May 19, 2023
Gasco Sediments Cleanup Action

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan

Prepared for U.S. Environmental Protection Agency, Region 10,
and the Oregon Department of Environmental Quality

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ABBREVIATIONS

µg	microgram
ASAOC	*Administrative Settlement Agreement and Order on Consent*
BFSC	blast furnace slag cement
cm	centimeter
COC	contaminant of concern
Combined BOD-PDR	*Combined Sediment Remedy Basis of Design and Preliminary Design Report*
CUL	cleanup level
DEQ	Oregon Department of Environmental Quality
Design Team	Anchor QEA, Sevenson Environmental Services, and Hahn and Associates
DNAPL	dense nonaqueous phase liquid
DOC	dissolved organic carbon
DSR	*Revised Final Pre-Remedial Design Data Gaps Data Summary Report*
EDL	estimated detection limit
EE/CA	*Draft Engineering Evaluation/Cost Analysis – Gasco Sediments Cleanup Action*
EPA	U.S. Environmental Protection Agency
ISS	in situ stabilization and solidification
L	liter
LEAF	Leaching Environmental Assessment Framework
MGP	manufactured gas plant
MIP	mercury intrusion porosimetry
NAPL	nonaqueous phase liquid
NCP	*National Contingency Plan*
NRC	not reliably contained
ORP	oxidation reduction potential
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PAR	*Preferred Alternative Report*
PC	Portland cement
PDMS	polydimethylsiloxane
Project Area	Gasco Sediments Site Project Area
PTW	principal threat waste
PTW-NAPL	source material containing visual mobile nonaqueous phase liquid
RAL	remedial action level
RD	remedial design
Revised TSWP	*Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan*

Revised TSWP Addendum	*Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan Addendum*
ROD	*Record of Decision – Portland Harbor Superfund Site, Portland, Oregon*
s	second
SEM	scanning electron microscopy
SPLP	synthetic precipitation leaching procedure
TOC	total organic carbon
TS	treatability study
TSWP	*In Situ Stabilization and Solidification Laboratory Pilot Study Work Plan*
Work Plan	*Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan*
UCS	unconfined compressive strength
VOC	volatile organic compound
W/C	water to cement admixture
WBZ	water-bearing zone

1 Introduction and Objectives

NW Natural appreciates the U.S. Environmental Protection Agency's (EPA's) and Oregon Department of Environmental Quality's (DEQ's) willingness to expedite bench scale treatability studies (TSs) for detailed evaluation of in situ stabilization and solidification (ISS) treatment technology at the Gasco Sediments Site. This *Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (Work Plan) has been prepared by NW Natural's Design Team (Anchor QEA, Sevenson Environmental Services, and Hahn and Associates) for the Gasco Sediments Site Project Area (Project Area), located on the Willamette River adjacent to the NW Natural Gasco and Siltronic Corporation properties in Portland, Oregon (Figure 1-1). This Work Plan has been jointly prepared under the *Administrative Settlement Agreement and Order on Consent* (ASAOC; EPA 2009a; CERCLA Docket No. 10-2009-0255) and *Statement of Work – Gasco Sediments Site* (EPA 2009b) between NW Natural and EPA and the *Voluntary Agreement* (DEQ 1994; No. WMCVC-NWR-94-13; as amended October 11, 2016 [DEQ 2016]). This Work Plan summarizes the proposed ISS bench scale TS for the integrated design area (including the Intermediate, Shallow, and Riverbank Regions [i.e., nearshore area]) and the associated field sampling and laboratory methodologies to achieve the objectives of the study. Consistent with EPA's *Guidance for Conducting Treatability Studies under CERCLA* (EPA 1992), these data will be used to allow the treatment technology, ISS, to be fully evaluated during remedial design (RD) and to reduce performance uncertainties such that an appropriately protective and permanent integrated ISS remedy can be designed and implemented within the nearshore area and top of riverbank.

The ISS technology will be designed both to prevent groundwater flux to ISS-treated sediments and riverbank soils and as a source control measure addressing contaminated groundwater in the fill and alluvial water-bearing zones (WBZs). Pursuant to the *Memorandum of Understanding for Portland Harbor Superfund Site* (EPA et al. 2001) and EPA's *Record of Decision – Portland Harbor Superfund Site, Portland, Oregon* (ROD; EPA 2017), EPA is the lead agency for remedial action in riverbank and in-water areas of the Project Area, and DEQ is the lead agency for upland source control measures at the Gasco Operable Unit (OU).

An initial draft of this Work Plan titled *In Situ Stabilization and Solidification Laboratory Pilot Study Work Plan* (TSWP), dated October 31, 2022, was submitted to EPA and DEQ, and it included treatability testing on both the in-water sediments and top of riverbank soils. Both agencies provided comments on January 18, 2023. NW Natural subsequently submitted a *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (Revised TSWP) to EPA and DEQ on February 16, 2023, and EPA provided comments on March 14, 2023. NW Natural subsequently submitted the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan Addendum* (Revised TSWP Addendum) to EPA and DEQ on March 13, 2023, and EPA provided comments on April 14, 2023. DEQ provided comprehensive comments on both the Revised TSWP and Revised TSWP Addendum on March 15, 2023, associated with the upland top of riverbank TS scope of work.

It is important to note that several EPA and DEQ comments provide feedback based on the use of a specific construction method and associated alignment for the integrated upland ISS treatment barrier wall. Various methods and alignments for the barrier wall construction are still being considered and are undergoing detailed technical evaluation. Those methods include the DeWind OnePass System as well as other established auger and cutter-head mixing methods, with alignments that include construction along the edge of the top of the riverbank to construction setbacks from the riverbank. The revisions to this Work Plan segregate the 2023 in-water sediments field pilot study from the uplands because upland evaluations will be dependent on which construction method and alignment is selected for design. Subsequent design deliverables will present the construction method(s) and associated alignment determined to be optimal for the upland ISS treatment barrier wall and will also include any additional testing needed to support design of the barrier wall.

NW Natural, EPA, and DEQ participated in a discussion on April 24, 2023, regarding DEQ's comment letter that was limited to the upland TS scope of work. The parties agreed that additional discussions are required to address the DEQ comments.

As discussed in Section 4 of this Work Plan, NW Natural is committed to completing a field pilot study that is dependent on the Phase I through III treatability testing described in this Work Plan. The field pilot study must be completed during the in-water construction window that extends from July 1 through October 31. To facilitate completion of the field pilot study during the forthcoming 2023 in-water construction window, NW Natural needs EPA's expeditious approval of the in-water sediments TS scope of work. Therefore, this Work Plan has been revised to only include the in-water sediments scope of work for review and approval by EPA. NW Natural responses to EPA's comprehensive comments on the TSWP, Revised TSWP, and Revised TSWP Addendum are provided in Appendix E, and this Work Plan has been revised accordingly. NW Natural is continuing to perform detailed technical evaluations regarding the various methods for construction of the integrated upland ISS treatment barrier wall and associated hydraulic controls. Following completion of these evaluations, NW Natural will submit an additional revised version of this Work Plan that addresses any modifications to the upland TS scope of work to address DEQ's March 15, 2023 comments or other project needs.

Section 1.1 provides project background and evaluations that led to the proposal of a remedy that comprehensively addresses EPA's comments (EPA 2021) on the *Combined Sediment Remedy Basis of Design and Preliminary Design Report* (Combined BOD-PDR; Anchor QEA 2021). It includes full dredging to the bottom depth of contamination requiring active remediation in the Navigation Channel Region followed by placement of cover materials for dredge residual management, ISS throughout the Intermediate, Shallow, and Riverbank Regions to treat 100% of the ROD (EPA 2017) remedial action level (RAL) exceedances and principal threat waste (PTW) in situ, and integration of an ISS treatment barrier wall at the top of riverbank. Section 1.2 includes a high-level description of ISS, Section 1.3 presents the objectives of the TS and discusses the ways in which the data generated as a result of the TS will be used during RD, and Section 1.4 presents the organization of the remainder of the document.

The *Preferred Alternative Report* (PAR; Anchor QEA 2022a) was submitted to EPA on October 31, 2022, to present EPA and its partners the design alternatives analysis and comparison for the Revised Dredge and Cap Design and the preferred Full Dredge and ISS Design. The preferred design includes an ISS treatment barrier wall that will only be included if EPA approves the ISS technology in the design for the nearshore area. EPA and DEQ commented that they agree with the general approach of ISS treatment at the Project Area with the caveat that site-specific details of the approach will need to be further developed in collaboration with EPA and DEQ during RD of the Full Dredge and ISS Design. NW Natural recognizes that supporting evaluations for the Full Dredge and ISS Design will need to be further developed and presented in future design deliverables and that these will be developed in collaboration with and approval by EPA and DEQ. NW Natural would like to implement this bench scale TS as soon as possible to: 1) incorporate more detailed design information earlier in the design process (i.e., in the Interim Design) to support EPA and DEQ's review and minimize the potential for substantive design changes during development of the Final Design; and 2) facilitate completion of a subsequent field pilot study during the in-water work window in 2023 to inform the means and methods elements of design and ensure Interim and Final Design documents can be produced without delay.

1.1 Background

NW Natural submitted the Combined BOD-PDR (Anchor QEA 2021) to EPA on April 30, 2021. The technology assignments in the preliminary design included dredging to the bottom depth of contamination in the navigation channel and a combination of dredging and capping in the nearshore portion of the Project Area. On August 17, 2021, EPA provided its *Comments on Combined Sediment Remedy Basis of Design and Preliminary Design Report* (EPA 2021). EPA's comments require additional evaluations of management of PTW-nonaqueous phase liquids (PTW-NAPL) beyond what was presented in the Combined BOD-PDR.

In response to these comments, the Design Team performed more detailed evaluations, initially focused on revising the dredge and cap technology assignments throughout the Project Area to address all of the EPA objectives identified in the comments. That effort identified several significant design challenges to the feasibility and implementability of extensive dredge and cap technologies. For that reason, NW Natural requested that the Design Team determine whether another accepted technology in the ROD, or combination of ROD technologies, could better address EPA's objectives for the ROD-identified Intermediate, Shallow, and Riverbank Regions of the Project Area. Several different technology configurations were considered.[1] These evaluations included the replacement of the cap on grade technology in the Shallow Region with partial dredge and cap and increased removal of PTW-NAPL/not reliably contained (NRC) to the extent feasible in the Shallow and Intermediate Regions.[2]

Only one design alternative is anticipated to fully achieve all of EPA's design objectives and prevent sediment recontamination. That design, the Full Dredge and ISS Design, combines full dredging to the depth of contamination based on ROD Table 21 RAL exceedances and the presence of PTW in the Navigation Channel Region, combined with ISS treatment throughout the Intermediate, Shallow, and Riverbank Regions of the Project Area, and an integrated deep ISS treatment barrier wall in the Gasco OU at the top of riverbank.[3] This design alternative includes an integrated deep ISS treatment barrier wall, groundwater interceptor trench, and network of monitoring wells that are all necessary components of the ISS sediment remedy as well as functioning as an alternative source control approach proposed to DEQ. An integrated deep ISS barrier wall along the shared US Moorings and Gasco property line is an important component of the integrated design, included to promote structural stability of the sediment remedy along this portion of the riverbank and serve as an additional alternative source control approach proposed to DEQ. This design alternative is fully consistent with EPA's selected "F Mod" remedy and is not a modification or change to EPA's ROD. Similarly, this design directly supports achievement of DEQ's source control program objectives at the Gasco OU to prevent recontamination of the Project Area.

1.2 ISS Description

ISS is a proven treatment technology identified in the *National Contingency Plan* (NCP; EPA 1994) and ROD that remediates contaminants within environmental media, such as soil and sediment, through a physical modification and chemical reaction to bind the target compounds (i.e., solidification) or transform them into a less mobile form (i.e., stabilization). Through the physical process of solidification, the contaminated material is encapsulated, and the physical properties of the environmental media are transformed by the addition of grout to modify the hydraulic conductivity and meet the specified performance standards. Stabilization is a chemical process where grout reacts with the contaminated media to significantly reduce leachability to

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[1] See Appendix A of the PAR (Anchor QEA 2022a).

[2] The revised partial dredge and cap design was not limited by the assumed excavation depth of 5 feet (followed by placement of a cap) discussed in Section 14.2.4 of the ROD (EPA 2017).

[3] Both EPA's *Portland Harbor RI/FS – Feasibility Study* (EPA 2016) (see Section 3.2.2.1 and Table 2.4-2) and the ROD (EPA 2017; see Section 10.1.1.2) included an evaluation of ISS for sediment cleanup and concluded it is an appropriate harborwide technology. The *National Contingency Plan* (NCP; EPA 1994) expressly includes ISS as a physical method for remediating contaminated sediments (see Appendix D, Paragraph (b)(2)). ISS has been effectively used for decades at hundreds of sites around the country, many of which are manufactured gas plant (MGP) sites like Gasco that are contaminated with free-phase and residual-phase NAPL. ISS is nationally established as an effective remedial technology to address contaminated sediments, specifically identified in the NCP, and selected for remedial action at large sediment cleanup Superfund sites, such as the Gowanus Canal in New York. ISS is currently being implemented within EPA Region 10 at the Wyckoff Co./Eagle Harbor Superfund Site in Washington State.

specific RD targets. ISS can be conducted in situ by mixing environmental media with stabilizers or binding agents, such as Portland cement (PC) and slag. The blend of cementitious materials (e.g., PC and slag) is defined as the admixture, and the grout is the mixture of admixture with water. The environmental media is then considered to be treated sediment or soil once the grout is added. This physical and chemical modification of the impacted materials has been proven to be effective for NAPL and a variety of contaminants in environmental media (Grubb et al. 2020; Olean et al. 2016; ITRC 2011; EPA 2009c). Laboratory pilot studies can be conducted to evaluate the compatibility of the contaminants and material(s) used and the grout ratios to optimize the remedial approach.

ISS has been effectively used for decades at hundreds of upland sites around the country, many of which are manufactured gas plant (MGP) sites like Gasco. ISS is also nationally established as an effective remedial technology to address contaminated sediments, specifically identified in the NCP (EPA 1994). ISS has been effectively used at many contaminated sediment sites, including the following:

- Gowanus Canal Superfund Site (EPA-led site) in New York included 872 cubic meters of treated sediments with NAPL (2015 pilot; Tsiamis et al. 2015) and approximately 15,000 cubic yards of treated sediments with NAPL (this cleanup is ongoing; B&B Engineers & Geologists 2020).
- Slurry Pond Sediment Project[4] in Montgomery, Alabama, included 550,000 cubic yards of treated sediments (2021).
- Koppers Co. Ashley River Superfund Site (EPA-led site)[4] in Charleston, South Carolina, included 2,450 cubic yards of treated sediments with NAPL (pilot study in 2003; EPA 2003).
- Former coal tar processing facility, Island End River[4] in Everett, Massachusetts, included 100,000 cubic yards of treated sediments with NAPL (2007; Arcadis 2008).
- New Bedford Harbor Superfund Site (EPA-led site) in New Bedford, Massachusetts, included 7,000 cubic yards of treated sediments (2011; Finn 2012).
- Sydney Tar Ponds in Sydney, Nova Scotia, included 700,000 cubic meters of treated sediments (2008 to 2010; PWGSC 2014).
- Connecticut River MGP in Springfield, Massachusetts, included 74 cubic yards of treated sediments with NAPL (pilot study in 2013; EPRI 2014).
- Darling International Site in New Jersey included 300 cubic yards of treated sediments (pilot study in 2005; Maher et al. 2005).
- Fox River (prior to EPA-led cleanup) in Menasha, Wisconsin, included 500 tons of treated sediments (pilot study in late 1990s; Renholds 1998).
- Crotty Street Channel in Bay City, Michigan, included 2.3 acres of treated sediment area (pilot study in 1999; GE et al. 2004).

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[4] Sevenson Environmental Services, a member of the Design Team, was the contractor who performed the sediment cleanup construction at this site.

- LaSalle Canal MGP Site in LaSalle, Illinois, included 70,000 cubic yards of treated sediments (2018; Lowry et al. 2019).
- Kendall Bay in Sydney, Australia, included 7,000 cubic meters of treated sediments (2021; Meric 2022).
- Jones Street Remediation in Manistee, Michigan, included 7,500 cubic yards of treated sediments with NAPL (2018; Zellmer et al. 2023).
- Berth 10 area at the Former Coastal Oil of New England Terminal in Boston, Massachusetts, included 15,650 cubic yards of potentially oil-impacted sediments (2018; GEI 2021).

1.3 Bench Scale Treatability Study Objectives

The Design Team has full confidence that ISS will be effective at the Project Area. It has been used to achieve remedial objectives at the list of in-water sediment cleanup sites with similar contaminants and conditions referenced in Section 1.2. ISS grout addition will obviously change the nature of the substrate, but concrete is accepted and widely used for in-water construction, and suitable cover materials can be placed as necessary overlying the treated sediments to support habitat improvement. The Design Team is unaware of any adverse effects from leaching of cementitious components. The exact parameters for optimizing ISS performance in the Project Area will be determined by this site-specific TS. This section describes the objectives of the TS to support design. It also describes the data that will be generated from the testing and how the data will be used to support RD.

1.3.1 Physical Property Testing Objectives and Evaluation Criteria

Physical property testing will be performed on homogenized samples collected from representative sample locations before and after the addition of various grout compositions and dosages to determine the strength and permeability of the untreated sediments and soils and treated sediment and soil.

A strength target for treated sediment and soil will be reaching a nominal 50 pounds per square inch or greater to structurally support the minimal post-construction loading on top of the ISS-treated materials, which will be limited to placement of cover (or cap, if applicable) materials such as materials for habitat restoration, as determined during RD. Strength data collected during the TS will be used during RD to confirm that the treatment zones can support the anticipated designed post-construction conditions. Similar to Olean et al. (2016), observations of potential stabilized NAPL in cylinders subjected to the strength testing will be documented.

A permeability of 10^{-6} centimeters per second (cm/s) or less will be targeted for treated sediment and soil. This target was selected to be consistent with performance criteria set forth for other ISS studies at similar sediment cleanup sites, including the Gowanus Canal, Quanta Resources Site (OU1; EPA 2011), Sydney Tar Ponds (PWGSC 2014), and the Connecticut River (EPRI 2014). The permeability data collected during the TS will be used during RD to inform chemical fate and transport evaluations for the post-construction condition. Confirmation of meeting the performance criterion of 10^{-6} cm/s will confirm negligible advective flux occurs through the ISS treatment area. The treatability test results and subsequent RD evaluations will be used to verify that the permeability performance criterion of 10^{-6} cm/s, or representative permeability achieved in treatability test samples (if lower), is sufficient to minimize or eliminate advective flux.

1.3.2 Leachability Testing Objectives and Evaluation Criteria

NW Natural is aware of the potential for diffusive mass flux of dissolved-phase contaminants through interconnected pore spaces in ISS-treated sediments. This is different than advective flux or transport of groundwater through the treated material. Given the expected final permeability target for ISS, there will be negligible advective flux through the treated areas. Diffusive mass flux is different. If present, diffusion would occur because of chemical concentration gradients between the treatment zone and surface water (e.g., higher concentrations in very small, isolated pores relative to lower concentrations in surface water). Contaminants of concern (COC) mass in the pores closest to surface water will deplete first, and over time, the concentration gradient and the diffusive mass flux from the treated material will decrease. Eventually, COC mass in distant pores may begin to diffuse toward surface water, but with a weaker concentration gradient (due to increased diffusion distance) and, therefore, lower diffusive mass flux. To determine the magnitude of diffusive contaminant flux, and whether and how it would need to be mitigated in design (e.g., cover and/or cap placement), leachability testing will be performed. The multiple lines of evidence leachability testing is described in Section 3.6.

In addition, Dean-Stark testing will be performed to measure dense NAPL (DNAPL) saturation in the treated sediment and soil given this parameter can influence long-term, diffusive mass flux. These data will be used to further support RD evaluations surrounding the most cost-effective grout composition and dosage to achieve a permanent and protective remedy in the nearshore. Free-phase DNAPL is not expected to remain in ISS-treated samples (Olean et al. 2016). If free-phase DNAPL is not observed following ISS treatment, it will be concluded that DNAPL is immobile.

1.4 Document Organization

The following sections are included in this Work Plan:

- Section 2 – Existing Data Review and Sample Location Selection
- Section 3 – Bench Scale Treatability Study Sampling and Analysis
- Section 4 – Bench Scale Treatability Study Schedule
- Section 5 – Reporting
- Section 6 – Bench Scale Treatability Study Costs
- Section 7 – ISS Field Pilot Study
- Section 8 – References

In addition, the following appendices are included in this Work Plan:

- Appendix A – Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan
- Appendix B – Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Protection Plan
- Appendix C – Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan
- Appendix D – Supporting Information for Proposed Sample Locations
- Appendix E-1 – Response to EPA and DEQ January 18, 2023 Comments on the In Situ Stabilization and Solidification Laboratory Pilot Study Work Plan
- Appendix E-2 – Response to EPA March 14, 2023 Comments on the Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan and April 14, 2023 Comments on the In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan Addendum

2 Existing Data Review and Sample Location Selection

Existing data were reviewed to inform the selection of representative TS sample collection locations and depth intervals throughout the nearshore Project Area treatment zone. Four in-water sediment and two riverbank soil locations were selected to cover a range of representative conditions for the strength, permeability, and leachability testing described in Section 3. Sections 2.1 and 2.2 describe the rationale for the selection of the sample locations.

2.1 In-Water Sediment Sample Locations and Depths

Based on the multiple lines of evidence evaluation, TS samples are proposed co-located with the following historical in-water sample locations and depths:

- Location C273 from 0 to 4 feet (contains 70% fines and 28% sand with 1.7 feet of PTW-NAPL)
- Location C301 from 0 to 4 feet (contains 63% fines and 35% sand with 2.5 feet of PTW-NAPL)
- Location C278 from 4 to 8 feet (contains 49% fines and 46% sand with 0.4 feet of PTW-NAPL)
- Location C302 from 4 to 8 feet (contains 15% fines and 86% sand with 2.5 feet of PTW-NAPL)

The following two primary and three secondary lines of evidence were used to identify the four in-water TS locations and subsurface sampling depth intervals presented in Table 2-1:

1. **Primary lines of evidence:** A primary objective of the TS is to perform bench scale testing using samples with a range of representative grain sizes that contain PTW-NAPL.
    a. **Presence of PTW-NAPL:** Existing sediment locations with PTW-NAPL within the proposed ISS treatment zone were identified using the site-specific definition of PTW-NAPL based on visual observations, as defined in the EPA-approved *Revised Pre-Remedial Design Data Gaps Work Plan* (Anchor QEA 2019). See Figures 2-1a through 2-1d. As discussed in item 1b below, the thickness of previously observed PTW-NAPL intervals was also considered to provide the highest likelihood of encountering PTW-NAPL at the proposed TS sediment sampling locations and depth intervals.
    b. **Grain size distribution:** Based on the physical processes and resulting effects of mixing cement with various grain sizes and the resulting crystalline structure, solidified materials, especially finer grained materials, can generate a range of results for leachability. Using the comprehensive EPA-approved data collected within the Project Area, grain size data were reviewed at historical locations and depth intervals with PTW-NAPL (see Figures 2-2a through 2-2d). Sediment sampling locations and depth intervals were selected to provide a representative range of grain size distributions in PTW-NAPL-containing sediments to test sediments with varying amounts of sands and fines. To facilitate achieving TS sample

volume requirements,[5] grain size data were evaluated and averaged across four depth intervals: 0 to 4 feet, 4 to 8 feet, 8 to 16 feet, and deeper than 16 feet.

Figures 2-3a and 2-3b present two histograms that show grain size distribution within the evaluated depth intervals[6] at all subsurface sediment locations with applicable grain size data within the ISS treatment zone (Figure 2-3a) and at the subset of those locations that have PTW-NAPL within the given depth interval (Figure 2-3b). As shown in Figure 2-3a, when compared to all sediment locations with grain size data, the proposed 4- to 8-foot depth interval at C302 (15% fines and 86% sand) is near the high end of the range of percent sands. The proposed 4- to 8-foot depth interval at C278 (49% fines and 46% sand) falls near the middle of the grain size distribution with an approximately even split of sands and fines. The proposed 0- to 4-foot depth interval at both C273 (70% fines and 28% sand) and C301 (63% fines and 35% sand) trend toward the moderately high end of the range of percent fines.

