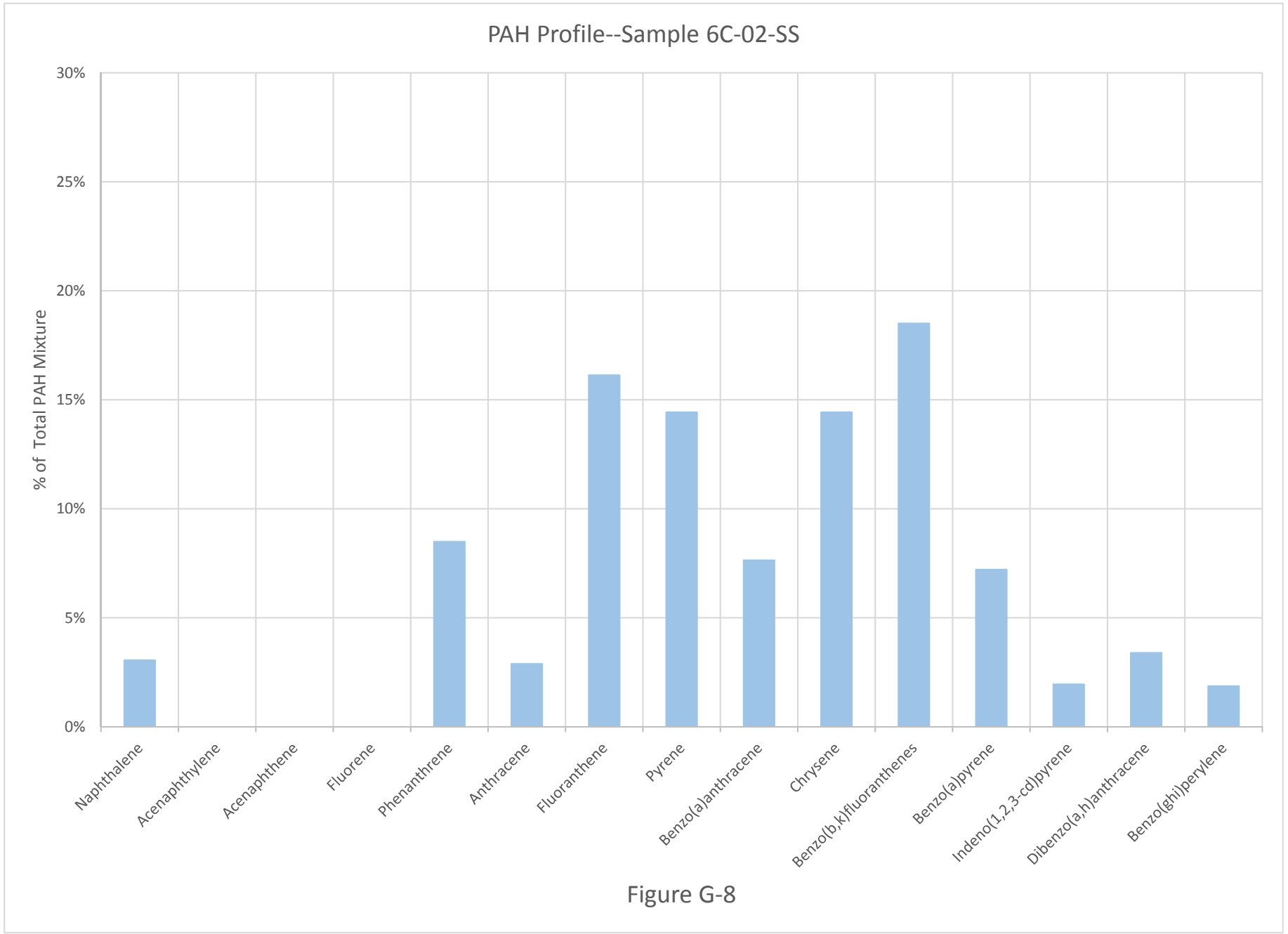

PAH Profile--Sample 6C-02-SS
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-8