Similar trends are apparent when comparing the grain size data at the proposed locations and depth intervals to the grain size data from the subset of locations and depth intervals that have both grain size data and historical PTW-NAPL observations (see Figure 2-3b). The proposed 4- to 8-foot depth interval at C302 has the highest percent sands of any such location and depth interval. The proposed 4- to 8-foot depth interval at C278 falls near the middle of the grain size distribution with an approximately even split of sands and fines. The proposed 0- to 4-foot depth interval at both C273 and C301 continue to trend toward the moderately high end of the range of percent fines. The locations and depth intervals with PTW-NAPL observations and higher percent fines than C273 (0 to 4 feet) and C301 (0 to 4 feet) were not proposed for sampling because both locations and depth intervals had larger observed PTW-NAPL depth intervals, so they are more likely to meet the objectives of the TS. Specifically, the following locations and depth intervals were not chosen for the following reasons:

i. **C662 (0 to 4 feet), 71% fines:** This location is immediately adjacent to the proposed location that is co-located with C301 (0 to 4 feet), which has a relatively similar percent fines (63%) to C662 (0 to 4 feet). However, C662 (0 to 4 feet) has a relatively thin PTW-NAPL depth interval, from 2.3 to 4 feet, whereas C301 (0 to 4 feet) has PTW-NAPL from 1.5 to 4 feet.

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[5] Grain size data in smaller (e.g., 1-foot) intervals would be difficult to target and to obtain sufficient sample volume required to meet TS objectives during field sampling.

[6] Each histogram was developed using the full depth of sediments with grain size data (i.e., all locations with grain size data anywhere from 0 to greater than 16 feet deep). This was done to better illustrate where the proposed locations and depth intervals fall within the overall grain size distributions that occur within the ISS treatment zone.

    - ii. **DGS-32SC (0 to 4 feet), 71.5% fines:** A relatively thin 0.6-foot-thick depth interval of sediments containing PTW-NAPL was observed within the 0- to 4-foot depth interval at this location. For comparison, a 1.7-foot-thick depth interval of PTW-NAPL was observed within the proposed 0- to 4-foot depth interval at C273, and a 2.5-foot-thick depth interval of PTW-NAPL was observed within the 0- to 4-foot depth interval at C301.
    - iii. **PDI-080SC (0 to 4 feet), 76% fines:** PTW-NAPL was observed from 0.6 to 2.3 feet at this location. The grain size sample at this location was collected from 2 to 5 feet. Review of the boring log for this location indicates the interval containing PTW-NAPL is a sand with silt, so the true percent fines over the entire 0- to 4-foot depth interval is likely lower than for C273 (0 to 4 feet) and C301 (0 to 4 feet).
    - iv. **PDI-079SC (4 to 8 feet), 87% fines:** A relatively thin 0.4-foot-thick depth interval of sediments containing PTW-NAPL was observed within the 4- to 8-foot depth interval at this location.
    - v. **PDI-069SC (8 to 16 feet), 93% fines:** A relatively thin 0.6-foot-thick depth interval of sediments containing PTW-NAPL was observed within the 8- to 16-foot depth interval at this location.

  The four proposed sediment sampling locations and depth intervals are representative of the range of grain sizes (i.e., one proposed sample interval contains high percent sand, another contains an approximately even split of sand and fines, and two contain high percent fines) while providing the highest likelihood that sufficient sample depth containing the target grain size can be collected. In addition, the proposed locations provide a high likelihood that PTW-NAPL will be encountered in the target sample intervals. No additional locations or depths are needed given the representativeness of the four proposed locations. Using the full range of grain size distribution and NAPL conditions ensures testing will confirm grout mix effectiveness in all areas of the site.

2. **Secondary lines of evidence:** While the presence of PTW-NAPL and grain size distributions were the most important considerations for selecting in-water locations, secondary lines of evidence considered include existing sediment concentrations, the presence of forms of product that do not achieve the Project Area-specific definition of PTW-NAPL, and spatial coverage across the ISS treatment zone. A brief summary of the evaluation findings for these lines of evidence is provided as follows:
    - a. **Existing sediment concentrations were considered for the following COCs:**
        - i. **Naphthalene:** Naphthalene PTW-NRC threshold exceedances were reviewed. As shown in Figures 2-4a through 2-4d, two of the four proposed sample locations

and depth intervals contain a naphthalene PTW-NRC exceedance. The PTW-NRC threshold exceedance factor at historical locations C301 from 0 to 4 feet and C302 from 4 to 8 feet are 12 and 140, respectively.

ii. **Benzene:** Benzene sediment concentrations in three of the four proposed sample locations and depth intervals are above the median value of benzene concentrations within the ISS treatment area. At historical location C302 from 4 to 8 feet, the benzene concentration is within the upper 95th percentile of benzene concentrations.

iii. **Chlorinated volatile organic compounds (VOCs; specifically trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethene, and vinyl chloride)[7]:** Transition zone water and in-river groundwater chlorinated VOC concentrations were evaluated in Appendix A of the *Draft Engineering Evaluation/Cost Analysis – Gasco Sediments Cleanup Action* (EE/CA; Anchor QEA 2012). As shown in Figures 4-2 and 4-5 through 4-7 of the EE/CA, the elevated concentrations are restricted to the navigation channel and the 10-foot lateral landward offset (to account for future maintenance dredging by the U.S. Army Corps of Engineers), which is outside the ISS treatment area. In addition, as shown in Table 4-3b in the *Revised Final Pre-Remedial Design Data Gaps Data Summary Report* (DSR; Anchor QEA 2022b), 324 nearshore subsurface sediment samples were analyzed for this full suite of chlorinated VOCs, and no detected concentrations were identified. Based on these data, these chemicals were not used as a line of evidence for locating the in-water locations. However, the two proposed in-water locations are directly shoreward of the sediments designated as Area 2 in the EE/CA based on detected chlorinated VOCs in transition zone water in the navigation channel.

iv. **Metals:** The main effect of grout addition is anticipated to be due to elevated pH imposed by the grout mix components, which could affect leachability of some inorganics. However, most cationic metals (e.g., zinc, lead) would be expected to be less leachable at high pH due to the insolubility of their hydroxides, and leachability of arsenic is generally reduced due to reaction with calcium and magnesium in the grout mix components to form relatively insoluble solid phases. However, metals data within the ISS treatment area were considered when evaluating proposed locations to confirm that metals bulk sediment concentrations at the proposed locations and depth intervals are expected to be representative of

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[7] These chlorinated VOCs are included as site-specific COCs in Section 3.3 of the *Statement of Work – Gasco Sediments Site* (EPA 2009b).

the range of concentrations present throughout the ISS treatment area. Anchor QEA confirmed that metals sediment concentrations at the four proposed sample locations and depth intervals are generally representative of the metals concentrations within the ISS treatment area, as shown in Table 2.

b. **Presence of forms of product that do not achieve the Project Area-specific definition of PTW-NAPL:** Core logs for the selected locations are included as Appendix D and show that forms of product that do not achieve the Project Area-specific definition of PTW-NAPL are expected to be present in the targeted samples. Forms of product that do not achieve the Project Area-specific definition of PTW-NAPL, where encountered, will therefore be included in the sediments collected for treatability testing.

c. **Representative spatial coverage:** The spatial coverage of the proposed in-water sampling locations across the Project Area was also considered to ensure not all proposed locations were collected in the same proximity.

The proposed in-water sample locations are shown in Figure 2-5. These locations are representative of a range of grain size conditions and depth intervals containing PTW-NAPL[8] across the Project Area and will be used to characterize ISS strength, permeability, and leachability performance in the nearshore treatment zone.

2.2 Riverbank Soil Sample Locations

Two rounds of riverbank angled boring have recently been completed to characterize riverbank soils along the Gasco and Siltronic properties. In 2019, a series of 11 riverbank borings were advanced at a 45-degree angle and sampled in large (approximately 10-foot) composite sample intervals to generally characterize riverbank soils. In April and May of 2023, 11 additional riverbank angled borings (each co-located with the 2019 riverbank angled borings) were advanced at a 20-degree angle (i.e., steeper angle from vertical) and sampled in 1-foot intervals to delineate the depth of contamination underlying the riverbank at the Gasco and Siltronic properties adjacent to the Project Area. TS samples are proposed co-located with two historical angled riverbank boring locations, PDI-134 (2019 boring location ID)/PDI-216 (2023 boring location ID) and PDI-142/PDI-224, located on the Gasco and Siltronic properties, respectively (Appendix D). The two proposed riverbank soil sample locations are shown on Figure 2-6, and the rationale for selection of these two locations is provided as follows.

The Design Team reviewed the results of the 11 angled riverbank borings adjacent to the Project Area, as presented in the DSR (Anchor QEA 2022b), to understand the physical characteristics

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[8] Locations and depths of previous PTW-NAPL observations were used to help target locations and depths where PTW-NAPL should be encountered during TS sample collection. During TS sample collection, field personnel will document that visible PTW-NAPL is present in each TS sample. If PTW-NAPL is not present, NW Natural will coordinate with EPA to identify a revised sampling location.

and chemical concentrations identified in the riverbank soil relative to the four proposed sediment TS locations to determine if separate leachability testing of the riverbank soil is warranted to support RD. Both physical and chemical results are available for the 2019 characterization, but only visual/olfactory observations for the borings performed adjacent to the Gasco property are available for the 2023 characterization. Chemical analyses for the 2023 borings collected adjacent to the Gasco property are ongoing and the 2023 borings proposed adjacent to the Siltronic property have not yet been performed.

As shown in DSR Appendix B-3, the logged depths of the eight 2019 angled riverbank borings on the Gasco property were composed predominantly of varying degrees of silts and gravelly silts, interspersed with thin zones of brick or concrete. These materials are indicative of non-native fill. PTW-NAPL was identified in a thin zone at one angled boring location (the interval begins and ends at 16.3 feet along the angled boring alignment at PDI-137). As shown in DSR Table 4-7a, RAL exceedances for total polycyclic aromatic hydrocarbons (PAHs) occurred in numerous samples at all angled riverbank borings on the Gasco property with the exception of PDI-140. Soils at PDI-134 contain varying amounts of lampblack and tar and have consistently elevated total PAH concentrations at all sample depths (860,000 to 12,000,000 micrograms per kilogram [µg/kg]). The soil types at PDI-134 (i.e., gravelly silts and debris fill) are unique relative to the sediments located just offshore of the bottom of the Gasco riverbank (i.e., generally fine-grained sediments) and are generally typical of fill soils along the Gasco property portion of the riverbank. The soil types identified at the collocated PDI-216 at a slightly steeper angle from vertical in 2023 were consistent with those identified at PDI-134 (Appendix D).

As shown in DSR Appendix B-3, the logged depths of the three 2019 angled riverbank borings on the Siltronic property within the Project Area were composed of sands with interspersed gravels, and no PTW-NAPL was identified. As shown on DSR Table 4-7a, one boring (PDI-142) contained one RAL exceedance for total PAHs (280,000 µg/kg). This location predominantly consisted of medium to coarse-grained, well graded sand. In contrast, the targeted 0- to 4-foot interval at sediment TS location ISSTS-003 located just offshore of the bottom of the Siltronic riverbank contains PTW-NAPL and fine-grained sediments. In addition, the 4- to 8-foot interval at sediment TS location ISSTS-004 located in the same area as ISSTS-003 contains PTW-NAPL and coarse sands. Chemical analysis of the untreated sediments from these TS locations is ongoing, but it is anticipated to identify elevated total PAH RAL exceedances based on the visual and olfactory characteristics.

Given the differences in the physical and chemical characteristics of the riverbank soil and sediment testing locations at the Gasco and Siltronic properties, the Work Plan has been revised to include two angled riverbank borings co-located with PDI-134/PDI-216 and PDI-142/PDI-224, and completion of initial characterization of untreated soil and Phase I through III testing. Consistent with the approach identified in the EPA-approved *Final Revised Additional Depth of Contamination Characterization*

Addendum within the Gasco Sediments Site Project Area (Anchor QEA 2023), the riverbank borings will be advanced at an approximately 20-degree angle to at least the visual/olfactory depth of contamination identified during the sampling work performed by Anchor QEA in April 2023. Unlike the TS sediment sample locations which targeted a specific sampling depth as described in Section 2.1, the riverbank soil borings are anticipated to represent the materials found within the Fill WBZ. Therefore, a single composite sample representative of the Fill WBZ in the riverbank area will be collected from the full length of the boring from the surface to the estimated depth of contamination based on visual and olfactory observations during boring logging.

3 Bench Scale Treatability Study Sampling and Analysis

This section describes the proposed TS sampling and analysis for in-water sediments and riverbank soils to support the design.

3.1 Sample Collection and Handling

As noted in Section 2, existing chemical and physical data were used to select the sample locations based on the full characterization of the Project Area. Samples will be collected at the locations identified in Section 2 using a vibracore sampler at in-water sediment sample locations and riverbank angled sonic boring soil sample locations. Sampling methodologies are described in the *In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan* (Appendix A), and laboratory analyses and quality control measures are described in the *In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan* (Appendix B). The anticipated sample collection, handling, and testing sequence is as follows (see Figures 3-1 through 3-3):

1. In-water sediment cores and riverbank angled sonic soil borings will be collected from each target location and subjected to steps 2 through 5. Multiple slightly offset sediment cores will need to be collected from each location to obtain sufficient bulk sediment materials for use in the TS. Sufficient bulk riverbank soil material will be available from each single deep sonic boring.
2. Sediment and soil from target intervals[9] will be collected and homogenized on site in a manner that limits loss of VOCs.
    a. Prior to homogenizing sediment cores collected at a given sampling location, the sediment cores will be visually assessed for the presence of PTW-NAPL. If PTW-NAPL is present, a portion of the sediment layer containing PTW-NAPL may be collected and shipped to the laboratory to attempt separating a pure DNAPL sample from the sediment via centrifugation. If successful, the DNAPL will be submitted for physical and chemical characterization, contingent on sample volume requirements.
3. The homogenized material from each location will be subsampled for baseline characterization of untreated samples (e.g., physical property testing, leachability testing prior to grout addition; see Section 3.2).
4. The remainder of the homogenized material from each location will be sent for grout component testing using the grout blends and dosages summarized below and detailed in Section 3.4. The homogenized material will be shipped in sealed containers with no headspace, to the extent feasible, and held at appropriate temperatures to minimize loss of VOCs during shipment and storage.

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[9] As described in Section 2, target depth intervals were determined using historical in-water core and upland boring information. While logging each core and boring, the field team will confirm the intervals that contain materials with the desired characteristics (i.e., presence of PTW-NAPL and general grain size distribution) for each target location.

    a. First, the grout compositions will be evaluated by varying the water to cement admixture (W/C) and blast furnace slag cement (BFSC) to PC ratios, as described in Section 3.4.
    b. Second, the selected grout composition will be applied to the sediment and soil materials in varying dosage rates to determine the appropriate dosage rate(s), as described in Section 3.5.
5. Section 3.5 describes the testing that will be used to select the grout dosage(s) that best achieve the RD objectives for strength and permeability testing. Sediment and soil samples will be treated with this dosage(s) for leachability testing. Replicates of those treated sediment and soil samples will be sent to Anchor QEA's Environmental Geochemistry Laboratory in Portland, Oregon, for leachability testing, as described in Section 3.6.1.

3.2 Initial Characterization of Grout Admixtures and Untreated Samples

In accordance with EPA's Specific Comment 12 (Appendix E-1), the BFSC and PC admixtures that will be used for the TS will be characterized via test results. Also, in accordance with EPA's March 14, 2023 Specific Comment 11 (Appendix E-2), the analytical suite shall be all COCs with a ROD Table 17 groundwater cleanup level (CUL), dioxin/furans, sulfate, and chloride. Dissolved organic carbon (DOC), pH, oxidation reduction potential (ORP), and specific conductivity will not be analyzed because those analyses are specific to water testing.

As identified in Section 2, sediment will be collected from four in-water locations, and soil will be collected from two locations on the riverbank. Material from each location will be homogenized in the field, and the homogenized material from each location will be subsampled and submitted for physical and chemical analysis of the untreated sediments or soils (i.e., baseline characteristics). The objective of performing chemical analyses on the bulk untreated sediment and soil samples is to provide a baseline chemical characterization for reference while interpreting the Phase III untreated and treated and Phase IV treated sediment and soil leachability testing results (see Section 3.6). As discussed in NW Natural's response to EPA Specific Comment 11 in Appendix E-1, the bulk untreated sediment and soil samples will be analyzed for all COCs with a ROD Table 17 groundwater CUL. Both the sediment and soil samples will also be analyzed for dioxin/furans, sulfate, chloride, permeability, grain size, bulk density, total organic carbon (TOC), total solids, moisture content, Atterberg Limits, and porosity.

The untreated sediment and soil leachability tests will be performed as described in Section 3.6.1.

3.3 Summary of Phased Treatment Testing Approach

This section describes the four phases of treatability analyses to be performed using ISS-treated sediment and soil samples. Phase I is to determine the most efficient composition of the two components, BFSC and PC. It evaluates the impacts to treated sediment and soil strength and permeability due to changes in the ratio of BFSC and PC under a constant grout dosage, as illustrated in Figure 3-1. This initial phase is completed using a single sediment sample that contains the greatest percent fines because these samples contain a higher potential for increased permeability post-treatment and both soil samples from the riverbank. Phase II uses the grout composition selected based on the Phase I testing results to evaluate the impacts to treated sediment and soil strength and permeability due to changes in the grout dosage in sediments and soils, as illustrated in Figure 3-2. This phase is completed using four in-water sediment and two riverbank soil sampling locations. Phase III testing will be performed on duplicate samples from the Phase II testing. It includes sediment and riverbank soil leachability testing via synthetic precipitation leaching procedure (SPLP) modified EPA Method 1312 on both untreated sediment and soil and treated sediment and soil using the single (or more if the multiple grout compositions equally achieve the composition criteria identified in Section 3.4) BFSC to PC ratio and grout dosage that best achieves the grout composition selection criteria identified in Section 3.4. Phase IV will be performed on additional duplicate sediment samples from the Phase II testing. It will consist of additional sediment leachability testing via Leaching Environmental Assessment Framework (LEAF) EPA Method 1315M (modified for organic COCs) on treated sediment using the single BFSC to PC ratio and grout dosage that achieves the lowest leachability during the Phase III leachability testing. However, consideration will also be given to the strength, cost considerations associated with adding increased dosage amounts (i.e., a lower dosage with a slightly higher leachability would be much more cost effective at approximately the same level of performance), amount of swell, and workability of the grout to determine if the lowest leaching grout should be advanced to Phase IV leachability testing. NW Natural will determine whether additional Phase V testing is warranted in coordination with EPA and DEQ based on the Phase IV testing results.

3.4 Phase I—Grout Composition Testing

During Phase I testing, ISS grout compositions will be mixed into homogenized samples of the sediments and soils in varying proportions in a program designed to achieve high-performing physical and (for treated sediment) leachability properties. Based on the Design Team’s past experience, the admixture materials will be a blend of cementitious materials (PC and BSFC). The TS will use Type 1L PC and grade 100 BFSC, consistent with the materials proposed for use during full-scale ISS implementation. Grout is the mixture of admixture materials and water that would be added to the homogenized samples. For this initial phase of the TS, the grout compositions will be evaluated by varying the W/C and BFSC/PC ratios (as shown in Figure 3-1) but maintaining the grout dosage (i.e., dry weight of admixture to wet weight of sediment/soil) constant.

Selection criteria for the Phase I grout composition include the following:

- Meeting the TS requirements for strength and permeability (Section 1.3.1).
- Limiting the overall volume increase (swell) during the ISS construction.
- Providing a mix consistency that meets constructability requirements and is suitable for efficient blending of sediment or soil with the grout. At the low end of grout addition, the

consistency should resemble a “slumpable” concrete blend, with no dry clods. At the upper end, it should not be so loose as to flow away in an uncontrollable manner, and there should be no free grout remaining in the blend following mixing.

BFSC and PC materials that are locally available will be combined in different BFSC/PC ratios (0:100, 30:70, 60:40, and 90:10) and with varying W/C ratios (0.8:1, 1:1, and 1.2:1) to optimize the grout composition that achieves the strength and permeability targets (Figure 3-1). These cementitious materials and ratios are based on direct experience from the Design Team on dozens of other upland ISS sites and the Design Team’s understanding of ratios used at the small number of in-water ISS sites completed to date referenced in the Work Plan. If the range of proposed grout dosages is not meeting the project objectives, the range will be modified during the ISS TS implementation in coordination with EPA and DEQ. For only this phase of the TS, the grout dosage rate (dry weight of admixture to wet weight of sediment/soil) will remain constant at 10% and 8% and will be added to base sediments or soils, respectively, with the highest fines content.[10] Table 3-1 presents a test grid that will be followed during this phase of the TS and shows that sediment/soil treated with various grout compositions will be tested for unconfined compressive strength (UCS; ASTM D2166) and permeability (ASTM D5084) after a 28-day cure time to select the grout composition(s) for use in subsequent Phase II through IV testing. Note that strength and permeability may be tested again after 56 days to inform final cure times and physical properties during ISS construction.

In addition to strength and permeability testing, the ISS-treated materials will be visually observed for the presence of DNAPL, formation of precipitates, gels, or other supernatants during setting. Observations will be recorded and photographed.

It is expected that one composition of BFSC/PC and W/C ratios (e.g., 1:1 W/C and 90:10 BFSC/PC) will provide results that meet the strength and permeability requirements (Section 1.3.1) for the in-water sediment samples. Given the sediments and soils may behave differently following grout addition, the same or a different composition of BFSC/PC and W/C ratios may be selected to meet the strength and permeability requirements (Section 1.3.1) for soil and for sediment. The grout composition(s) that best achieves the selection criteria outlined in this section will be selected for the Phase II grout dosage rate testing with sediment and soil.

3.5 Phase II—Grout Dosage Testing

Following selection of the BFSC/PC and W/C ratios that optimally achieve the selection criteria for sediment and soil samples, as described in Section 3.4, the grout dosage rate will be varied and

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[10] From experience, base sediment or soils with higher sands content are easier to stabilize/solidify and have a larger impact on the reduction of leachability. Therefore, locations with highest fines content are expected to provide the most informative, conservative results during this phase of the work that would be applicable throughout the ISS treatment zone. The Design Team selected a 10% grout dosage for a single in-water sediment and 8% grout dosage for the two riverbank soil sampling locations based on past ISS experience and an understanding of the grout dosage used at other similar ISS cleanup sites.

physical tests will be performed to test strength and permeability of each sediment-mix and soil-mix blend (Table 3-2 and Figure 3-2). The selection criteria for the Phase II grout dosage testing are identical to the Phase I criteria. This section describes the grout dosage rates and tests that will be performed.

For Phase II testing, cylinders will be created using the BFSC/PC and W/C ratios selected following grout component testing (Section 3.4) and varying grout dosages. For sediment, the grout dosages will be 4%, 8%, 12%, 16%, and 20% (wet weight of sediment/soil to dry weight of admixture). For soils, the grout dosages will be 6%, 8%, and 10%.[11] The range of grout dosages evaluated for sediment and soil is different due to the higher moisture content and fines content in sediment. In general, higher fines and moisture content can retard strength development or decrease the UCS, while higher fines can decrease (i.e., improve) the permeability. As shown in Figure 3-2, UCS (ASTM D2166) will be tested at 3-to-5-day, 7-day, 14-day, and 28-day curing intervals following mixing, and permeability (ASTM D5084) will be tested after 7 days and again after 28 days. A visual assessment for the presence of DNAPL will be conducted before and after UCS testing, and the samples will be photographed. If any free-phase DNAPL is visually apparent, its presence will be recorded. However, consistent with results from the Gowanus Canal site, free-phase DNAPL is not expected to remain in ISS-treated samples (Olean et al. 2016). If free-phase DNAPL is not observed, it will be concluded that DNAPL is immobile due to the stabilization and solidification treatment.

3.6 Phases III, IV, and V—Leachability Properties

The grout composition and dosage(s) that optimally achieve the Phases I and II selection criteria for grout identified in Section 3.4 (i.e., meeting the strength and permeability targets, limiting the overall volume increase [swell] during the ISS construction, and providing a mix consistency that meets constructability requirements and is suitable for efficient blending of sediment or soil with the grout) will be subject to the leachability testing described in this section. It is important to note that there may be more than one Phase II dosage that equally achieves the Phase II selection criteria, in which case more than one dosage may be used in the leachability testing. The Phase III leachability testing will be performed for treated and untreated sediment and soil samples to assess the effectiveness of the optimized Phase II grout dosage(s) in reducing leachability of the COCs. The leachability testing may be conducted in three tiered phases (i.e., Phases III, IV, and V). Each successive phase incorporates more sophisticated testing and will involve equal or fewer (in the case that more than one dosage is performed during the Phase III testing) sediment/grout composition(s) than the previous phase. Table 3-3 and Figure 3-3 summarize the three-tiered leachability testing phases. The remainder of this section describes each phase of testing.

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[11] If dosage rates higher than the proposed 10% rate are identified for upland soil during the Phase II testing, NW Natural will coordinate with EPA and DEQ to incorporate a higher dosage rate(s) in the testing.

Phase III testing using untreated sediment *and* treated sediment is expected to demonstrate that, when subjected to the same leaching test, the magnitude of leaching from treated material is less than that from untreated material.

It is anticipated that sediment treatment will practically eliminate the mass flux associated with advection. Advection is, therefore, not relevant to treated sediment, but diffusion associated with treated sediment will be evaluated by Phase IV testing. The Phase IV testing will quantify the mass flux via diffusion for target COCs from treated sediments because that information is required to inform the RD. Diffusion rates of COCs from untreated sediment have no relevance for the RD, nor for monitoring the remedy after construction. Thus, the additional cost for Phase IV tests of untreated sediment is not justified, and Phase IV tests will focus solely on treated sediments.

Treated riverbank soil will not undergo Phase IV testing. The portions of the treated riverbank soils that are above the river level will have negligible potential to leach COCs, and data from untreated riverbank soils are not relevant for design. Further, any exposed portions of the treated riverbank that could be periodically wetted by precipitation would have little contact time due to the slope of the impermeable ISS surface. The portions of the riverbank soil that are below river level will be subject to capping or covered with appropriate material, consistent with the RD for submerged sediment; therefore, no Phase IV testing is needed for treated riverbank soils to support the RD.

3.6.1 Phase III Leachability Testing

The optimized Phase II grout composition and dosage(s) will be used to perform Phase III leachability testing at Anchor QEA's Environmental Geochemistry Laboratory in Portland, Oregon. In Phase III, untreated and treated soil and sediment cylinders will be evaluated by a single time point batch extraction test (i.e., SPLP modified EPA Method 1312[12]) to document changes in leachability due to the selected grout composition and dosage(s) and to narrow down the number of sediment/grout and soil/grout compositions, if necessary, for further leaching tests in Phase IV. The Design Team reviewed the full list of COCs containing a ROD Table 17 groundwater CUL and determined that the following subset of COCs includes a broad range of analytes for which leachability reduction is anticipated to be critically dependent on grout dose and, therefore, will be used for both the untreated and treated sediment and soil Phase III leachability testing: PAHs, VOCs, metals, cyanide, TOC, DOC,[13] pH, ORP, and specific conductivity.

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[12] Modifications to EPA Method 1312 are discussed in Appendix A.

[13] As discussed in Section 2.1, the main effect of grout addition is anticipated to be due to elevated pH imposed by the grout mix components. The basic pH may also enhance DOC leaching from sediment, and some studies suggest that PAHs can be mobilized with DOC (ITRC 2011). Inclusion of DOC is intended to assess the potential effect of geochemical changes on leachability, if any, due to cement addition.

Additional details about Phase III leachability testing and analytical methodologies, including the proposed modifications to EPA Method 1312, are included in Appendices A and B.

3.6.2 Phase IV Leachability and Advanced Physical Testing

It is anticipated that the grout composition and dosage that achieves the lowest leaching during Phase III testing will advance to Phase IV leachability testing for target COCs (i.e., EPA LEAF Method 1315M, modified for organic COCs[14]). However, other factors may also be considered in the final selection of grout composition and dose that advances to Phase IV testing. Those factors include strength, amount of swell, workability, and cost considerations associated with increased grout dosage (e.g., a lower dosage with a slightly higher leachability may be selected for Phase IV testing if it would be much more cost effective). EPA Method 1315M will be performed on treated sediments, and the data generated will be used to quantify diffusive mass flux of target COCs from freshly treated sediment to support cover (or cap, if applicable) design. As such, Phase IV leachability testing will not include untreated sediment since diffusive mass flux from untreated sediment is not required for cover/cap design.

EPA Method 1315M is modified from the original EPA Method 1315 by including a polydimethylsiloxane (PDMS) liner insert in the extraction vessel to maintain an aqueous concentration gradient of organics COCs across the surface of the treated cylinder, resulting in a constant diffusive flux (EPRI 2009; ITRC 2011; van der Sloot 2009; Gentry et al. 2014; Grubb et al. 2020). The PDMS liner acts as a sink for target organic COCs released from the treated cylinder to the surrounding solution, thereby preventing concentrations from building up to equilibrium concentrations in the solution, which would discontinue the diffusive flux and reduce the cumulative mass release of organic COCs from the cylinder. The leaching interval duration will follow the standard EPA Method 1315 procedure (9 intervals over 63 days). Diffusive flux will be evaluated for each COC in terms of the cumulative mass released over time by summing the aqueous concentrations and, for organic COCs, the mass accumulated on the PDMS liner insert for each leaching interval.

3.6.2.1 Phase IV Target COCs

Target COCs for Phase IV testing will include:

- PAHs and VOCs, which will be analyzed in the water bath and PDMS liner
- Metals and cyanide, which will be analyzed only in the water bath in accordance with the EPA Method 1315M procedure for inorganic COCs

The water bath will also be analyzed for TOC, DOC, pH, ORP, and specific conductivity.

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[14] Modifications to EPA LEAF Method 1315 are discussed in Appendix A.

It is technically unnecessary and cost-prohibitive to measure the diffusive mass flux of all COCs with ROD Table 17 groundwater CULs during the Phase IV leachability testing; therefore, data collection will focus on the listed target COCs. However, the data collected during Phase IV testing will provide sufficient information to develop conservative estimates of diffusive flux for all non-target COCs with ROD Table 17 groundwater CULs.

3.6.2.2 Application of Phase IV Test Results to Estimate Diffusive Mass Flux for Non-Target COCs

The diffusive mass flux of a COC across the surface of the treated cylinder is the product of the effective diffusion coefficient (D_e) of the targeted COC and the aqueous concentration gradient between the porewater inside the treated cylinder and the concentration in the surrounding water bath.

The porewater concentration for non-target COCs in the treated cylinder can be conservatively estimated using equilibrium partitioning calculations based on concentrations of non-target COCs and TOC in untreated bulk sediment, and site-specific partitioning coefficients (K_D for inorganics or K_{OC} for organics). A comprehensive summary and evaluation of site-specific sediment-water partitioning coefficients for all ROD Table 17 COCs is included in Appendix G of the Combined BOD-PDR (Anchor QEA 2021). Porewater concentrations calculated using bulk sediment analytical results and sediment-water partitioning coefficients are considered conservative because following ISS treatment, partitioning will be either reduced (due to physical encapsulation of contaminated particles or chemical interactions with grout components) or remain relatively unaffected. In addition, the presence of NAPL mass in the untreated sediment samples will result in a conservatively high estimate of equilibrium porewater concentrations for non-target COCs.

The effective diffusion coefficient (D_e) of a dissolved constituent in a porous medium is related to its aqueous (free-water) diffusion coefficient (D_0) by:

$$D_e = D_0 \times \frac{\theta}{\tau}$$

where:

θ = porosity

τ = tortuosity

D_0 = aqueous diffusion coefficient, fundamental property of a chemical constituent, which is available in the literature

Porosity and tortuosity are properties of the porous medium (i.e., treated cylinder) and do not depend on the diffusing compound. The ratio θ/τ for a given treated sediment sample is determined by dividing D_e for a target COC (calculated from EPA Method 1315M data) by D_0. Effective diffusion coefficients for target COCs, and therefore θ/τ, will be quantified based on the EPA Method 1315M test results. Knowing θ/τ, effective diffusion coefficients can be calculated for the non-target COCs.

This evaluation will identify the non-target COCs with relatively high diffusive flux, which will inform the subsequent field pilot sampling design. Empirical demonstration that ISS treatment will be protective for the full list of COCs containing ROD Table 17 groundwater CULs will be performed in the field following the completion of the ISS field pilot study.

3.6.2.3 Equilibrium Porewater Concentration Measurement for Target COCs

Following completion of the EPA Method 1315M leachability tests, treated sediment cylinders will be removed from the last EPA Method 1315M reaction vessels and placed in new vessels containing unused reagent water to estimate equilibrium porewater concentrations of target COCs inside the treated sediment cylinders. The purpose of this test will be to allow the water in the container to approach or achieve equilibrium with the porewater in the treated cylinder. No PDMS liner will be inserted into the new vessels, and aqueous samples will be collected at several time intervals to estimate equilibrium aqueous concentrations. An empirical study of coal tar dissolution demonstrated that effective solubility for PAHs and VOCs was achieved in the aqueous phase within approximately 84 minutes in contact with DNAPL in a porous medium (Eberhardt and Grathwohl 2002). Data collected during long-term equilibration testing of ISS cylinders for the Gowanus Canal site indicated naphthalene equilibrated in 4 to 6 weeks (Grubb et al. 2020). The equilibration test will be carried out over a period of 8 weeks—with four sampling times—and should provide sufficient data to confirm equilibration of target COCs. For any target COCs that do not appear to have reached equilibrium within 8 weeks, the data will be used to estimate equilibrium values by extrapolation of concentration versus time trends. If a sheen or NAPL is visible in/on the water in an equilibrium test container, the water sample may be collected using a porous ceramic filter to avoid including sheen or NAPL in the analyzed aqueous sample. DOC concentrations and pH in the leachate will also be measured.

Additional details about Phase IV leachability testing and analytical methodologies, including the proposed modifications to EPA Method 1315, are included in Appendices A and B.

3.6.2.4 Phase IV—Microscale Pore Characterization

Scanning electron microscopy (SEM) will be used to visually observe the microstructures developed in untreated sediment samples and the treated sediment cylinders that undergoes Phase IV leachability testing. The treated sediment cylinders will be appropriately dried to remove water and processed with minimum disturbance so as to not damage the pore structure of the sample or cylinder. SEM images will be taken from different angles at different levels of magnification in the range of approximately 1,000× to 30,000× to provide the necessary imagery to show microstructures developed inside and outside of the samples. SEM images of untreated sediment and treated sediment cylinders will be compared to assess how the selected grout composition and dosage influences the development of the pore structure, which can influence leachability of the COCs.

3.6.2.5 Phase IV—Pore Size Distribution Measurement

Mercury intrusion porosimetry (MIP) will be conducted in accordance with ASTM D4404-18 to evaluate porosity, pore size distribution, and pore volume of untreated sediment samples and the treated sediment cylinders that undergo Phase IV leachability testing. These data will be utilized to assess how the selected grout composition and dosage influences the porosity, pore size distribution, and pore volume, which may affect leachability of COCs from the untreated sediment and treated sediment cylinders. The specimens for MIP will be prepared in a similar manner as SEM analysis.

3.6.2.6 Phase IV—DNAPL Saturation and Visual Assessment

Treated sediments that undergo Phase IV leachability testing will also be analyzed for DNAPL, water, and air pore fluid saturation using the Dean-Stark analysis (ASTM-D425M) given this parameter may affect leachability of COCs from treated media.

In addition, treated sediments that undergo Phase IV leachability testing will be visually assessed for the presence of DNAPL. If any free-phase DNAPL is visually apparent, its presence will be recorded and photographed. Visual assessments will occur before and after Phase IV leachability testing.

3.6.3 Phase V Leachability Testing

The need for Phase V testing will be determined, after reviewing the Phase IV testing, microscale characterization, porosity, and DNAPL saturation results. If deemed necessary, details of Phase V column setup and operation will be developed in coordination with EPA. If warranted, the sediment/grout composition from Phase IV would be advanced for column testing in which the optimized grout composition and dosage treated sediments will be placed in columns with simulated cover and/or cap material on top of the treated sediments to evaluate the potential for movement of COCs into the cover and/or cap layer and associated concentrations if movement occurs.

4 Bench Scale Treatability Study Schedule

This section presents a proposed schedule for TS field collection and testing activities. The schedule is contingent upon contractor and laboratory availability.

- EPA and DEQ review of the Work Plan: 30 days
- NW Natural revisions to Work Plan, if needed: 30 days
- EPA and DEQ review and approval of Work Plan, if needed: 14 days
- Sample material field collection program: 14 days
- Phases I and II grout composition and dosage testing: 60 to 90 days
- Phase III leachability testing: 30 to 60 days
- Phase IV leachability testing: 120 to 150 days
- Post-Phase IV equilibrium aqueous concentration assessment: 90 days
- Developing Phase V leachability testing plan, if needed, and agency review and approval: 60 days
- Phase V leachability testing, if warranted: 120 to 150 days

As shown in the schedule, different study elements will be completed sequentially over more than a year. This schedule, however, does not affect the Project Area RD process already underway. That is because the data are not needed to determine if ISS will be effective. The data will be used to ensure the means and methods for ISS technology used in the Project Area are optimally designed for site-specific conditions. For that reason, we recommend a separate Revised Basis of Design Report and Preliminary Design be resubmitted as soon as possible. Because substantial RD evaluations were performed to develop the *Combined Sediment Remedy Basis of Design and Preliminary Design Report* (Anchor QEA 2019) and extensive evaluations of the revised ISS and Full Dredge Design have been completed (presented to EPA, DEQ and the Technical Coordination Team in 2022), the next version of the Preliminary Design is expected to be at the 50 percent design level. The results of the TS and subsequent proposed ISS field pilot study (see Section 7) will be incorporated into the subsequent Interim Design. Any feedback received from EPA and DEQ on the Interim Design will be addressed and incorporated into the Final Design. This approach enables forward progress on design while also ensuring the necessary data and responses to EPA and DEQ comments are incorporated into the relevant phases of design.

5 Reporting

Given the duration of the entire TS program, NW Natural recommends that reporting be performed in stages as data become available. When the Interim Design is submitted, all TS data available at that point in time will be incorporated. Any TS testing not completed by the Interim Design will be reported and incorporated in the Final Design. Alternatively, testing results that are received after the Interim Design is submitted can be reported to EPA and DEQ as a separate deliverable prior to submitting the Final Design. In all cases, TS results will be included in an appendix of the applicable RD deliverable.

All TS data included in interim and final design documents will provide the following:

- Short narrative outlining any deviations from this Work Plan
- Final sample coordinates for all sampling stations
- Updated sampling location figures
- Tabulated table of final mix formulas
- Tabulated final validated data for all analytical tests performed
- Tabulated final data for all physical property tests performed
- Field forms including a daily form, a health and safety form, and all collection and processing logs
- Applicable photographs
- Laboratory Data Reports
- Data Validation Reports

6 Bench Scale Treatability Study Costs

As described throughout this Work Plan and in the response to EPA General Comment 11 (Appendix A), the ISS bench scale TS is an iterative process; therefore, it is not possible to provide a precise cost for the study. The range of potential costs for the study are included in the overall RD cost estimate that forms the basis for financial assurance provided under the Gasco Sediments Site ASAOC (EPA 2009a), and funding of all potential phases of the study has been approved by NW Natural. The TS costs are within the RD estimate that forms the basis for financial assurance under the ASAOC, and no adjustment to the financial assurance is required because of this work.

7 ISS Field Pilot Study

An ISS field pilot study is proposed and currently in development to support the implementability of ISS in the Project Area. The field pilot study is anticipated to include the evaluation of ISS for both sediment and soil. The results from the ISS bench scale TS Phase III leachability testing (i.e., the grout composition and dosage that performed the best) will be used to inform the selected grout(s) for the in-water and upland work. The results from the subsequent Phase IV and potential Phase V leachability tests are not required to be complete prior to the commencement of the field pilot study because the Phase IV and potential Phase V leachability tests are intended to evaluate if management of diffusion is required following the treatment of the sediment.

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Tables

Table 2-1
Summary of Bench Scale Treatability Study Sample Primary and Seconday Lines of Evidence

Location ID	Target Interval (feet BML)	Co-Located Historical Location	Primary Lines of Evidence						Secondary Lines of Evidence			
			Average Grain Size Composition				Presence of PTW-NAPL	PTW-NAPL Interval(s) (feet BML)	Naphthalene PTW-NRC Exceedance	Elevated Benzene	Metals	Presence of Forms of Product That Are Not PTW-NAPL
			Clay (pct)	Total Fines[1] (pct)	Sand (pct)	Gravel (pct)						
ISSTS-001	0-4	C273	12.4	70	28	1	X	0-2.7	—	X	Metals concentrations are representative of the central tendency of data in the Project Area, as summarized in Table 2-2.	X
ISSTS-002	4-8	C278	12.6	49	46	1	X	7-7.4	—	—		X
ISSTS-003	0-4	C301	14.1	63	34.5	0.5	X	1.5-7.2 12.4-12.8 13.5-13.6	X	X		X
ISSTS-004	4-8	C302	3.6	15	86	1	X	3.3-6.5	X	X		X

Notes:
1. Total fines includes silt and clay.
BML: below mudline
NAPL: nonaqueous phase liquid
NRC: not reliably contained
pct: percent
Project Area: Gasco Sediments Site Project Area
PTW: principal threat waste

Table 2-2

Summary of Bench Scale Treatability Study Sample Secondary Line of Evidence Sediment Metals Concentrations

Secondary Line of Evidence					
Location ID	**ISSTS-001**	**ISSTS-002**	**ISSTS-003**	**ISSTS-004**	**Sediment Average Concentration**
Co-Located Historical Location	**C273**	**C278**	**C301**	**C302**	
Target Interval (feet BML)	**0-4**	**4-8**	**0-4**	**4-8**	
Metals (mg/kg)					
Arsenic	3.44	1.6 J	3.77	4.49	3.1
Cadmium	0.3444	0.13	0.4	0.383	0.3
Chromium	32.9	12.8	34.9	38.2	25.3
Copper	56.4	14	39.1	50.1	32.7
Lead	39.8	9.47 J	50.7	30.1	26.6
Mercury	0.227	0.066	0.307	0.131	0.2
Zinc	136	47.7	156	155	107.1

Notes:
BML: below mudline
mg/kg: milligrams per kilogram
J: measured laboratory concentration is estimated

Table 3-1
Phase I Grout Composition Testing Plan

W/C	BFSC/PC	Grout Dosage Rate	UCS 28-Day	UCS 56-Day (If Needed)	Permeability 28-Day	Permeability 56-Day (If Needed)
Representative Sediment Sample (location with highest fines content: ISSLPS-001 based on data from C273)						
0.8	90/10	10%				
1	90/10	10%				
1.2	90/10	10%				
0.8	60/40	10%				
1	60/40	10%				
1.2	60/40	10%				
0.8	30/70	10%				
1	30/70	10%				
1.2	30/70	10%				
0.8	0/100	10%				
1	0/100	10%				
1.2	0/100	10%				
Representative Soil Sample (location with highest fines content: to be determined based on results of hydrogeological testing[1])						
0.8	90/10	8%				
1	90/10	8%				
1.2	90/10	8%				
0.8	60/40	8%				
1	60/40	8%				
1.2	60/40	8%				
0.8	30/70	8%				
1	30/70	8%				
1.2	30/70	8%				
0.8	0/100	8%				
1	0/100	8%				
1.2	0/100	8%				

Table 3-1

Phase I Grout Composition Testing Plan

Notes:

1 - Hydrogeologic testing includes porosity, grain size, and bulk density.

Grout Dosage Rate is dry weight of admixture to wet weight of sediment.

28-day testing will inform the grout blend to be tested as presented in Tables 3-2 and 3-3.

56-day testing will provide data to inform expected final strength and permeability properties after field implementation.

BFSC/PC (blast furnace slag cement to Portland cement): admixture ratio of dry components to each other, by dry weight

UCS: unconfined compressive strength

W/C: water to cement ratio, by weight

Table 3-2
Phase II Grout Dosage Testing Plan

Sediment Locations

ISSTS-001
Historical Sample Location: C273 (0-4 ft average)
Average Grain Size Composition:

Clay	12.4 %
Total Fines (Clay + Silt)	70 %
Sand	28 %
Gravel	1 %
PTW-NAPL Interval(s)	0-2.7 ft

Batch Number	Grout Dosage Rate[1]	UCS psi				Perm		Estimated Volume Increase Following Grout Addition[2] (%)
		3-to-5-Day	7-Day	14-Day	28-Day	7-Day	28-Day	
1	4%							7.4%
2	8%							14.8%
3	12%							22.1%
4	16%							29.5%
5	20%							36.9%

ISSTS-002
Historical Sample Location: C278 (4-8 ft average)
Average Grain Size Composition:

Clay	12.6 %
Total Fines (Clay + Silt)	49 %
Sand	46 %
Gravel	1 %
PTW-NAPL Interval(s)	7-7.4 ft

Batch Number	Grout Dosage Rate[1]	UCS psi				Perm		Estimated Volume Increase Following Grout Addition[2] (%)
		3-5 day	7 day	14 day	28 day	7-day	28-Day	
1	4%							7.9%
2	8%							15.8%
3	12%							23.7%
4	16%							31.6%
5	20%							39.5%

ISSTS-003
Historical Sample Location: C301 (0-4 ft average)
Average Grain Size Composition:

Clay	14.1 %
Total Fines (Clay + Silt)	63 %
Sand	34.5 %
Gravel	0.5 %
PTW-NAPL Interval(s)	1.5-7.2 ft 12.4-12.8 ft 13.5-13.6 ft

Batch Number	Grout Dosage Rate[1]	UCS psi				Perm		Estimated Volume Increase Following Grout Addition[2] (%)
		3-5 day	7 day	14 day	28 day	7-day	28-Day	
1	4%							7.4%
2	8%							14.8%
3	12%							22.1%
4	16%							29.5%
5	20%							36.9%

ISSTS-004
Historical Sample Location: C302 (4-8 ft average)
Average Grain Size Composition:

Clay	3.6 %
Total Fines (Clay + Silt)	15 %
Sand	86 %
Gravel	1 %
PTW-NAPL Interval(s)	3.3-6.5 ft

Batch Number	Grout Dosage Rate[1]	UCS psi				Perm		Estimated Volume Increase Following Grout Addition[2] (%)
		3-5 day	7 day	14 day	28 day	7-day	28-Day	
1	4%							8.4%
2	8%							16.9%
3	12%							25.3%
4	16%							33.7%
5	20%							42.2%

Table 3-2
Phase II Grout Dosage Testing Plan

<table>
<tr><td rowspan="14">Riverbank Soil Locations</td><td colspan="10">ISSTS-010
Historical Sample Location: PDI-142 and PDI-224 (to be determined)</td></tr>
<tr><td rowspan="2">Batch Number</td><td rowspan="2">Grout Dosage Rate[1]</td><td colspan="4">UCS psi</td><td colspan="2">Perm</td><td rowspan="2">Estimated Volume Increase Following Grout Addition[2] (%)</td></tr>
<tr><td>3-5 day</td><td>7 day</td><td>14 day</td><td>28 day</td><td>7-day</td><td>28-Day</td></tr>
<tr><td>1</td><td>6%</td><td></td><td></td><td></td><td></td><td></td><td></td><td>12.6%</td></tr>
<tr><td>2</td><td>8%</td><td></td><td></td><td></td><td></td><td></td><td></td><td>16.9%</td></tr>
<tr><td>3</td><td>10%</td><td></td><td></td><td></td><td></td><td></td><td></td><td>21.1%</td></tr>
<tr><td colspan="9">ISSTS-011
Historical Sample Location: PDI-134 and PDI-216 (to be determined)</td></tr>
<tr><td rowspan="2">Batch Number</td><td rowspan="2">Grout Dosage Rate[1]</td><td colspan="4">UCS psi</td><td colspan="2">Perm</td><td rowspan="2">Estimated Volume Increase Following Grout Addition[2] (%)</td></tr>
<tr><td>3-5 day</td><td>7 day</td><td>14 day</td><td>28 day</td><td>7-day</td><td>28-Day</td></tr>
<tr><td>1</td><td>6%</td><td></td><td></td><td></td><td></td><td></td><td></td><td>12.6%</td></tr>
<tr><td>2</td><td>8%</td><td></td><td></td><td></td><td></td><td></td><td></td><td>16.9%</td></tr>
<tr><td>3</td><td>10%</td><td></td><td></td><td></td><td></td><td></td><td></td><td>21.1%</td></tr>
</table>

Notes:
1. Grout dosage rates are dry weight of admixture to wet weight of sediment.
2. Estimated volume increase following grout addition is based on an assumed 1:1 W/C ratio. This volume increase will vary depending on the selected W/C ratio.