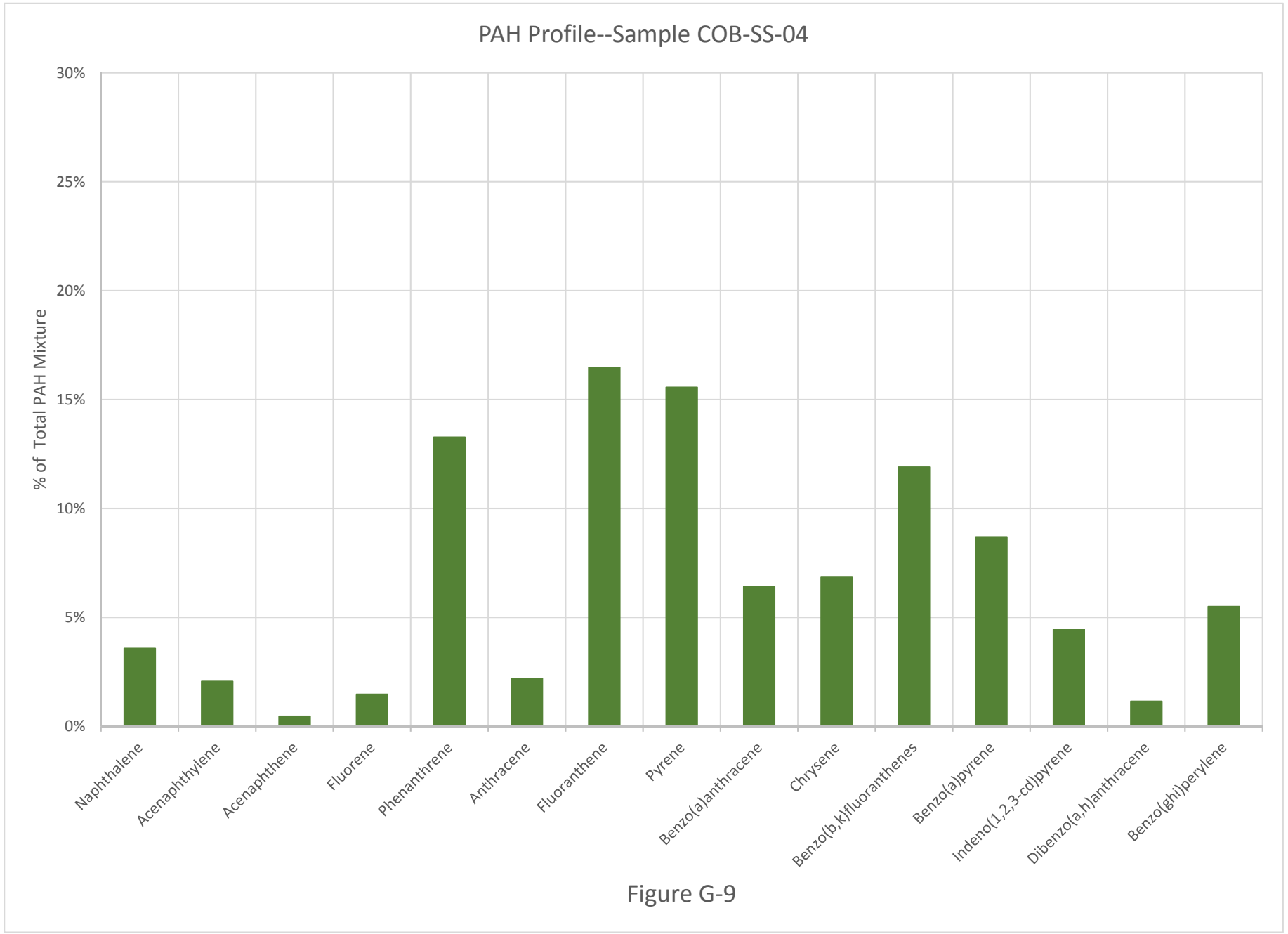

PAH Profile--Sample COB-SS-04
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-9