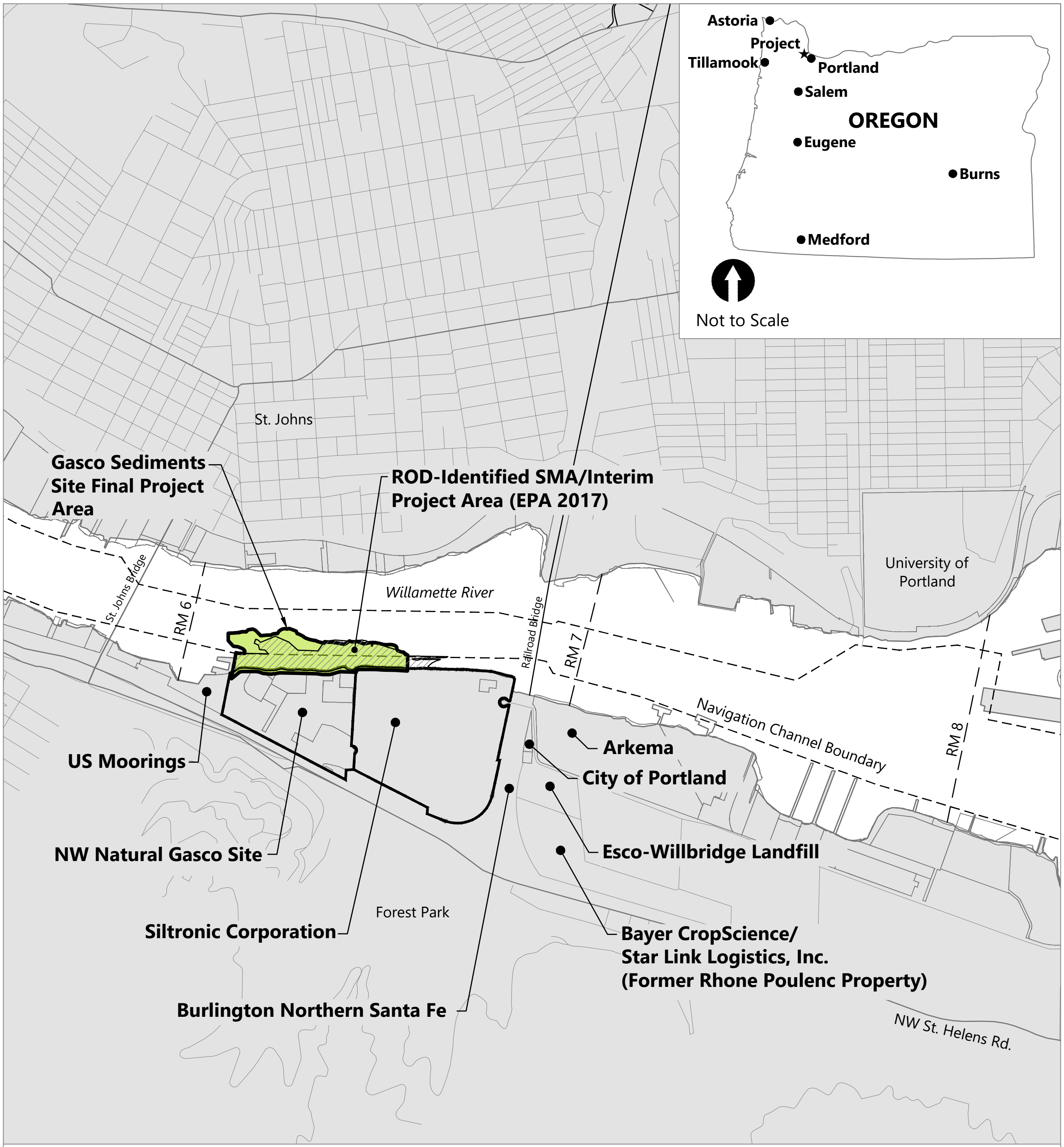
NAPL: nonaqueous phase liquid
psi: pound per square inch
PTW: principal threat waste
UCS: unconfined compressive strength
W/C: water to cement

Table 3-3
Phase III Through V Leachability Testing Plan

Grout Add Rate	Phase III Leachability Testing	Phase IV Leachability Testing	Phase V Column Testing (if needed)
The number and specifics of sediment/grout or soil/grout compositions will be selected based on performance in strength and permeability testing.	2 cylinders needed: - 1 cylinder needed for each SPLP Method 1312M test (per mix) - 1 additional cylinder proposed for backup/duplicate/other parameter testing (e.g., porosity)	6 cylinders needed: - 4 cylinders needed for each LEAF Method 1315M test (per mix) - 2 additional cylinder proposed for backup/duplicate/other parameter testing (e.g., porosity)	2 cylinders (custom-sized) needed for each column test (per mix)

Notes:
EPA: U.S. Environmental Protection Agency
LEAF: Leaching Environmental Assessment Framework
SPLP: synthetic precipitation leaching procedure

Figures



HORIZONTAL DATUM: Oregon State Plane North, North American Datum (NAD83/HARN 91), International Feet.

NOTE: All locations are approximate.

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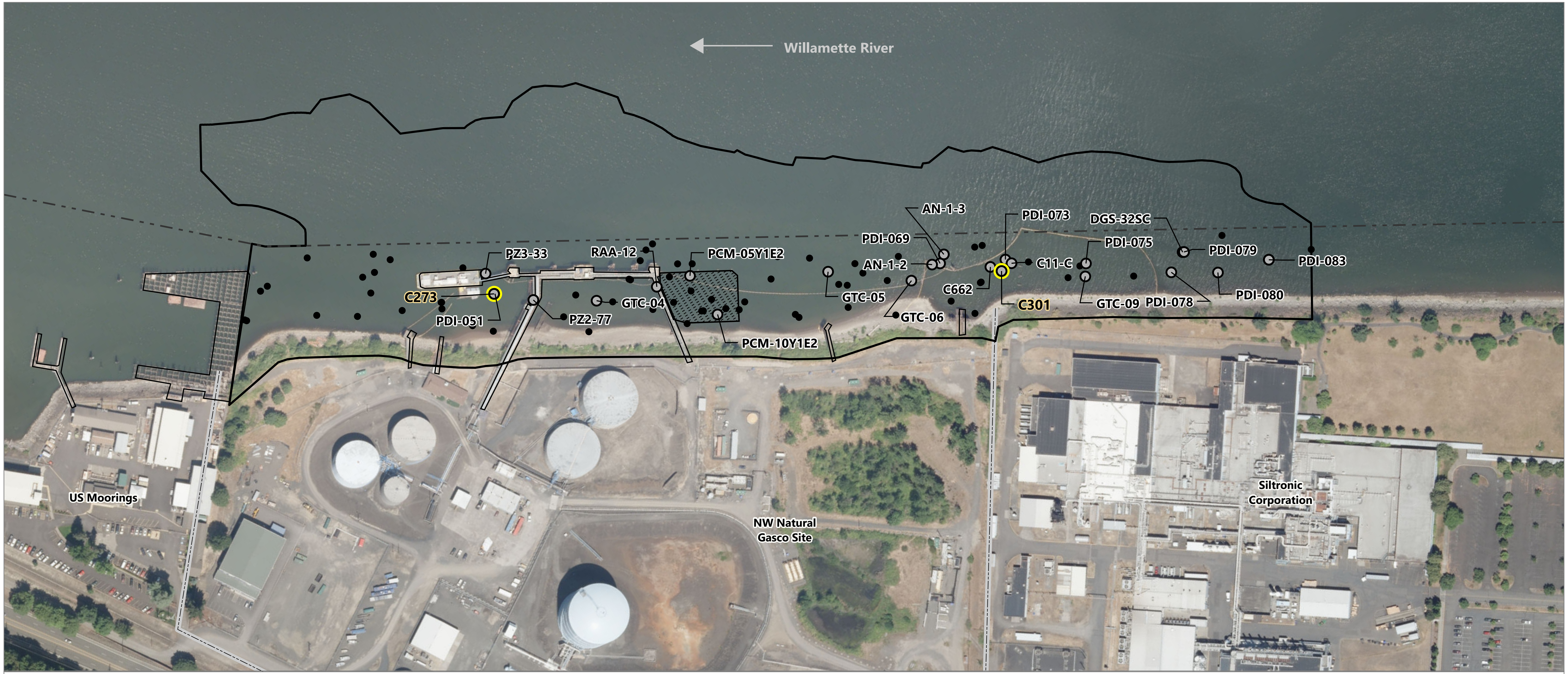
Figure 1-1
Vicinity Map

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

○ Proposed Sample Location and Depth Interval

◉ PTW-NAPL Observation

● Historical Subsurface Sediment Sample Location

□ Gasco Sediments Site Final Project Area

▤ Gasco Early Action Removal Action Pilot Cap

□ Structures

⌜⌟ Navigation Channel

▭ Property Line

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

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Feet

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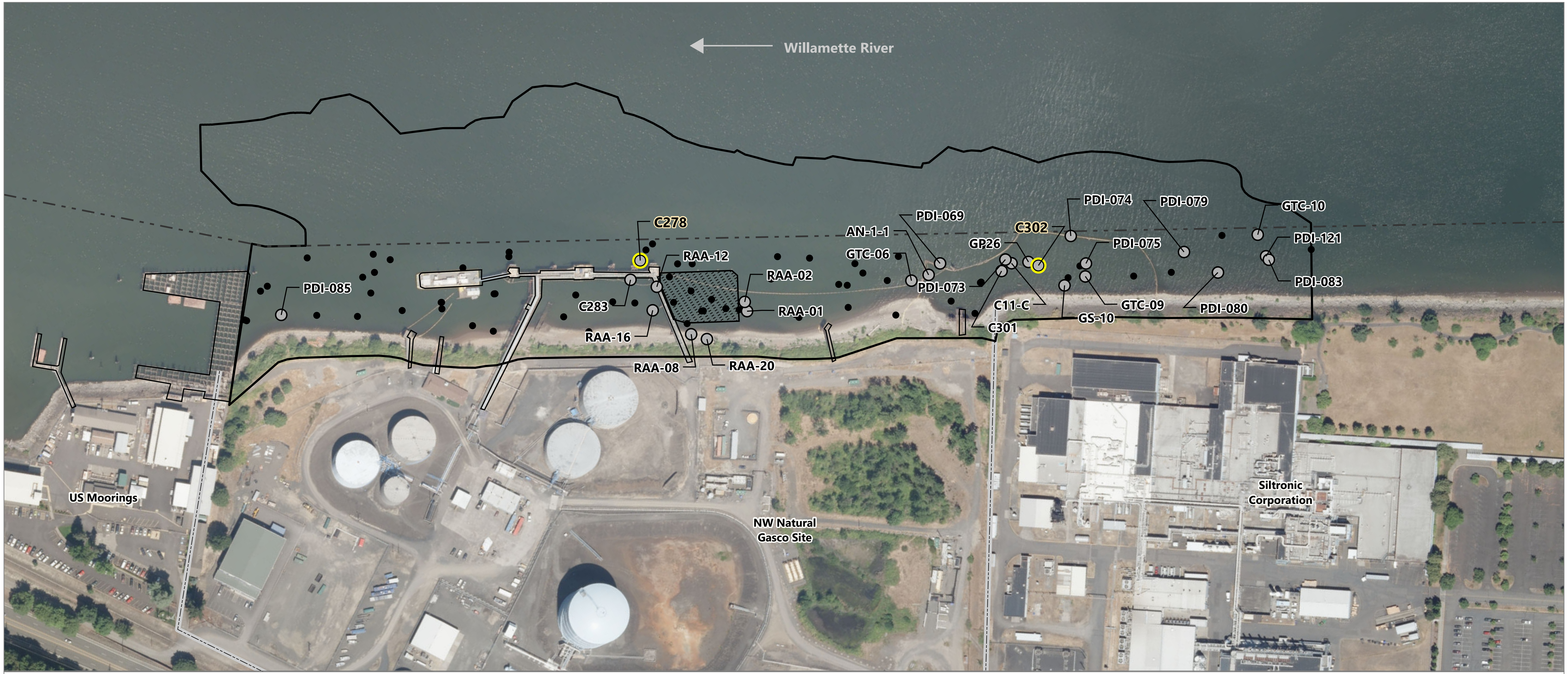
Figure 2-1a

PTW-NAPL Observations: 0 to 4 Feet

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- ○ Proposed Sample Location and Depth Interval
- ● PTW-NAPL Observation
- • Historical Subsurface Sediment Sample Location
- ▭ Gasco Sediments Site Final Project Area
- ▨ Gasco Early Action Removal Action Pilot Cap
- ▭ Structures
- ⌜⌟ Navigation Channel
- ▬ Property Line

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

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Feet

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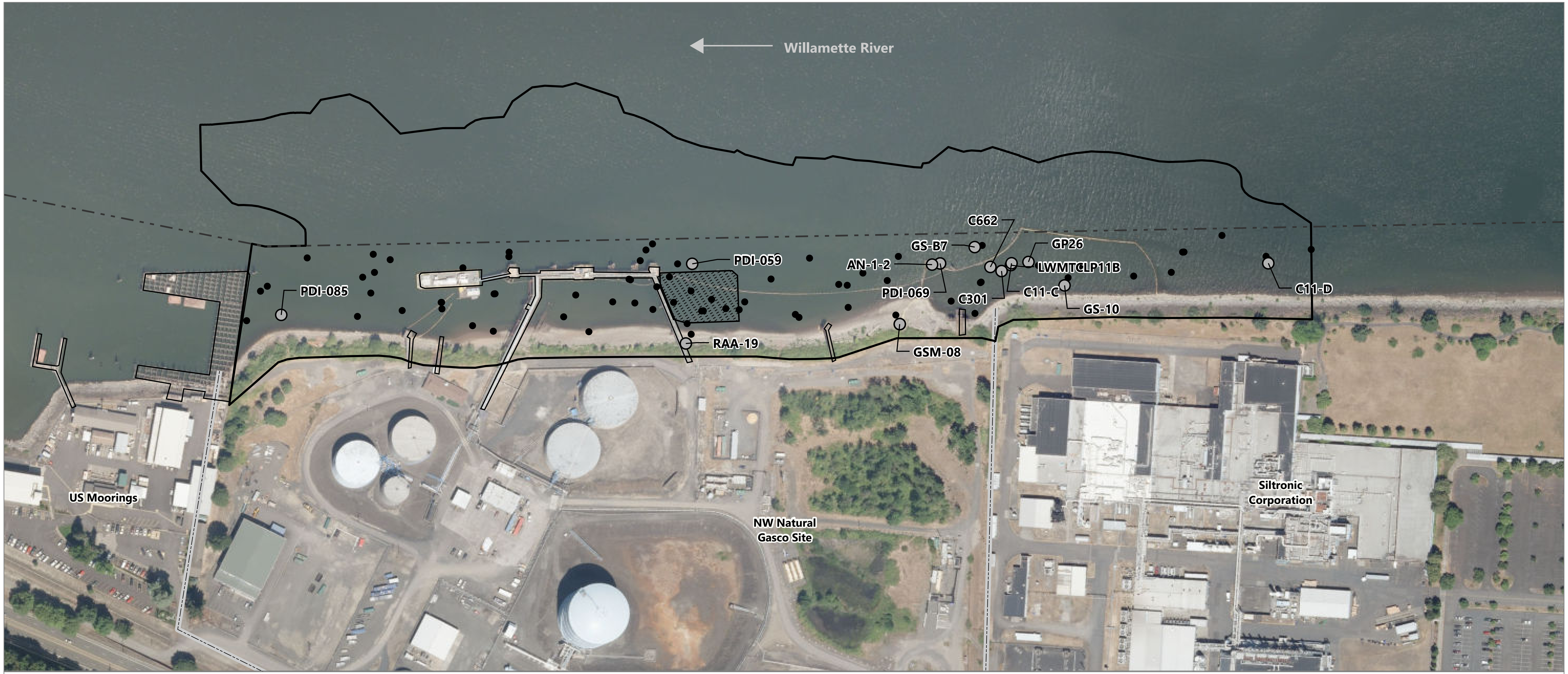
Figure 2-1b

PTW-NAPL Observations: 4 to 8 Feet

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- ● PTW-NAPL Observation
- • Historical Subsurface Sediment Sample Location
- ▭ Gasco Sediments Site Final Project Area
- ▤ Gasco Early Action Removal Action Pilot Cap
- ▭ Structures
- ⌜⌟ Navigation Channel
- ‒ ‒ Property Line

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

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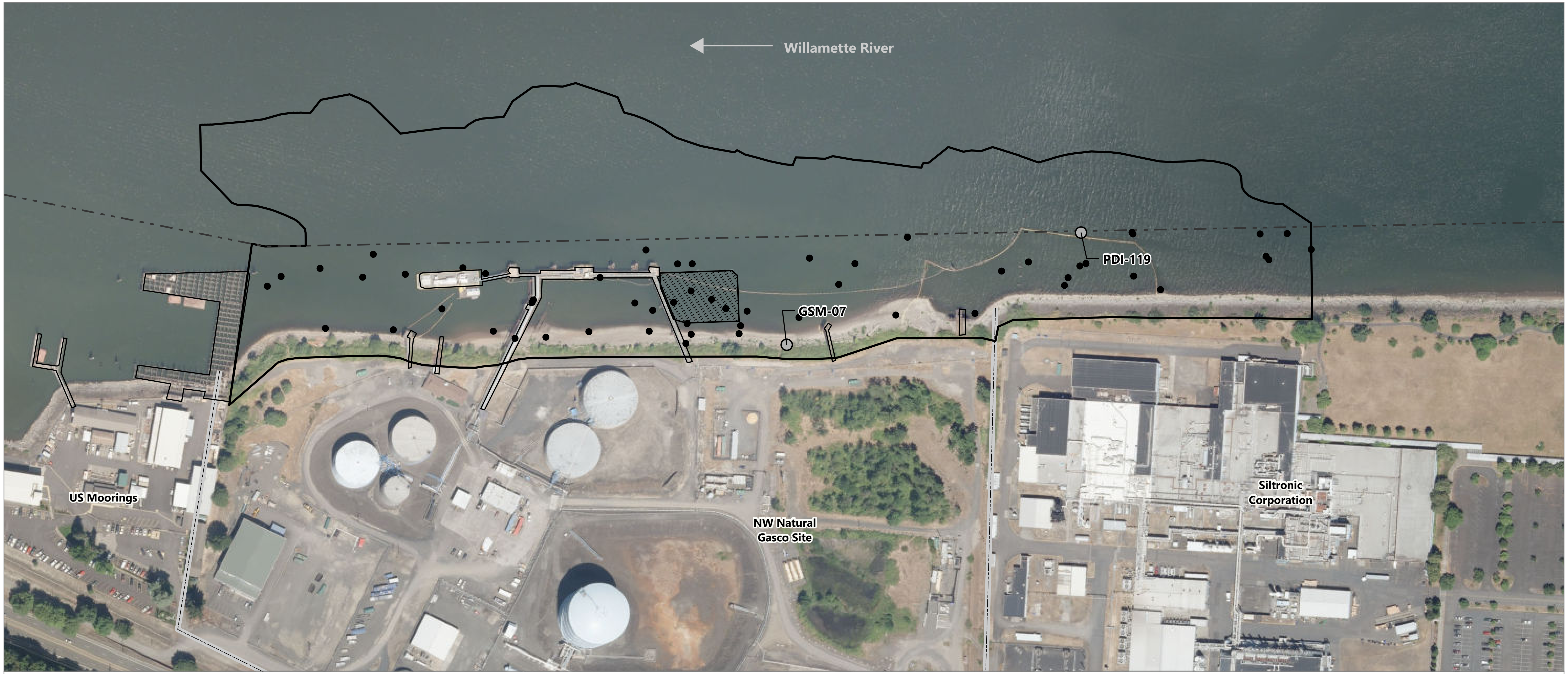
Figure 2-1c

PTW-NAPL Observations: 8 to 16 Feet

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- ● PTW-NAPL Observation
- • Historical Subsurface Sediment Sample Location
- ▭ Gasco Sediments Site Final Project Area
- ▤ Gasco Early Action Removal Action Pilot Cap
- ▭ Structures
- ⌜⌟ Navigation Channel
- ┄ Property Line

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

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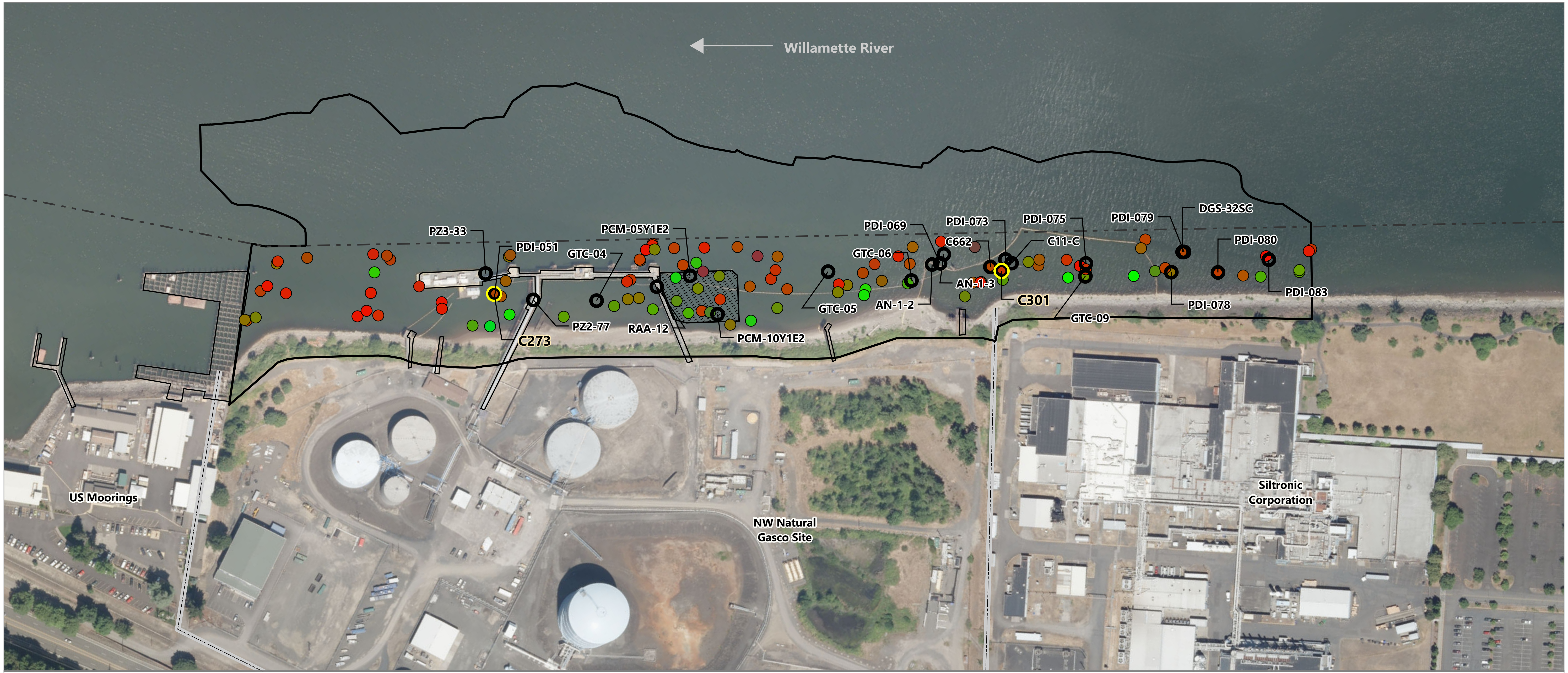
Figure 2-1d

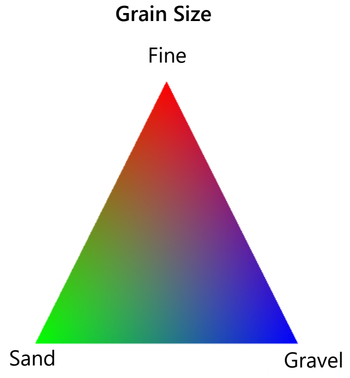
PTW-NAPL Observations: Deeper Than 16 Feet

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- ○ Proposed Sample Location and Depth Interval
- ● PTW-NAPL Observation [5]
- ▨ Gasco Early Action Removal Action Pilot Cap
- ☐ Structures
- ⌜⌟ Navigation Channel
- ☐ Gasco Sediments Site Final Project Area
- ---- Property Line



NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.
5. Hollow PTW-NAPL Observations indicate that no grain size data is available at this location and depth interval.