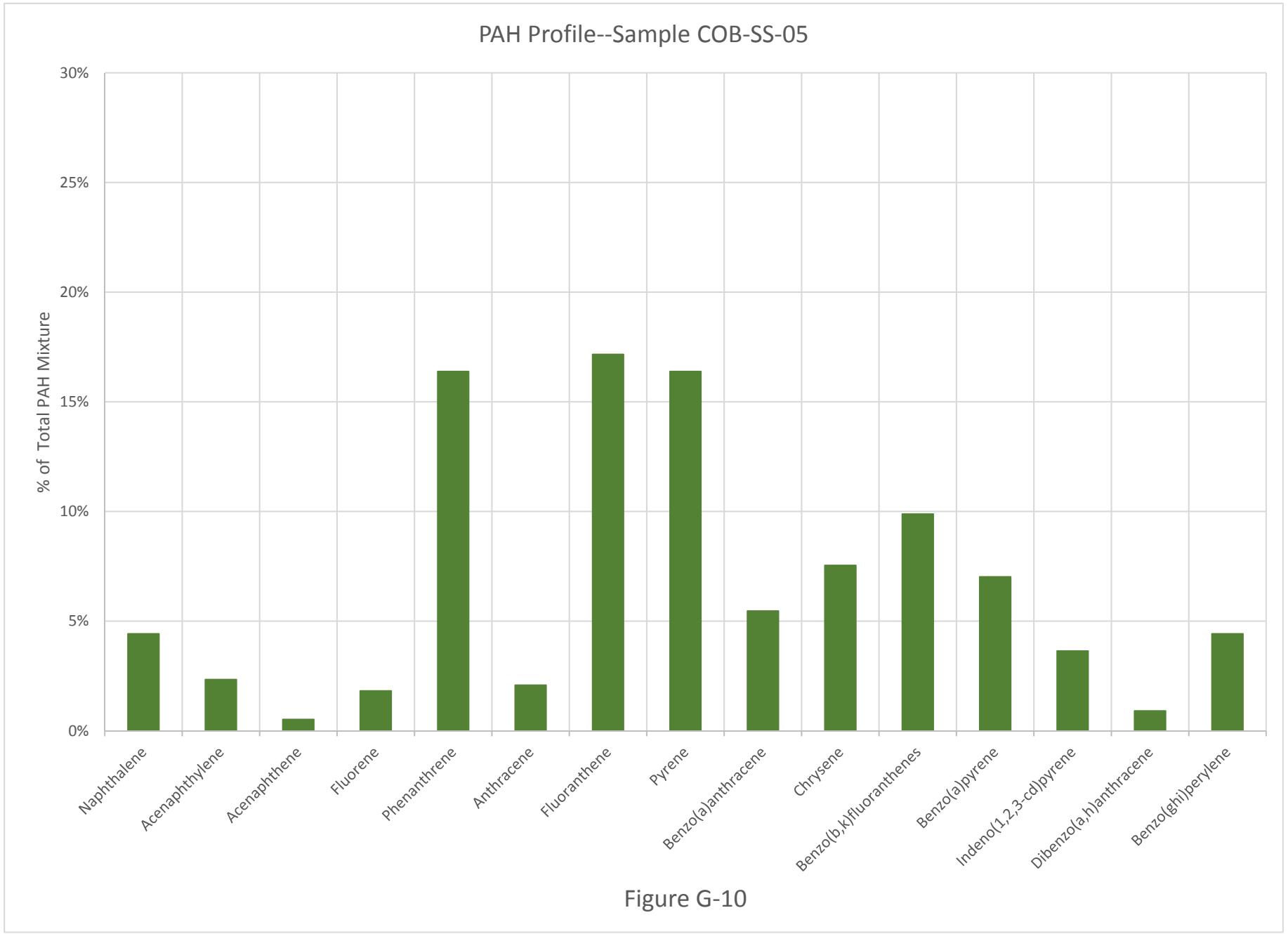

PAH Profile--Sample COB-SS-05
% of Total PAH Mixture
30%
25%
20%
15%
10%
5%
0%
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)anthracene
Chrysene
Benzo(b,k)fluoranthenes
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(ghi)perylene

Figure G-10

GeoEngineers