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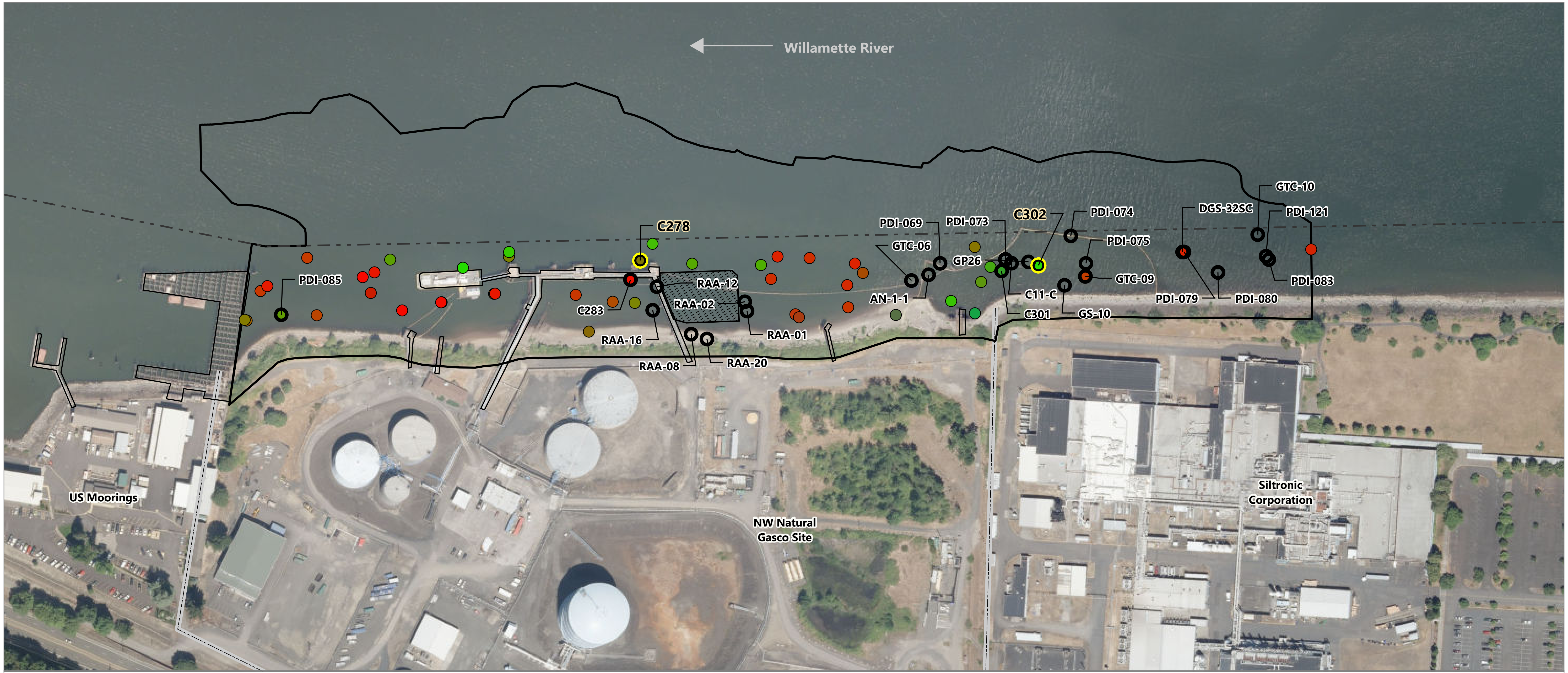
Figure 2-2a

Average Grain Size Distribution: 0 to 4 Feet

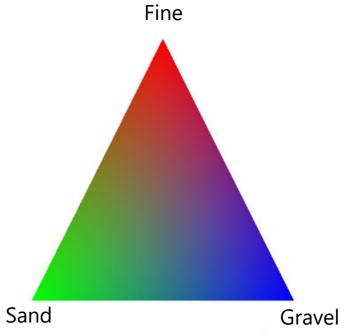
Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- ○ Proposed Sample Location and Depth Interval
- ● PTW-NAPL Observation [5]
- ▨ Gasco Early Action Removal Action Pilot Cap
- ☐ Structures
- ⌐ ¬ Navigation Channel
- ☐ Gasco Sediments Site Final Project Area
- ---- Property Line

Grain Size



NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.
5. Hollow PTW-NAPL Observations indicate that no grain size data is available at this location and depth interval.

0 220
Feet

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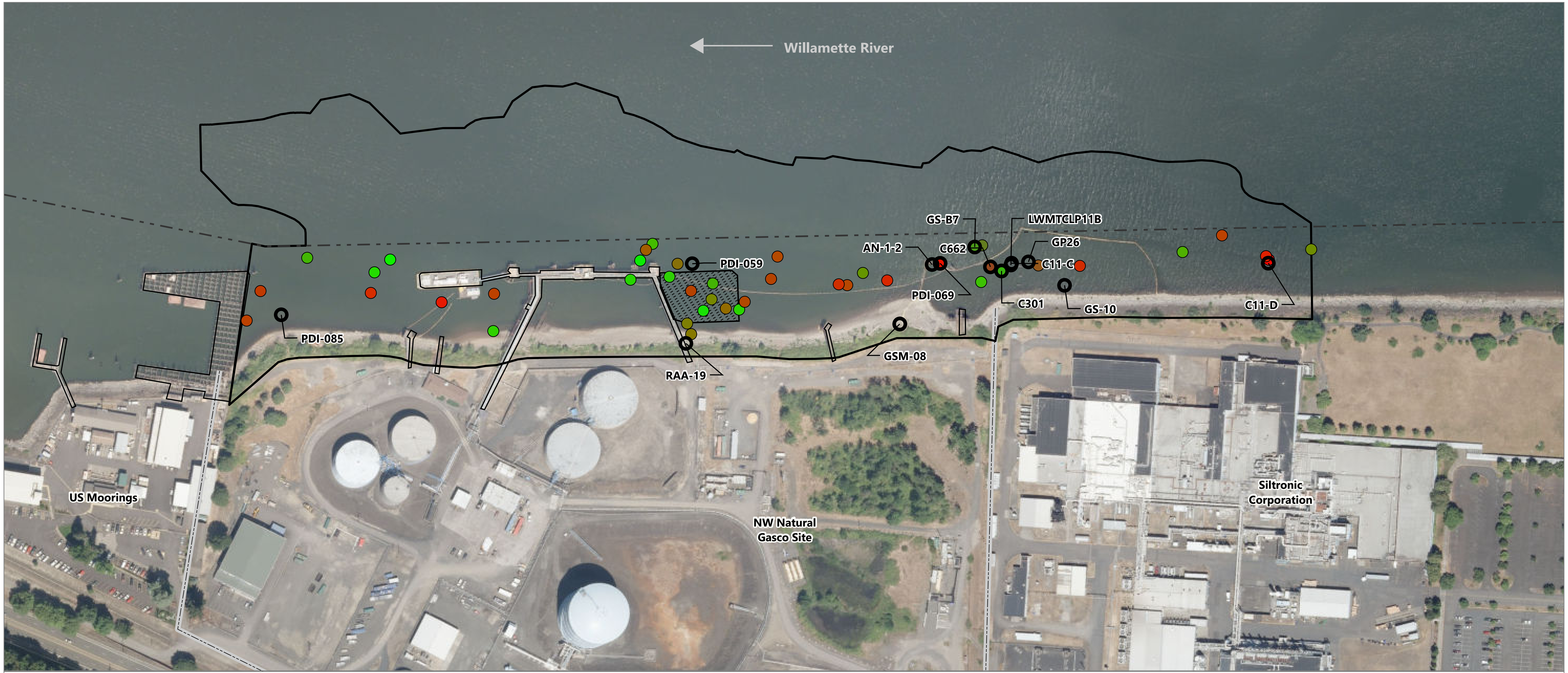
Figure 2-2b
Average Grain Size Distribution: 4 to 8 Feet
Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

○ PTW-NAPL Observation [5]

▤ Gasco Early Action Removal Pilot Cap

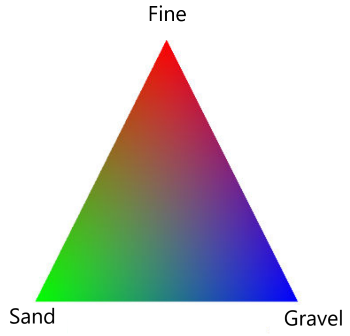
☐ Structures

⬚ Navigation Channel

☐ Gasco Sediments Site Final Project Area

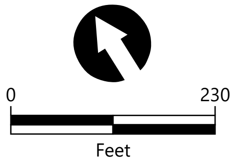
--- Property Line

Grain Size



NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.
5. Hollow PTW-NAPL Observations indicate that no grain size data is available at this location and depth interval.



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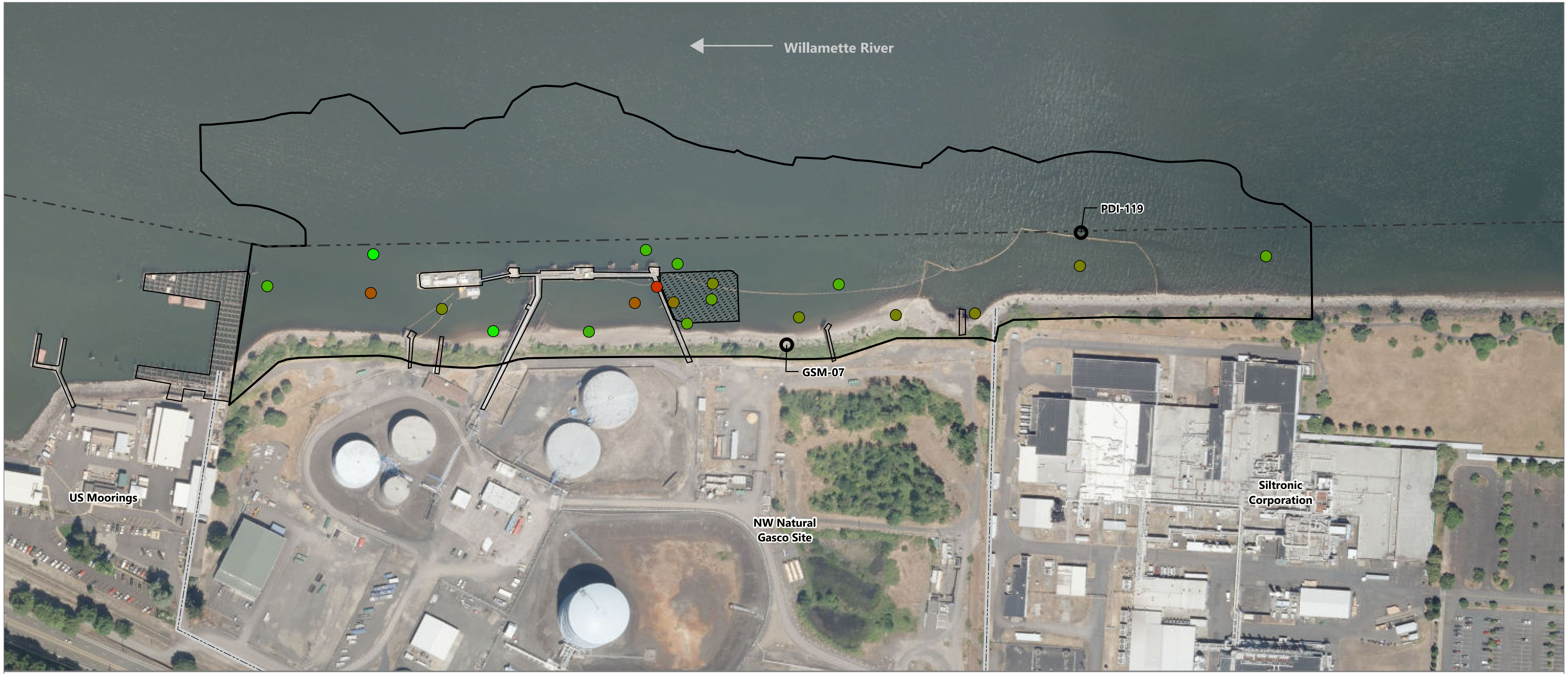
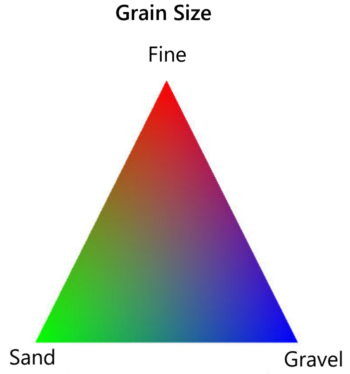
ANCHOR QEA

Figure 2-2c
Average Grain Size Distribution: 8 to 16 Feet
Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- ▤ Gasco Early Action Removal Action Pilot Cap
- ☐ Structures
- ⌐¬ Navigation Channel
- ☐ Gasco Sediments Site Final Project Area
- ┅ Property Line



NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.
5. Hollow PTW-NAPL Observations indicate that no grain size data is available at this location and depth interval.

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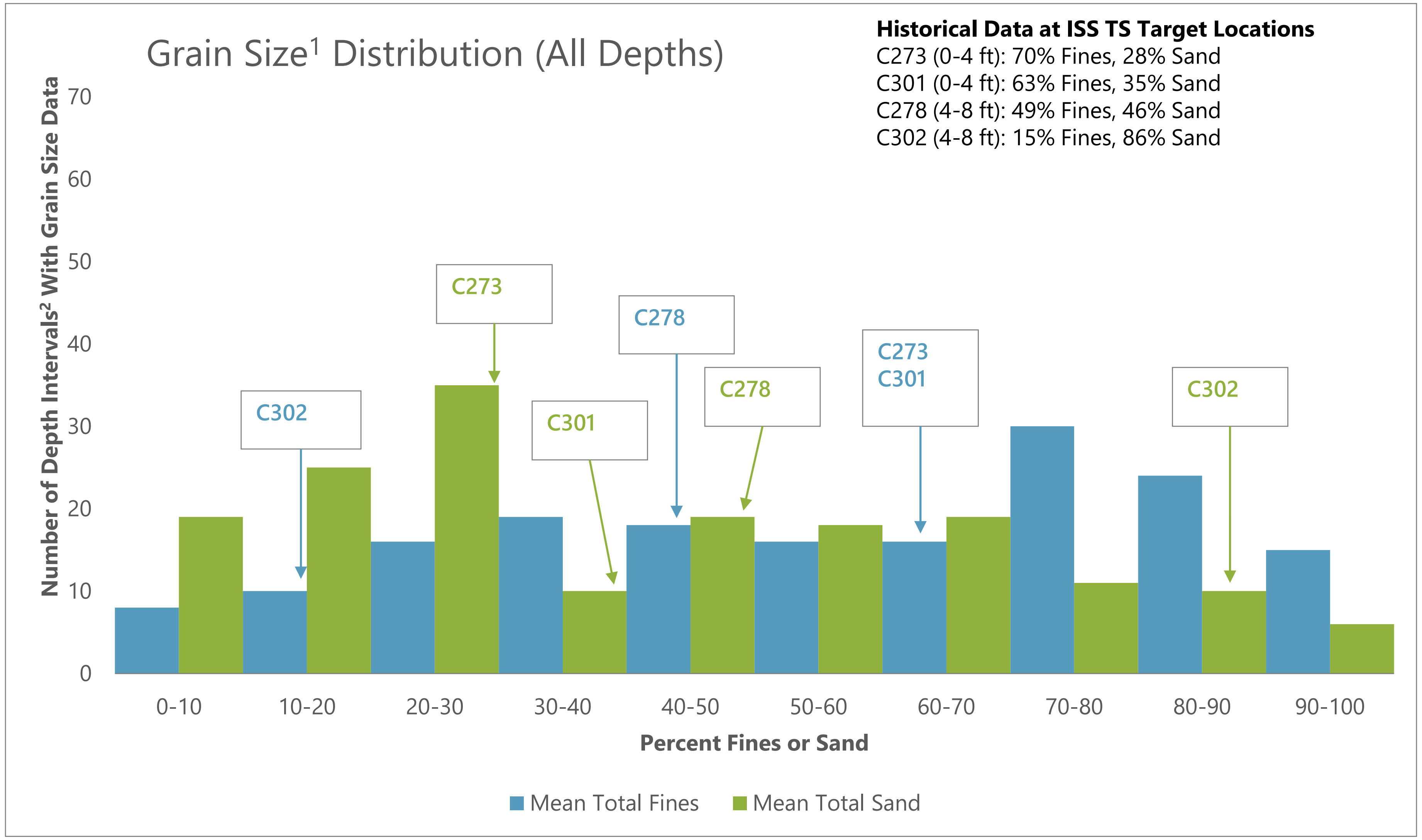
Figure 2-2d

Average Grain Size Distribution: Deeper Than 16 Feet

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



Notes:

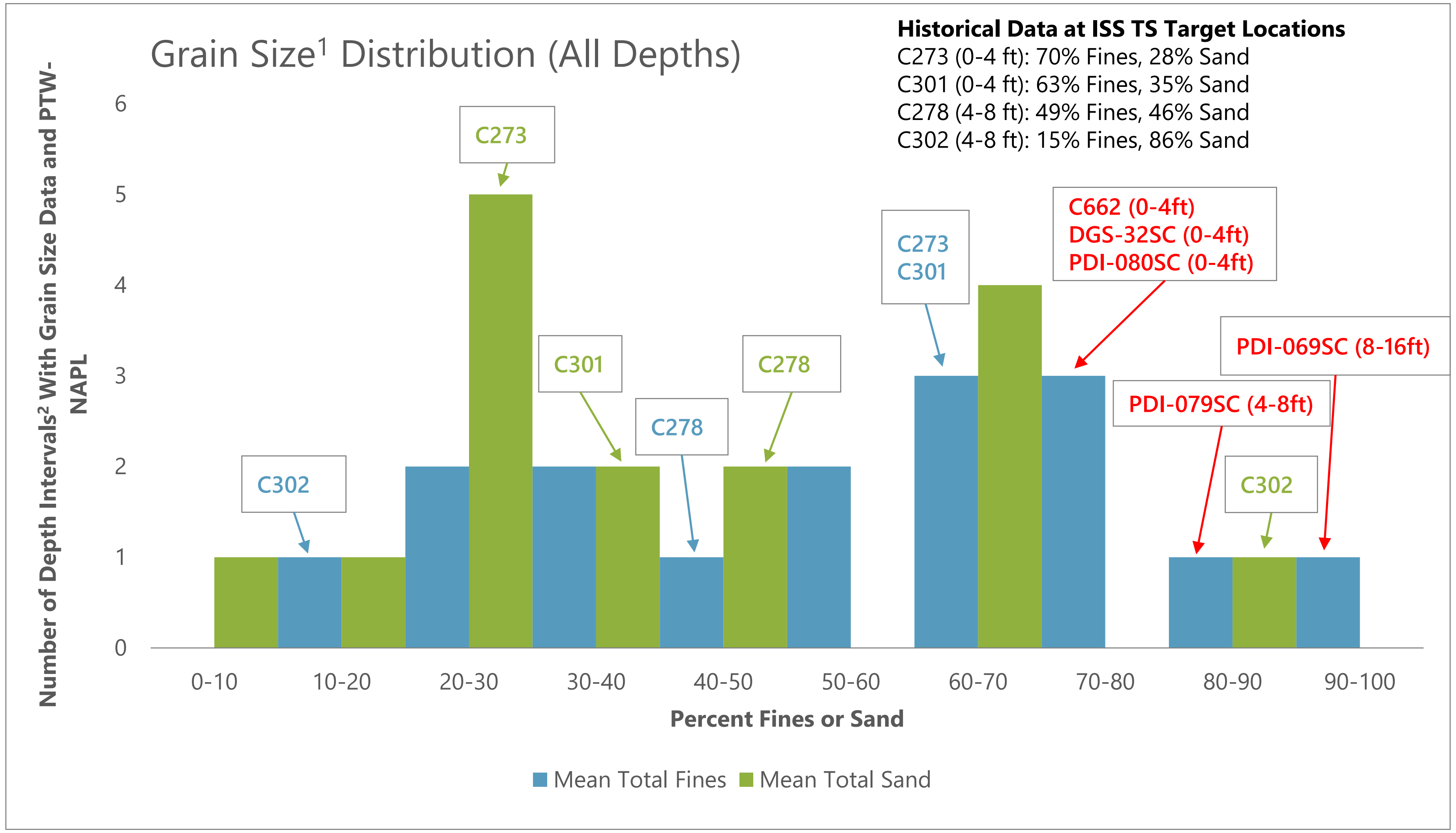
1. Most samples contained very little gravel (typically less than 10%) and, as discussed in Section 2.1 of the Work Plan, locations with high fines and sand were targeted for the ISS TS; therefore, gravel data is not included in this histogram.
2. The depth intervals included in this histogram are 0 to 4 feet, 4 to 8 feet, 8 to 16 feet, and deeper than 16 feet. Mean total fines and mean total sand represent the fines and sand fractions from all samples collected within each of the evaluated depth intervals.

Analysis:

The proposed 4- to 8-foot depth interval at C302 is in the high range of sands content relative to all locations and depth intervals with grain size data (regardless of whether the depth interval also contains PTW-NAPL). The proposed 4- to 8-foot depth interval at C278 has an approximately even split of sands and fines. The proposed 0- to 4-foot depth interval at both C273 and C301 trend toward the moderately high end of fines content. Because PTW-NAPL is one of the two primary lines of evidence used for selecting proposed sample locations and depth intervals, additional analysis was performed on the subset of locations and depth intervals that contain PTW-NAPL—see Figure 2-3b.

Figure 2-3a

Grain Size Histogram Demonstrating Representativeness of Proposed In-Water Sampling Locations: All Locations with Grain Size Data



Notes:

1. Most samples contained very little gravel (typically less than 10%) and, as discussed in Section 2.1 of the Work Plan, locations with high fines and sand were targeted for the ISS TS; therefore, gravel data is not included in this histogram.
2. The depth intervals included in this histogram are 0 to 4 feet, 4 to 8 feet, 8 to 16 feet, and deeper than 16 feet. Mean total fines and mean total sand represent the fines and sand fractions from all samples collected within each of the evaluated depth intervals.

Analysis:

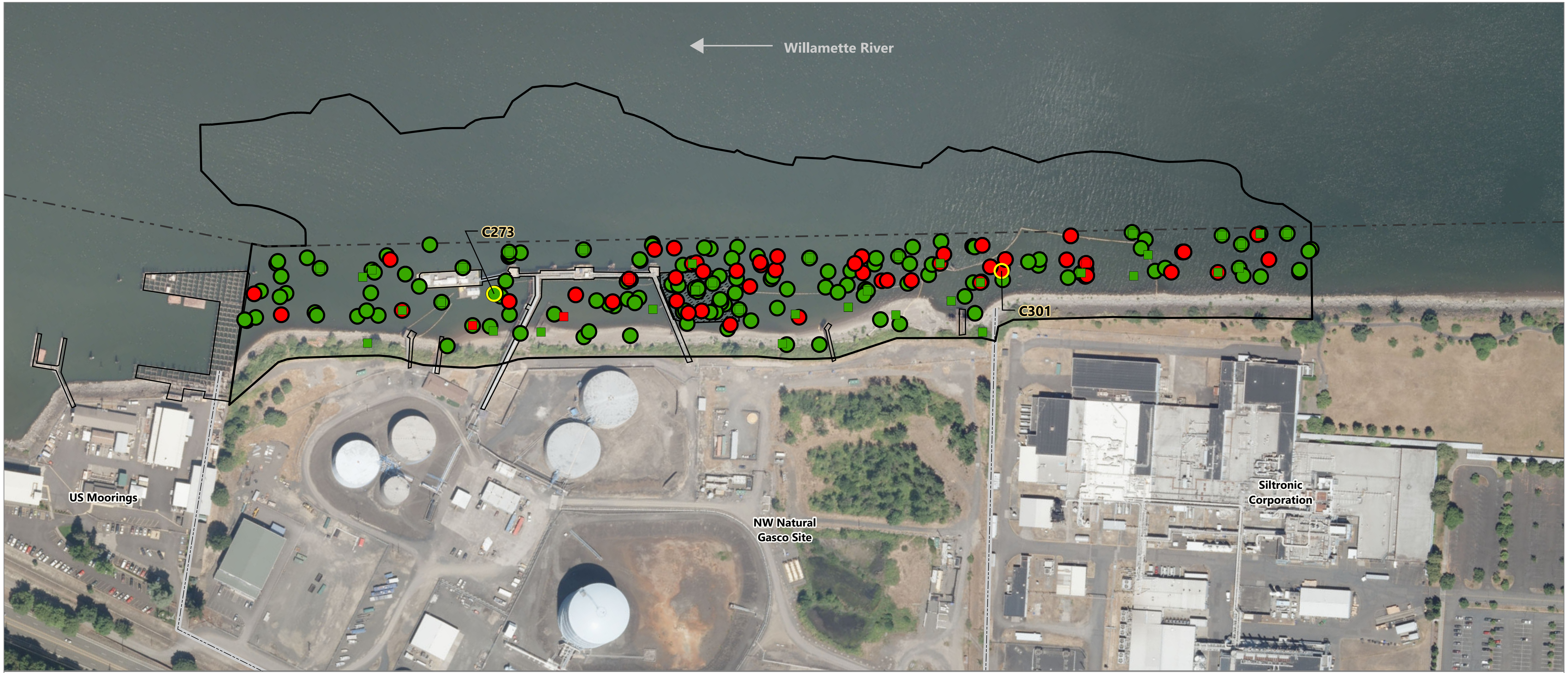
As shown in Figure 2-3a, the proposed 4- to 8-foot depth interval at C302 has the highest sands content of any location and depth interval that also contains PTW-NAPL. The proposed 4- to 8-foot depth interval at C278 has an approximately even split of sands and fines. The proposed 0- to 4-foot depth interval at both C273 and C301 trend toward the moderately high end of fines content. The locations and depth intervals with PTW-NAPL observations and higher percent fines than the proposed sampling locations, depicted in red text in this histogram, were not proposed for sampling because C273 and C301 would be more likely to meet the objectives of the ISS TS. Additional discussion and rationale is presented in Section 2.1 of the Work Plan.

Conclusion:

The four proposed sediment sampling locations and depth intervals are representative of the range of grain sizes (i.e., one proposed sample interval contains high percent sand, another contains an approximately even split of sand and fines, and two contain high percent fines) while providing the highest likelihood that sufficient sample volume containing the target grain size can be collected. In addition, the proposed locations provide the highest likelihood that PTW-NAPL will be encountered in the target sample intervals. No additional locations or depths are needed given the representativeness of the four proposed sampling locations.

Figure 2-3b

Grain Size Histogram Demonstrating Representativeness of Proposed In-Water Sampling Locations: Locations with Grain Size Data and PTW-NAPL



LEGEND:

- ▭ Gasco Sediments Site Final Project Area
- ▦ Gasco Early Action Removal Action Pilot Cap
- ⌐¬ Navigation Channel
- ▭ Structures
- ┅ Property Line
- ○ Proposed Sample Location and Depth Interval
- ○ Sample Detected
- ☐ Sample not Detected

Naphthalene Concentration (µg/kg)

- 🟢 0 - 140,000
- 🔴 > 140,000

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

0 230
Feet

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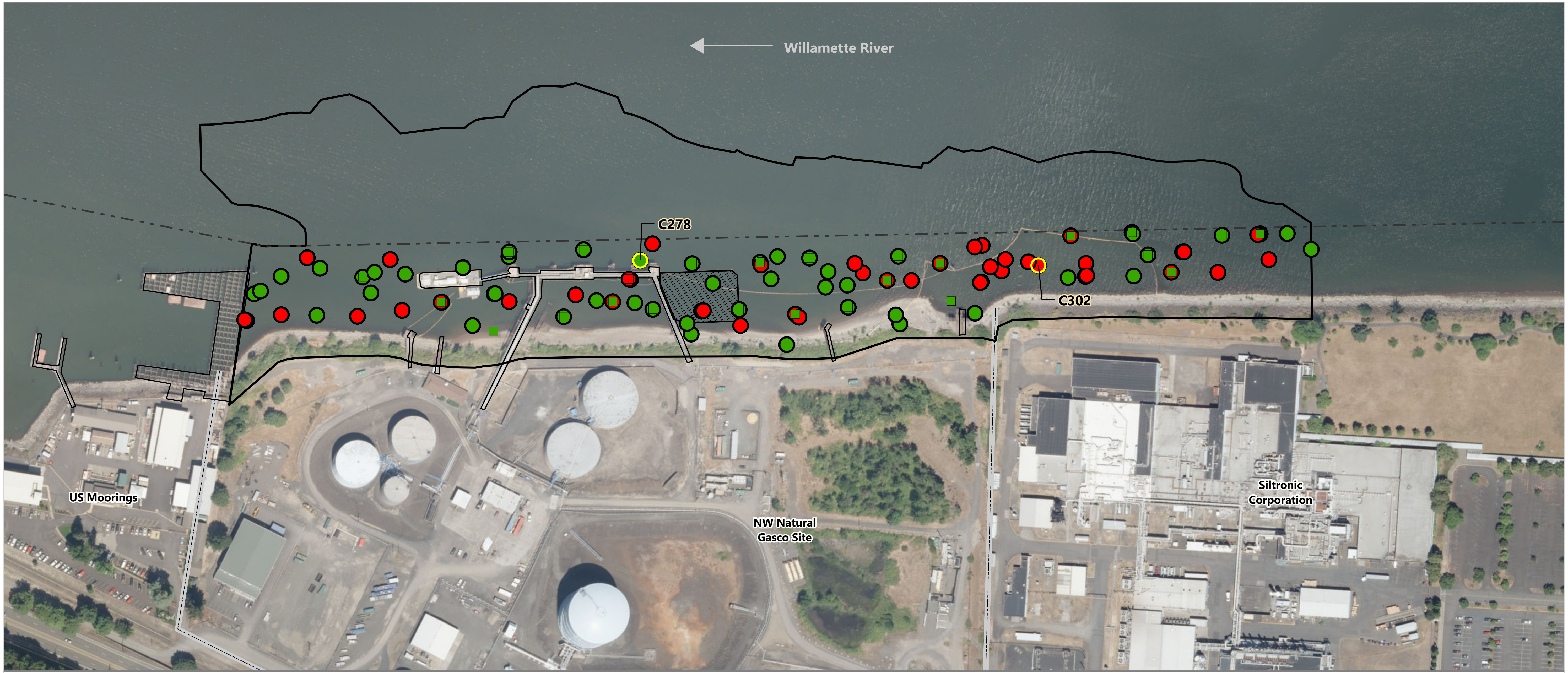
Figure 2-4a

Naphthalene PTW-NRC Exceedances: 0 to 4 Feet

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- ▭ Gasco Sediments Site Final Project Area
- ▦ Gasco Early Action Removal Action Pilot Cap
- ⌜⌟ Navigation Channel
- ▭ Structures
- ╌ Property Line
- ○ Proposed Sample Location and Depth Interval
- ○ Sample Detected
- ☐ Sample not Detected

Naphthalene Concentration (µg/kg)

- 🟢 0 - 140,000
- 🔴 > 140,000

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

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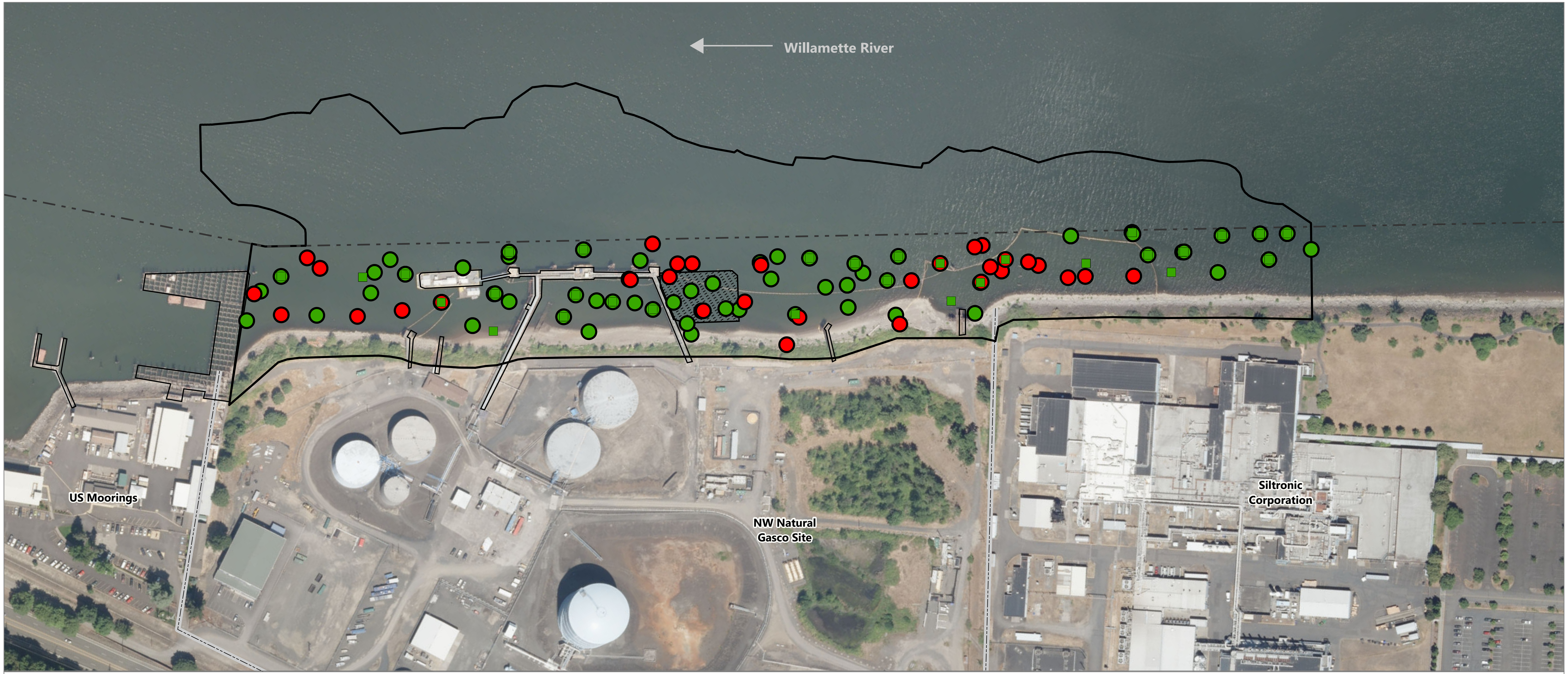
Figure 2-4b

Naphthalene PTW-NRC Exceedances: 4 to 8 Feet

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- ▭ Gasco Sediments Site Final Project Area
- ▦ Gasco Early Action Removal Action Pilot Cap
- ⌜⌟ Navigation Channel
- ▭ Structures
- --- Property Line
- ○ Sample Detected
- □ Sample not Detected

Naphthalene Concentration (µg/kg)

- 🟢 0 - 140,000
- 🔴 > 140,000

NOTES:
1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

0 230
Feet

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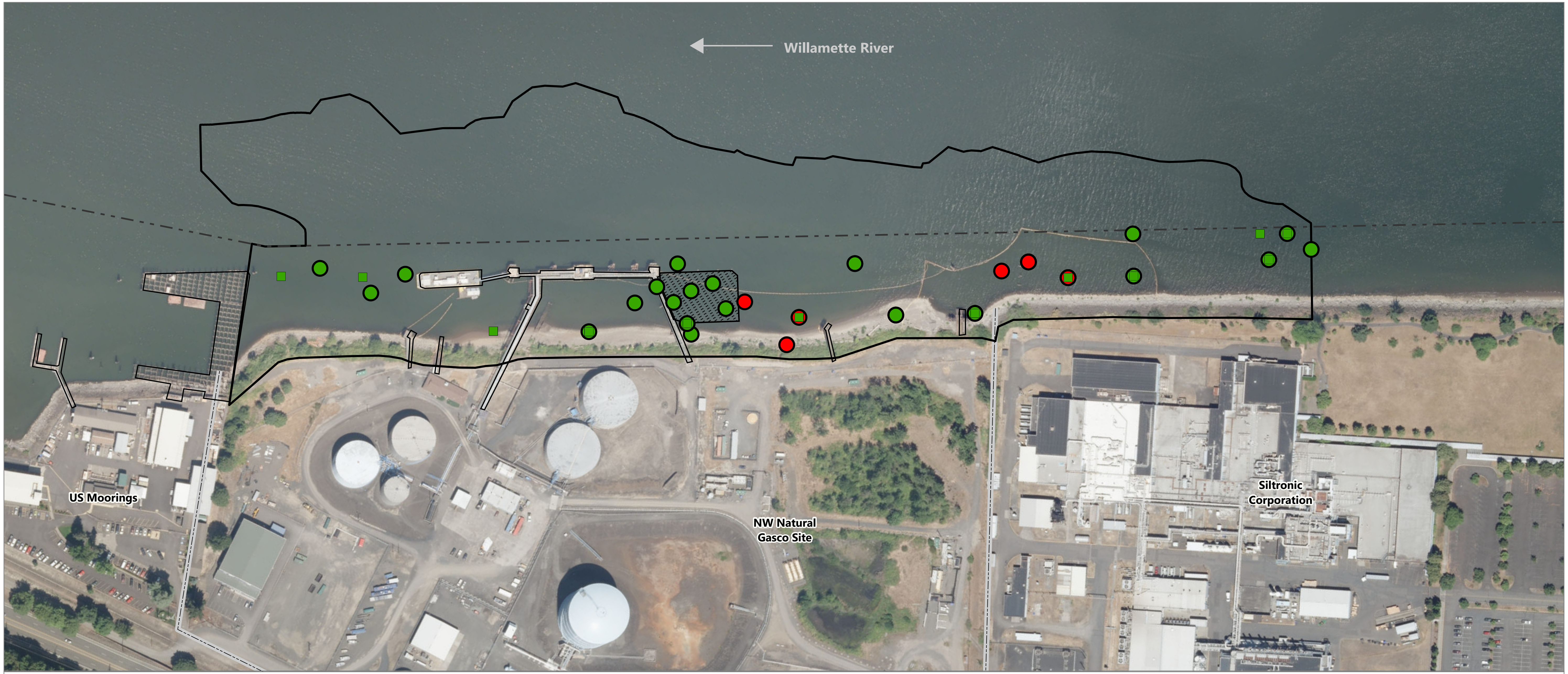
QEA

Figure 2-4c

Naphthalene PTW-NRC Exceedances: 8 to 16 Feet

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



LEGEND:

- ▭ Gasco Sediments Site Final Project Area
- ▨ Gasco Early Action Removal Action Pilot Cap
- ⌜⌟ Navigation Channel
- ▭ Structures
- ┄ Property Line
- ○ Sample Detected
- ☐ Sample not Detected

Naphthalene Concentration (µg/kg)

- 🟢 0 - 140,000
- 🔴 > 140,000

NOTES:
1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

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Figure 2-4d

Naphthalene PTW-NRC Exceedances: Deeper than 16 Feet

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action

LEGEND:

- ● Proposed In-water Sediment Sample Locations
- ▨ Gasco Early Action Removal Action Pilot Cap
- ☐ Structures
- ⌜⌟ Navigation Channel
- ▭ Gasco Sediments Site Final Project Area
- ╌ Property Line

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

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Figure 2-5

Proposed In-water Sediment Bench Scale Treatability Study Sample Locations

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action

LEGEND:

- ● Proposed Riverbank Soil Sample Location
- ▨ Gasco Early Action Removal Action Pilot Cap
- ☐ Structures
- ⌜⌟ Navigation Channel
- ☐ Gasco Sediments Site Final Project Area
- ┄ Property Line

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

DOC: Depth of Contamination
ISS: In Situ Stabilization and Solidification

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Feet

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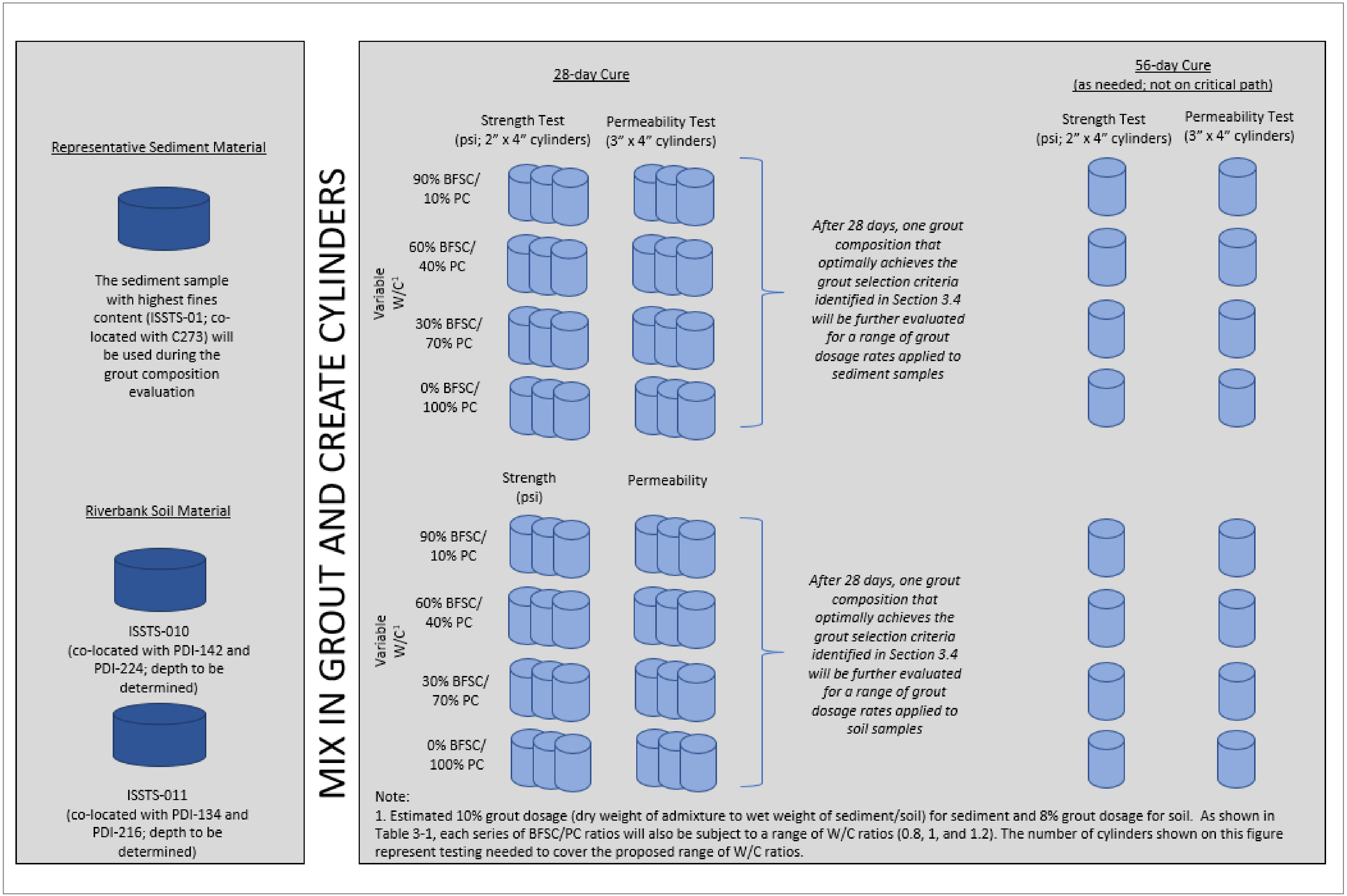
Figure 2-6
Proposed Riverbank Soil Bench Scale Treatability Study Sample Locations
Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



The sediment sample with highest fines content (ISSTS-01; co-located with C273) will be used during the grout composition evaluation

ISSTS-010 (co-located with PDI-142 and PDI-224; depth to be determined)

ISSTS-011 (co-located with PDI-134 and PDI-216; depth to be determined)

After 28 days, one grout composition that optimally achieves the grout selection criteria identified in Section 3.4 will be further evaluated for a range of grout dosage rates applied to sediment samples

After 28 days, one grout composition that optimally achieves the grout selection criteria identified in Section 3.4 will be further evaluated for a range of grout dosage rates applied to soil samples

Note:

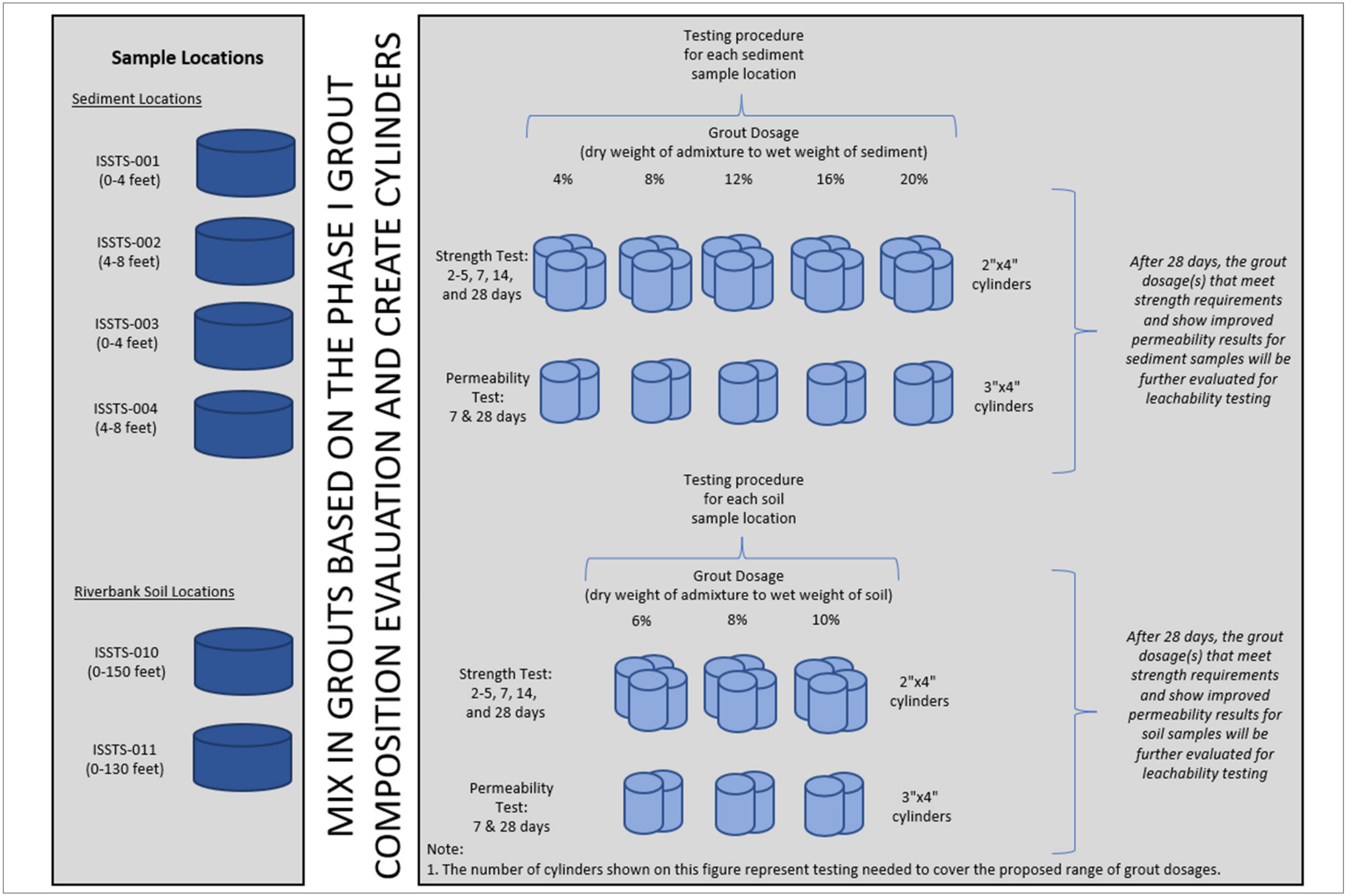
1. Estimated 10% grout dosage (dry weight of admixture to wet weight of sediment/soil) for sediment and 8% grout dosage for soil. As shown in Table 3-1, each series of BFSC/PC ratios will also be subject to a range of W/C ratios (0.8, 1, and 1.2). The number of cylinders shown on this figure represent testing needed to cover the proposed range of W/C ratios.

Figure 3-1

Overview of Phase I Grout Composition Testing

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan

Gasco Sediments Cleanup Action



Note:
1. The number of cylinders shown on this figure represent testing needed to cover the proposed range of grout dosages.

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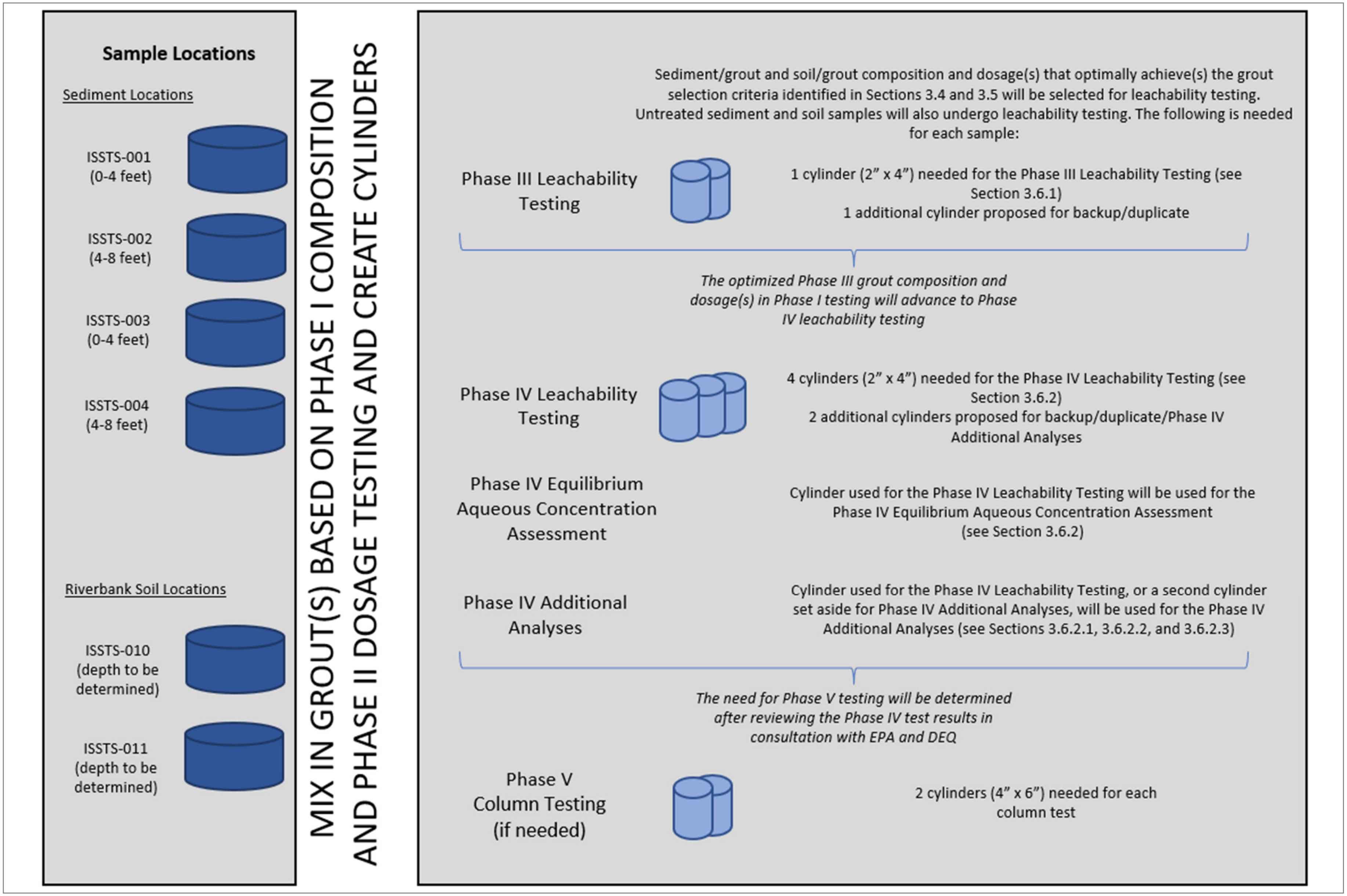
Figure 3-2
Overview of Phase II Grout Dosage Testing
Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan
Gasco Sediments Cleanup Action



Sample Locations

Sediment Locations

ISSTS-001 (0-4 feet)

ISSTS-002 (4-8 feet)

ISSTS-003 (0-4 feet)

ISSTS-004 (4-8 feet)

Riverbank Soil Locations

ISSTS-010 (depth to be determined)

ISSTS-011 (depth to be determined)

MIX IN GROUT(S) BASED ON PHASE I COMPOSITION AND PHASE II DOSAGE TESTING AND CREATE CYLINDERS

Sediment/grout and soil/grout composition and dosage(s) that optimally achieve(s) the grout selection criteria identified in Sections 3.4 and 3.5 will be selected for leachability testing. Untreated sediment and soil samples will also undergo leachability testing. The following is needed for each sample:

Phase III Leachability Testing	1 cylinder (2” x 4”) needed for the Phase III Leachability Testing (see Section 3.6.1) 1 additional cylinder proposed for backup/duplicate

The optimized Phase III grout composition and dosage(s) in Phase I testing will advance to Phase IV leachability testing

Phase IV Leachability Testing	4 cylinders (2” x 4”) needed for the Phase IV Leachability Testing (see Section 3.6.2) 2 additional cylinders proposed for backup/duplicate/Phase IV Additional Analyses
Phase IV Equilibrium Aqueous Concentration Assessment	Cylinder used for the Phase IV Leachability Testing will be used for the Phase IV Equilibrium Aqueous Concentration Assessment (see Section 3.6.2)
Phase IV Additional Analyses	Cylinder used for the Phase IV Leachability Testing, or a second cylinder set aside for Phase IV Additional Analyses, will be used for the Phase IV Additional Analyses (see Sections 3.6.2.1, 3.6.2.2, and 3.6.2.3)

The need for Phase V testing will be determined after reviewing the Phase IV test results in consultation with EPA and DEQ

Phase V Column Testing (if needed)	2 cylinders (4” x 6”) needed for each column test

Figure 3-3

Overview of Phase III Through V Leachability Testing

Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan

Gasco Sediments Cleanup Action

Appendix A
Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan

May 19, 2023
Gasco Sediments Cleanup Action

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan

Prepared for U.S. Environmental Protection Agency, Region 10,
and the Oregon Department of Environmental Quality

May 2023
Gasco Sediments Cleanup Action

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan

Prepared for
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Oregon Department of Environmental Quality
Northwest Region Portland Office
2020 SW 4th Avenue, Suite 400
Portland, Oregon 97201

Prepared by
Anchor QEA, LLC
6720 S Macadam Avenue, Suite 300
Portland, Oregon 97219

On Behalf of
NW Natural
250 SW Taylor Street
Portland, Oregon 97204

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENT

Attachment A	Field Forms

ABBREVIATIONS

ASTM	ASTM International
BFSC	blast furnace slag cement
bml	below mudline
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
CMMP	*Contaminated Media Management Plan*
COC	contaminant of concern
COP	City of Portland datum
DEQ	Oregon Department of Environmental Quality
DGPS	differential global positioning system
DI	deionized
DNAPL	dense nonaqueous phase liquid
DOC	dissolved organic carbon
EGL	Environmental Geochemistry Laboratory
EPA	U.S. Environmental Protection Agency
EPH	Extractable Petroleum Hydrocarbons
FSP	*Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan*
GPS	global positioning system
HARN91	High Accuracy Reference Network 91
HDPE	high-density polyethylene
IDW	investigation-derived waste
ISS	in situ stabilization and solidification
LEAF	Leaching Environmental Assessment Framework
mL	milliliter
MIP	mercury intrusion porosimetry
NAD83	North American Datum of 1983
NAPL	nonaqueous phase liquid
PAH	polycyclic aromatic hydrocarbon
PC	Portland cement
PCB	polychlorinated biphenyl
PDMS	polydimethylsiloxane
Project Area	Gasco Sediments Site Project Area
PTFE	polytetrafluoroethylene
PTW	principal threat waste
QA	quality assurance

QAPP	*Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan*
QC	quality control
RCRA	Resource Conservation and Recovery Act
ROD	*Record of Decision – Portland Harbor Superfund Site, Portland, Oregon*
SEM	scanning electron microscopy
SOP	standard operating procedure
SOW	*Statement of Work – Gasco Sediments Site*
SPLP	synthetic precipitation leaching procedure
SVOC	semivolatile organic compound
TCE	trichloroethene
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TS	treatability study
UCS	unconfined compressive strength
USCS	Unified Soil Classification System
Vibracore	vibratory core sampling
VOC	volatile organic compound
W/C	water to cement admixture
WBZ	water-bearing zone
Work Plan	*Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan*

1 Introduction

This *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan* (FSP) has been prepared as Appendix A to the *Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (Work Plan), which has been prepared jointly under the *Administrative Settlement Agreement and Order on Consent* (Docket No. CERCLA 10-2009-0255) and *Statement of Work – Gasco Sediments Site* (SOW; EPA 2009) between NW Natural and EPA and the *Voluntary Agreement* (Oregon Department of Environmental Quality [DEQ] No. WMCVM-NWR-94-13, as amended October 11, 2016. The Work Plan and associated appendices summarize the proposed in situ stabilization and solidification (ISS) bench scale treatability study (TS) for the Shallow, Intermediate, and Riverbank Regions (i.e., nearshore) of the Gasco Sediments Site Project Area (Project Area; see Figure A-1), including the top of the riverbank within the Gasco Operable Unit, and the associated field sampling and laboratory methodologies to achieve the primary objectives of the study. This FSP presents the objectives, the proposed field sampling and data collection methodologies, and the analytical testing to be conducted during the implementation of the TS at the Project Area.

1.1 Purpose and Objectives of the Field Sampling Plan

This FSP details the methods and processes that will be used to collect data in support of the objectives laid out in the Work Plan. The TS objectives are discussed in detail in the Work Plan. References to where these objectives are presented in the Work Plan are included in each investigation component's individual subsection in Section 3 of this FSP.

1.2 Document Organization

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

- Section 2 – Project Management and Responsibilities
- Section 3 – Sample Collection, Processing, and Handling Procedures
- Section 4 – Field Documentation, Sample Handling, Decontamination Procedures, and Investigation-Derived Waste Management
- Section 5 – Bench Scale Treatability Study Testing
- Section 6 – Field Sampling Schedule
- Section 7 – References

2 Project Management and Responsibilities

This section describes the project management structure for implementing this FSP. Additional information about staff responsible for project management and other roles is defined in the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan* (QAPP; Appendix B of the Work Plan).

The project manager for Anchor QEA is Mr. Ryan Barth. Mr. Barth will be responsible for overall project coordination and providing oversight on planning and coordination, all project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. He will also be the main point of contact for the U.S. Environmental Protection Agency (EPA) regional project manager and DEQ project manager.

The field coordinator from Anchor QEA is Mr. Nik Bacher. Mr. Bacher will provide overall direction for the sampling program in terms of logistics, personnel assignments, and field operations. Furthermore, he will be responsible for managing field activities and general field quality assurance (QA)/quality control (QC) oversight. He will ensure that appropriate protocols for sample collection, preservation, and holding times are observed and oversee delivery of environmental samples to the designated laboratories for chemical and physical analyses.

The project chemist will be Ms. Delaney Peterson. Ms. Peterson's responsibilities will include coordination with laboratories regarding sample receipt, requested analyses, and turnaround times. She will also answer technical and logistical questions related to the analyses requested, including issues related to limited sample availability, which impact detection limits and matrix interferences.

Sample analysis will be conducted by certified laboratories, and the laboratory project managers will act as the primary points of contact at each analytical laboratory, as discussed in the QAPP (Appendix B of the Work Plan). The project chemist will communicate with the laboratory project managers to resolve sampling, receipt, analysis, and storage issues. Multiple laboratories will be analyzing samples during the TS sampling program, and each laboratory will have a laboratory project manager.

3 Sample Collection, Processing, and Handling Procedures

The subsurface sediment and riverbank soil sampling methods described in this document were previously presented in the EPA-approved *Revised Pre-Remedial Design Data Gaps Work Plan* (Anchor QEA 2019) and *Final Revised Additional Depth of Contamination Characterization Addendum within the Gasco Sediments Site Project Area* (Anchor QEA 2023). Components of this work that rely on ASTM International (ASTM) methods will refer to currently adopted versions of the methods to ensure data quality.

To complete the field activities, Anchor QEA will work with qualified health- and safety-focused subconsultants to complete the sediment and riverbank soil sampling needed to support design.

3.1 PTW-NAPL Identification

Anchor QEA will visually inspect the full depth of each individual core and will note the presence of principal threat waste (PTW)-nonaqueous phase liquid (NAPL) and the depth interval of occurrence consistent with past sediment characterization in the Project Area.

PTW-NAPL will be identified in accordance with the site-specific visual definition, defined in Section 3.6.2.1 of the SOW (EPA 2009) as "any layer or seam of product, regardless of thickness, that is clearly defined as liquid NAPL that is also mobile (i.e., 'oozes' or 'drips' out of the core during core observations)."

Small depressions will be made in each core in areas showing both the visual absence and presence of petroleum-impacted soils and sediments to evaluate the presence of PTW-NAPL. If dense NAPL (DNAPL) freely flows into a depression, additional depressions will be made immediately above and below to delineate the depth of PTW-NAPL.

3.2 Subsurface Sediment Sampling

Sections 3.2.1 through 3.2.3 describe the subsurface sediment sample collection, processing, and handling procedures to be followed during the TS sampling to be performed by Anchor QEA. The QAPP (Appendix B of the Work Plan) details the QA/QC protocols to be followed during these activities.

3.2.1 Subsurface Sediment Sampling Plan

As described in the Work Plan, the intent of the subsurface sediment sampling program is to collect additional information to support site-specific ISS TS testing. To achieve these objectives, 16-foot sediment cores[1] will be collected for the TS testing. Sediment cores will be collected at the four locations shown in Figure A-2.

Sample IDs, proposed coordinates, and sampling depths for each program are shown in Table A-1. Chemical testing is discussed in Section 5. Sample preparation (i.e., laboratory TS testing) and analytical methods and QA/QC information are discussed in the QAPP (Appendix B of the Work Plan). The proposed locations may change based on field conditions (e.g., presence of riprap, accessibility based on existing structures, and lack of sufficient water depth).

The subsurface sediment sampling protocols used in this investigation are consistent with the protocols in the EPA-approved *Revised Pre-Remedial Design Data Gaps Work Plan* (Anchor QEA 2019c).

3.2.2 Subsurface Sediment Collection Methods

Subsurface sediment samples will be collected using vibratory core sampling (vibracore) methods. Sampling locations will be located using a differential global positioning system (DGPS), and the proposed sampling location coordinates are provided in Table A-1. Prior to collecting each core, the depth to mudline will be determined using a calibrated fathometer or lead line.

Subsurface sediment will be collected in 3.75-inch-inside-diameter aluminum core tubes with a stainless-steel core catcher riveted to the bottom end. Core tubes will be decontaminated prior to use following the protocols outlined in Section 4.3. Care will be taken during sampling to avoid contact of the core tube with potentially contaminated surfaces. Extra core tubes will be available during sampling operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated will not be used.

The vibracore will be deployed from the bow of the vessel using an A-frame and winch assembly. A 16-foot decontaminated aluminum pipe will be clamped to the vibracore. If the location is on a sloping mudline, the vibracore base can be reconfigured to attempt to match the slope to facilitate vertical penetration of the core. Once in position, the vibracore unit will be deployed, energized, and driven to a maximum of 16 feet below mudline (bml) or refusal. The physical characteristics at each proposed sampling location are anticipated to be variable precluding an accurate estimation of the core recovery at each location prior to collection. Once a penetration of 16 feet bml or refusal occurs, the vibracore will be turned off and returned to the surface for comparison to the sample acceptability criteria. The location of refusal will be recorded using a DGPS for future reference. The penetration depth will be evaluated based on data from the vessel's onboard penetration monitor and marker rings attached to the side of the vibracore base guiding rods that are pushed up on the

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[1] Shorter cores may be collected if the recovered depth of sediment can still meet all the TS objectives detailed in the Work Plan. This will be determined in consultation with the coring subcontractor.

guiding rods as the core barrel is driven into the sediments. Upon retrieving a core, the following information will be recorded:

- Date and time the core was collected
- Depth to mudline
- Total drive length
- Recovered length
- Overlying water is present, and the core surface is intact
- Core tube is in good condition and not excessively bent
- Preliminary assessment of sediment characteristics contained in the core catcher at the bottom of the tube
- Project name, location, and sampling date on an appropriately labeled photograph

To determine if a core is suitable for processing, the following acceptability criteria will be used:

1. Recovery was at least 70% of the length of core penetration. A target core recovery of 70% was determined to be appropriate based on an assessment of historical data collected within the Project Area. If refusal or poor recovery is consistently encountered during coring, a change in approach (e.g., reduce number of required attempts) will be discussed with EPA.
2. Cored material did not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube.
3. There were no obstructions noted in the core catcher that might have blocked the subsequent entry of sediment into the core tube and resulted in incomplete core collection.

Core tubes longer than 4 feet will be cut to facilitate upright storage and truck transport to the processing location. The cut tubes will be individually labeled and sealed with core caps taped over with duct tape to prevent material loss during transport. Core orientation will also be noted on each tube. Labels identifying the core section will also be securely attached to the outside of the tube using tape and waterproof ink or by scribing the information into the core tube with a metal screwdriver. The core sections will be stored upright in the core storage box on the boat until transferred to the uplands core processing area. Ice will be added to the core storage box on the boat if the core sections are kept on the boat for extended periods (e.g., not transferred in the middle of the day and at the end of each day). At the uplands core processing area, the core sections will be stored approximately upright in iced containers, or in a refrigeration unit, in the appropriate orientation until core processing is conducted. If multiple core rejections (three attempts) occur within a 20-foot radius of the planned location, the core with the best recovery will be deemed acceptable and processed. In some of the proposed nearshore locations, the cores may need to be relocated further channelward if riprap is encountered on the mudline that prevents adequate core recovery.

The sediment volume required to complete the proposed TS testing (Table A-2; see Sections 3.4 through 3.6 of the Work Plan for a description of the proposed TS tests) may require multiple cores to be collected from one proposed sediment sampling location. If multiple cores are required to obtain sufficient sediment sample volume, the vibracore will be offset as little as practicable (i.e., within approximately 50 feet) from the first accepted core so that a co-located core can be collected. This process will be repeated until sufficient volume has been obtained from a proposed location.

3.2.3 Subsurface Sediment Core Logging and Processing Procedures

All cores will be carefully transferred from the sampling vessel to large containers full of ice, or a refrigeration unit, at a designated shoreside location where processing will be conducted. The anticipated processing facility is on the Gasco property along the central portion of the property near the top of the riverbank area. Core processing occurred in this same location during completion of the *Revised Pre-Remedial Design Data Gaps Work Plan* (Anchor QEA 2019c). At the processing facility, cores will be cut open horizontally on a table and logged.

The following is a detailed account of the core processing procedures:

- Lay out the core tubes for the entire penetration depth for a sampling location. Cut the core tubes longitudinally using a circular saw, setting the saw blade depth to avoid penetration and disturbance of the sediment during cutting.
- Visually assess for the presence of PTW-NAPL using the site-specific definition provided in Section 3.1. Depressions will be made in the sediment using a melon baller to evaluate for the presence of liquid DNAPL that is also potentially mobile (i.e., oozes or drips out of the sample during processing).
- Subsample for DNAPL centrifugation and characterization. If a sediment interval is encountered that contains PTW-NAPL, a portion of the sediment layer containing PTW-NAPL may be collected and shipped to the laboratory to attempt separating a pure DNAPL sample from the sediment via centrifugation (1,000-gravity spin for at least 1 hour). If successful, the separated DNAPL sample may be submitted for physical and chemical characterization as discussed in Section 3.2.3, contingent on DNAPL sample volume and laboratory method requirements.[2]
- Record the description of the full length of the core sample on the core log form, including but not limited to the following observations, as appropriate:
  - Sample recovery (recovered sediment depth relative to penetration depth and percent compaction)

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[2] During the 2019 PDI Investigation, attempts were made to collect a pure DNAPL sample from sediment via large-scale shake tests. Those attempts did not produce a DNAPL sample of sufficient volume for physical and chemical analysis, so another attempt will be made during TS sample collection that will target sediments with previously identified PTW-NAPL.

  - Physical soil description in general accordance with Unified Soil Classification System (USCS) (includes soil type, density/consistency, color, and other similar descriptors)
  - Presence of PTW-NAPL[3] and other signs of petroleum contamination (e.g., sheens)
  - Odor (e.g., hydrogen sulfide, petroleum)
  - Presence of organic material (e.g., vegetation, roots, and twigs)
  - Anthropogenic debris
  - Biological activity (e.g., shells, tubes, bioturbation, or organisms)
  - Any other distinguishing characteristics or features
- Take digital photographs of each 1-foot core interval with a label indicating the location and depth of the core interval.
- Identify estimated target depth intervals and materials in each core per Table A-1. Targeted materials will be confirmed during core logging and depth intervals sampled from each core will be noted in the core log. The following sample depth interval identification procedures will be followed during core logging:
  - Review the targeted depth intervals and materials in Table A-1.
  - Note the core intervals that appear to meet the targeted material characteristics.
  - As a QC step, communicate with the field coordinator (or the field coordinator's designee) to confirm the depth intervals to be sampled from each core.
  - Note that selected sample depth intervals may be located outside of the targeted depth intervals identified in Table A-1, if necessary, to obtain sediments with the targeted material characteristics for each location. In addition, selected depth intervals may not be continuous (e.g., selected depth intervals in a given core could be 0.8 to 2.2 feet and 2.7 to 3.9 feet) if materials that do not meet target characteristics are present intermittently throughout the core. To meet TS objectives, obtaining samples with targeted materials is more important than sampling specific depth intervals. The sediment volume required to complete the proposed TS testing may require multiple cores to be collected at each location. If multiple co-located cores are collected, the selected sample depth intervals from each core may differ to meet the target characteristics (e.g., selected depth intervals in one core could be 0.8 to 3.4 feet, and its co-located core could be 1.5 to 3.1 feet).
- Using a decontaminated stainless-steel spoon, place sediment from the identified sample depth interval(s) into a single cleaned stainless steel or high-density polyethylene (HDPE) bucket or drum.
- Homogenization will occur on site with a paddle mixer affixed to the end of a drill. To avoid loss of volatile organic compounds (VOCs) to the extent practicable during mixing, the shaft

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[3] Locations and depths of previous PTW-NAPL observations were used to help target locations and depths where PTW-NAPL should be encountered during TS sample collection. During TS sample collection, field personnel will document that visible PTW-NAPL is present in each TS sample. If PTW-NAPL is not present, NW Natural will coordinate with EPA to identify a revised sampling location.

of the paddle mixer will be fed through a small hole in a bucket or drum lid, approximately the diameter of the paddle mixer shaft, such that mixing is performed in a near-airtight environment. Homogenize until uniform color and texture is achieved. Sediment from multiple cores, if needed to obtain sufficient sample volume, will be homogenized together.
- Using a decontaminated stainless-steel spoon, fill pre-labeled, laboratory-provided sample containers for all proposed baseline sampling on homogenized, untreated sediment samples (see Section 5.1). VOC sample jars should be filled such that there is little to no airspace. The remaining volume following filling of the sample containers will be placed into cleaned stainless steel or HDPE buckets or drums for Phase I grout composition testing, Phase II grout dosage testing, and Phases III through V leachability testing of treated sediment samples (i.e., TS testing; see Sections 5.2 through 5.4). Required volumes for TS testing are included in Table A-2.
- Immediately place filled and sealed sample containers in a cooler with ice to maintain temperature at approximately 4°C until delivered to the project laboratories, while following the handling and chain-of-custody procedures described in Section 4.2.3. The required sample volumes, preservation, and maximum holding times for the categories of analytes are presented in the QAPP (Appendix B of the Work Plan).

3.3 Riverbank Angled Borings

Sections 3.3.1 through 3.3.3 describe the sample collection, processing, and handling procedures to be followed during the collection of subsurface riverbank soil samples during the TS sampling by the selected contractor. The QAPP (Appendix B of the Work Plan) outlines the analytical methods and details the QA/QC protocols to be followed during these activities.

3.3.1 Subsurface Riverbank Soil Sampling Plan

As described in the Work Plan, the objective of the riverbank angled soil boring sampling program is to collect additional information to support site-specific ISS TS testing within the riverbank area.

Borings will be advanced at two locations within the riverbank, as shown in Figure A-3. Sample IDs, proposed boring depths, and proposed coordinates are provided in Table A-1. Chemical testing is discussed in Section 5. Sample preparation (i.e., laboratory TS testing) and analytical methods and QA/QC information are discussed in the QAPP (Appendix B of the Work Plan).

3.3.2 Riverbank Angled Boring Collection Methods

The riverbank angled borings will be advanced by a sonic drill rig after clearing the target location, as necessary, to facilitate access. The target locations may need to be adjusted based on contractor access. The riverbank borings will be advanced at a 20-degree angle to at least the visual/olfactory depth of contamination identified during the depth of contamination sampling work that occurred in

April and May 2023. The depth may be adjusted downward if there are visual/olfactory signs of contamination at deeper depths during boring logging. A single composite sample will be collected from the full length of the boring from the surface to the identified depth of contamination. Riverbank soil samples will be obtained and sampled at the frequency and depth intervals identified in Table A-1.

The riverbank soil volume required to complete the proposed TS testing (Table A-2; see Sections 3.4 through 3.6 of the Work Plan for a description of the proposed riverbank soil TS tests) may require multiple borings to be collected from one proposed riverbank soil sampling location. If multiple borings are required to obtain sufficient riverbank soil sample volume, the boring will be offset as little as practicable (i.e., within approximately 50 feet, where accessible) from the first accepted boring to sample the same target area described in the Work Plan. This process will be repeated until sufficient volume has been obtained from a proposed location.

3.3.3 Riverbank Soil Logging and Processing Procedures

The following description provides a detailed account of the riverbank angled boring sample processing procedures:

- Lay out the sample bags horizontally for each run at a boring location. Cut the bags longitudinally using scissors or similar sharp device to avoid penetration and disturbance of the riverbank soil during cutting.
- Visually assess for the presence of PTW-NAPL using the site-specific definition provided in Section 3.1. Depressions will be made in the sediment using a melon baller to evaluate for the presence of liquid DNAPL that is also potentially mobile (i.e., oozes or drips out of the sample during processing).
- Record the description of the full length of the sampled interval (Table A-1) on the boring log form, including but not limited to the following observations, as appropriate:
  - Sample recovery (recovered riverbank soil depth relative to penetration depth and percent compaction)
  - Physical riverbank soil description in general accordance with USCS (ASTM D2488 – Standard Practice for Description and Identification of Soils [Visual-Manual Procedures]), including riverbank soil type, density/consistency, color, and other similar descriptors
  - Presence of PTW-NAPL and other signs of petroleum contamination (e.g., sheens)
  - Presence of substantial product (e.g., tar or black bands of product) that does not meet the site-specific definition of PTW-NAPL)
  - Odor (hydrogen sulfide, petroleum)
  - Presence of organic material (e.g., vegetation, roots, and twigs)
  - Anthropogenic debris, including presence and characteristics

  - Any other distinguishing characteristics or features
- Take digital photographs of each borehole sample interval with a label indicating the location and depth of the interval.
- Using a decontaminated stainless-steel spoon, place riverbank soil from the identified sample depth interval (top of boring to depth of contamination) into a single cleaned stainless-steel or HDPE bucket or drum and homogenize until uniform color and texture is achieved. Riverbank soil from multiple borings, if needed to obtain sufficient sample volume, will be homogenized together.
- Homogenization will occur on site with a paddle mixer affixed to the end of a drill. To avoid loss of VOCs to the extent practicable during mixing, the shaft of the paddle mixer will be fed through a small hole in a bucket or drum lid, approximately the diameter of the paddle mixer shaft, such that mixing is performed in a near-airtight environment.
- Using a decontaminated stainless-steel spoon, fill pre-labeled, laboratory-provided sample containers for all proposed baseline sampling on homogenized, untreated riverbank soil samples (see Section 5.1). VOC sample jars should be filled such that there is little to no headspace. The remaining volume following filling of the sample containers will be left in the stainless-steel or HDPE buckets or drums for Phase I grout composition testing and Phase II grout dosage testing, and Phase III leachability testing of treated riverbank soil samples (see Sections 5.2 through 5.4). Required volumes for TS testing are included in Table A-2.
- Immediately place filled and sealed sample containers in a cooler with ice to maintain temperature at approximately 4°C until delivered to the project laboratories, while following the handling and chain-of-custody procedures described in Section 4.2.3. The required sample volumes, preservation, and maximum holding times for the categories of analytes are presented in the QAPP (Appendix B of the Work Plan).

3.3.4 Riverbank Soil Boring Abandonment

Riverbank soil borings will be abandoned using the approach approved at the upland Gasco property by the DEQ and Oregon Water Resources Department (Bayuk 2009). The bentonite grout slurry that will be placed from the bottom of the borehole to the ground surface using a tremie pipe. The discharge end of the tremie pipe will be submerged in the grout to avoid breaking the seal while filling the borehole. For intervals where DNAPL is present, the grout slurry will consist of a bentonite/organoclay blend consisting of approximately 9 parts Wyoming sodium bentonite and 1 part organoclay by volume, mixed to a 20% solids content. The resulting mud weight of the 20% solids solution will be approximately 9.5 to 9.7 pounds per gallon. The use of granular bentonite across the portion of the borehole within the vadose zone is an acceptable alternative to the placement of the grout slurry across this zone.

3.4 Horizontal Positioning and Vertical Control

Horizontal positioning at each sampling location will be determined using a DGPS with a handheld GPS unit as backup if necessary. All vertical geographical coordinates will be relative to the City of Portland datum (COP), and horizontal geographical coordinates will be in the North American Datum of 1983 (NAD83) High Accuracy Reference Network 91 (HARN91), Oregon State Plane, North Zone, in international feet.

Mudline elevations of each sediment sampling location will be determined relative to COP by measuring the water depth with a calibrated fathometer or lead line and subtracting the tidal elevation. River elevations will be determined using the on-site river gauge transducer installed on the Gasco Dock.

Depths associated with the top of the riverbank soil borings will be recorded in field documentation as depth below ground surface. The elevation of ground surface at each boring location will be surveyed following completion of riverbank soil boring installation activities.

3.5 Field Quality Assurance/Quality Control Samples

Field QA/QC samples will be collected and used to evaluate the variability resulting from sample handling and the efficiency of field decontamination procedures (Section 4.3). All field QC samples will be documented in the log book.

3.5.1 Field Duplicates

Field duplicates (i.e., homogenization duplicates) will be collected at a frequency of one per 20 samples. The field duplicates will be prepared by dividing aliquots of the homogenate (during grab, core, or boring processing and/or field collection) into two distinct samples for the laboratory (the original sample and a duplicate). The samples will be processed in the same way as the original sample and will be submitted to the laboratory as blind samples. The duplicate samples will be analyzed for the full suite of bulk sediment and riverbank soil testing listed in the QAPP (Appendix B of the Work Plan). Field duplicate sample identification procedures are described in Section 3.6.

3.5.2 Field Blanks

Field blank samples will be collected to evaluate the efficiency of field decontamination procedures. One rinsate blank and one field blank will be collected weekly for each type of sampling technique used. The rinsate blank will consist of rinsing down the sediment coring, riverbank soil boring, and homogenization equipment after sample collection and decontamination and collecting the rinsate. The field blank will be collected by pouring distilled water directly in the sampling containers. In addition, a trip blank will be included in each container shipped to the analytical laboratory containing samples to be analyzed for volatiles (i.e., VOCs). The field blank samples will be analyzed for all chemicals within a given sampling program. Rinsate blank and field duplicate sample identification procedures are described in Section 3.6.

3.6 Location and Sample Identification

Each discrete sediment sample will be assigned a unique alphanumeric identifier according to the method described in this section. The identifiers facilitate sample tracking by incorporating identifying information. The alphanumeric identifiers will be assigned for sediments and riverbank soils as described in Sections 3.6.1 and 3.6.2.

3.6.1 Sample Identification

The alphanumeric identifiers will be assigned in the following manner for each sample:

- The first six characters for both the sediment and riverbank soil locations identify the sample location by the project descriptor: ISSTS = ISS Treatability Study.
- The next three characters identify the sample location: 001 = Location 001 (A, B, C, etc. suffixes will be applied to co-located core locations).
- The next six characters identify the collection date in YYMMDD format.

In addition to the sample identification outlined above, additional identifiers will be used to create unique sample identification for each of the chemical and physical testing evaluations. These additional identifiers are presented in Table A-3. For example, sample number ISSTS-001-221110_Ph3 indicates Phase III leachability testing on an untreated sample for Location 001 and collected on November 10, 2022. In addition, for treated samples, each grout blend that will be evaluated in the TS will be given a unique number, and each grout dosage will be given a unique letter, as shown in Tables A-4a and A-4b. For example, sample number ISSTS-001_221110_G01-A_Ph3 indicates Phase III leachability testing on a sample treated with grout number 01 (0.8 water to cement admixture [W/C] ratio and 90/10 blast furnace slag cement [BFSC]/Portland cement [PC] ratio) with dosage letter A (4% dry weight of admixture to wet weight of sediment/riverbank soil) for Location 001 and collected on November 10, 2022.

The sampling depth intervals will also be noted in the field logs and provided in the chemical analytical results tables.

3.6.2 Field Quality Assurance/Quality Control Sample Identification

The field QA/QC samples will be assigned a unique alphanumeric identifier according to the following method:

- The first six characters identify the sample location by using the first letter of each word in the location name: ISSTS = ISS Treatability Study.

- The rinsate blank samples will be followed with an "–RB" followed by the date in YYMMDD format.
- The field blank samples will be followed with an "–FB" followed by the date in YYMMDD format.
- The homogenization duplicate will be followed with "–XXX-YYMMDD" where "XXX" is the location number plus 1000 and "YYMMDD" is the sampling date.

For example, sample number ISSTS-RB(FB)-221101 represents a rinsate blank (field blank) collected on November 1, 2022.

4 Field Documentation, Sample Handling, Decontamination Procedures, and Investigation-Derived Waste Management

Consistent methods of field documentation, sample handling, equipment decontamination, and investigation-derived waste (IDW) management will be used throughout the program.

4.1 Field Documentation

A complete record of all field activities will be maintained, including the following:

- Documentation of all field activities in field log books
- Documentation of all samples collected for analysis

The field staff will maintain the field log books, which will consist of bound, numbered pages. All on-site activities, including health and safety entries, and field observations will be documented in these log books. All entries will be made in indelible ink. The field log books are intended to provide sufficient data and observations to enable readers to reconstruct events that occurred during the sampling period. The field log books will include clear information concerning any modifications to the details and procedures identified in this FSP. Sediment core and riverbank soil boring collection log sheets will be completed for each sampling location (sample log sheets are presented in Attachment A).

Logs and field notes of all samples will be maintained as samples are collected and correlated to the sampling location map. The following information will be included as part of this documentation:

- Percent recovery and factors used to determine the recovery (for cores)
- Coordinates of each location as determined by the Work Plan
- Date and time of collection of each sample
- Names of field supervisor and personnel collecting and logging in the sample
- Observations made during sample collection, including presence of PTW-NAPL per the site-specific definition provided in Section 3.1, weather conditions, complications, ship traffic, and other details associated with the sampling effort
- Sample location number
- Length and depth intervals of each core/boring section
- Qualitative notation of apparent resistance of sediment/riverbank soil column when coring/boring
- Any deviation from the approved Work Plan and FSP

4.2 Sample Handling

This section describes the sample containers, sample handling and storage, chain-of-custody forms, and sample shipping for all sampling activities.

4.2.1 Sample Containers for Analysis

All sample containers received from the analytical laboratory will be pre-cleaned and certified. Prior to shipping, the analytical laboratory will add preservative, where required.

Prior to filling, each container will be clearly labeled with the name of the project, sample number, type of analysis, date, time, and initials of the person preparing the sample.

4.2.2 General Sample Handling and Storage

The guidelines for sample handling and storage for collected samples are provided in the QAPP (Appendix B of the Work Plan). Sample containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with environmental media must meet high standards of cleanliness. All equipment and instruments used to remove sediment or riverbank soil from the sampler will be made of glass, stainless steel, or polytetrafluoroethylene (PTFE) and will be decontaminated prior to each day's use and between sampling or homogenization events.

All working surfaces and instruments will be thoroughly cleaned, decontaminated (following the protocols in Section 4.3), and covered with tinfoil to avoid outside contamination between sampling events. Disposable gloves will be discarded after processing each location and replaced prior to handling decontaminated instruments or work surfaces. Sample containers will be kept in packaging as received from the analytical laboratory until use; a sample container will be withdrawn only when a sample is to be collected and returned to a cooler containing completed samples.

4.2.3 Sample Transport and Chain-of-Custody Procedures

All containerized samples will be delivered to the designated analytical laboratories after preparation is completed. Specific sample shipping procedures will be as follows:

- The shipping containers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container, and consultant's office name and address) to enable positive identification.
- Individual sample containers will be placed in a sealable plastic bag, packed to prevent breakage, and transported in a sealed ice chest or other suitable container.
- Glass jars will be separated in the shipping container by shock absorbent material (e.g., bubble wrap) to prevent breakage.
- Ice (in separate, sealed plastic bags) will be placed in the cooler to maintain a storage temperature of approximately 4°C.
- A sealed envelope containing chain-of-custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler.
- The cooler lids will be secured by wrapping the coolers in strapping tape.
- Signed and dated chain-of-custody seals will be placed on all coolers prior to shipping.

- Each cooler or container containing the sediment and riverbank soil samples for analysis will be picked up at the Gasco facility by courier daily or shipped to laboratory at the end of the field sampling effort.

Upon transfer of sample possession to the analytical laboratory, the persons transferring custody of the sample container will sign the chain-of-custody form. Upon receipt of samples at the laboratory, the shipping container seal will be broken, and the receiver will record the temperature and condition of the samples and cross-check the sample inventory with the chain-of-custody form. Chain-of-custody forms will be used internally in the laboratory to track sample handling and final disposition.

4.3 Field Equipment Decontamination

To prevent sample cross contamination, sampling and processing equipment in contact with the environmental media will undergo the following decontamination procedures prior to and between collection activities in accordance with EPA protocols (EPA 2001). Between samples, all sampling equipment that will come in contact with the sample media will be decontaminated prior to use by the following procedures:

- Rinse with river water and wash with a scrub brush until free of sediment.
- Wash with phosphate-free detergent (e.g., Alconox).
- Visually inspect the sampler and repeat the rinse and scrub step, if necessary. If scrubbing and rinsing with Alconox is insufficient to remove visually observable tar/oil-related contamination on sampling equipment, the equipment will be scrubbed and rinsed using acetone (or similar type solution) until all visual signs of contamination are absent.
- Rinse with deionized (DI) water three times.

All sample homogenizing equipment (e.g., spoons and bowls) will be decontaminated prior to and between processing cores/borings at each location using the same procedures detailed in this section.

4.4 Management of Investigation-Derived Waste and Surface Water Sheens

Information regarding the management of IDW and incidental surface water sheens produced during sampling are detailed in Sections 4.4.1 and 4.4.2.

4.4.1 Management of Investigation-Derived Waste

IDW, including excess sediments remaining following chemical and physical subsampling, purge water, fluids used for decontamination of sampling equipment, and disposable wastes (e.g., gloves, paper towels, and foil) will be placed into appropriate containers and staged on-site for disposal. All solid waste will be disposed of off site at an appropriate Resource Conservation and Recovery Act (RCRA)-permitted solid waste disposal facility.

Sediments and riverbank soil remaining after collection and processing will be placed into sealable containers (55-gallon open-top drums or covered drop boxes). General municipal solid waste that has potentially been impacted or has had incidental contact with site contaminants will be placed in receptacles lined with garbage bags. When a receptacle is at capacity, the bag will be sealed, removed, and placed within a second garbage bag. The double-bagged materials will be placed into a site dumpster and transported by the contracted disposal vendor to a RCRA-permitted Subtitle D non-hazardous solid waste disposal facility.

Consistent with the current *Contaminated Media Management Plan* (CMMP; Anchor QEA and HAI 2021), sediment and riverbank soil IDW will be characterized by collecting and analyzing one five-part composite sample per drop box and one composite sample per every five to ten 55-gallon drums. Samples will be tested for the following contaminants of concern (COCs) and hazardous waste characteristics (ignitable, reactive, or corrosive):

- Free liquids
- VOCs
- Diesel- and oil-range hydrocarbons
- Gasoline-range hydrocarbons
- RCRA eight metals (total)
- Total cyanide
- Semivolatile organic compound (full list)
- Ignitability
- Corrosivity
- Total solids/percent dry weight

All sediment and riverbank soil IDW will be screened to determine suitable waste disposal options. In addition, sediment and riverbank soil IDW generated will be screened against F002 Threshold Screening Values, DEQ's most current risk-based concentrations for human health occupational exposure pathway for F002-related constituents, to determine whether the waste will need to be handled as an F002-listed RCRA (Pearl Legal Group 2018). The CMMP (Anchor QEA and HAI 2021) identifies the following chemicals as F002-related constituents:

- Trichloroethene (TCE)
- Cis-1,2-dichloroethene
- Trans-1,2-dichloroethene
- 1,1-dichloroethene
- Vinyl chloride

After laboratory results have been compiled and screened as required, NW Natural will prepare a waste profile package that will include a cover letter summarizing the following: laboratory testing results, screening results, the facility selected for disposal, and a final waste profile specific to the selected disposal facility. The waste profile package will be submitted to the selected disposal facility requesting acceptance of the waste for the disposal. Upon acceptance by the disposal facility, waste will be transported from the site to the facility by a selected licensed contractor.

The decontamination fluids and other water generated during the investigation will be stored in sealable containers and disposed of on site at the purge/decontamination water tank adjacent to the Siltronic Corporation pretreatment facility, which is part of the permitted Gasco Groundwater Treatment System.

4.4.2 Management of Surface Water Sheens

There is potential for surface water sheens to develop while implementing the TS investigation sampling. Sheens observed may be the result of natural processes or investigation methods. To ensure that any sheen observed is managed appropriately, the following protocols will be followed:

- Sheens resulting from the disturbance of sediments will be handled using the following procedures:
    - Sorbent booms will be deployed to capture any significant sheen observed on the water surface during sediment core collection.
    - If necessary, the sorbent booms will be deployed/managed by a small support vessel to allow the sampling vessel to operate without interruption.
    - Depending on the size of the sheen observed, the National Response Center (800-424-8802) will be contacted to advise on additional mitigation measures and appropriate agency notifications, if necessary. The EPA project manager will also be notified under this scenario.

5 Bench Scale Treatability Study Testing

This section summarizes the target physical and chemical analyses for the various media that will be sampled. Sample analyses will be conducted in accordance with EPA-approved methods (where available) and the QAPP (Appendix B of the Work Plan). Prior to analysis, samples will be maintained according to the appropriate holding times and temperatures for each analysis. The methods for each of the chemical and physical analyses are described in the QAPP.

Prior to the chemical analysis of the samples, the laboratories will calculate method detection limits for each analyte of interest, where applicable. Method detection limits will be below the values specified in the QAPP if technically feasible. To achieve the required detection limits, some modifications to the specified analytical methods may be necessary. These modifications will be provided by the laboratories at the time of establishing the laboratory contract.

Sediment and riverbank soil chemical and physical testing will be conducted by the following laboratories as identified in the QAPP:

- Apex Laboratories, LLC
- ALS Environmental
- Analytical Resources, Inc.
- Environmental Geochemistry Laboratory (EGL)
- Thielsch Engineering
- GeoTechnics
- Core Laboratories
- CorEnvirons, LLC
- Laboratory Data Consultants, Inc.
- Enthalpy Analytical
- GeoTesting Express
- RC Imaging and Analyses

Chemical and physical testing will adhere to SW-846 QA/QC procedures and analysis protocols (EPA 1986) or follow the appropriate ASTM or other standard method. The analytical laboratories will prepare detailed reports in accordance with the QAPP.

Samples will be submitted for analysis as described in the following sections. Analytical methods and QA/QC requirements are discussed in the QAPP. The targeted sampling intervals for the chemical and physical testing are discussed in Sections 3.2.3 and 3.3.3 and presented in Table A-1. A summary of the analyses that will be performed on the untreated sediment and riverbank soil samples and treated sediment and riverbank soil cylinders is presented in Table A-5.

5.1 Initial Characterization of Untreated Samples

Details regarding the testing and analysis performed on homogenized, untreated sediment and riverbank soil samples (i.e., baseline testing) are presented in this section.

5.1.1 In-Water Sediment Sample Baseline Testing

Following homogenization of untreated sediments, samples will be submitted for the following analyses:

- Bulk sediment analyses for the following contaminants that have *Record of Decision – Portland Harbor Superfund Site, Portland, Oregon* (ROD; EPA 2017) Table 17 groundwater cleanup level (individual analytes are specified in the QAPP [Appendix B of the Work Plan]: semivolatile organic compounds (SVOCs, including PAHs; EPA Method 8270E), volatile organic compounds (VOCs; EPA Method 8260D), metals (EPA Method 6020B), cyanide (ASTM D7511), polychlorinated biphenyls (PCBs) (EPA Method 8082A), pesticides (EPA Method 8081B), herbicides (EPA Method 8151A), C10-C12 aliphatic hydrocarbons (Washington Extractable Petroleum Hydrocarbons [EPH]), and perchlorate (EPA Method 6850).
- Bulk sediment analysis for dioxin/furans (EPA Method 1613B).
- Various physical property testing, including:
  - Permeability (ASTM D5084)
  - Grain size (ASTM D6913 and D7928)
  - Bulk density (ASTM D7263)
  - Specific gravity (ASTM D854)
  - Porosity (calculated from bulk density and specific gravity results)
  - Total organic carbon (TOC; EPA Method 9060A mod)
  - Total solids (SM 2540G)
  - Moisture Content (ASTM D2216)
  - Atterberg Limits (ASTM D4318)
- Synthetic precipitation leaching procedure (SPLP) testing (EPA Method 1312M; see Section 5.4.1 for details regarding EPA Method 1312M for Phase III leachability testing)
- Untreated sediment samples may also be submitted for the following:
  - Scanning electron microscopy (SEM; see Section 5.4.2.3)
  - Mercury intrusion porosimetry (MIP; see Section 5.4.2.3)

5.1.2 Riverbank Soil Sample Baseline Testing

Following homogenization of untreated riverbank soils, samples will be submitted for the following analyses:

- Bulk riverbank soil analyses for the following contaminants that have ROD (EPA 2017) Table 17 groundwater cleanup levels (individual analytes are specified in the QAPP

[Appendix B of the Work Plan]: SVOCs (including PAHs; EPA 8270E), VOCs (EPA Method 8260D), metals (EPA Method 6020B), cyanide (ASTM D7511), PCBs (EPA Method 8082A), pesticides (EPA Method 8081B), herbicides (EPA Method 8151A), C10-C12 aliphatic hydrocarbons (Washington EPH), and perchlorate (EPA Method 6850)

- Bulk riverbank soil analyses for sulfate (EPA Method 300.0) and chloride (EPA Method 300.0)
- Bulk riverbank soil analysis for dioxin/furans (EPA Method 1613B).
- Various physical property testing, including:
  - Permeability (ASTM D5084)
  - Grain size (ASTM D6913 and D7928)
  - Bulk density (ASTM D7263)
  - Specific gravity (ASTM D854)
  - Porosity (calculated from bulk density and specific gravity results)
  - TOC (EPA Method 9060A mod)
  - Total solids (SM 2540G)
  - Moisture Content (ASTM D2216)
  - Atterberg Limits (ASTM D4318)
- SPLP testing (EPA Method 1312M; see Section 5.4.1 for details regarding EPA Method 1312M for Phase III leachability testing)

5.1.3 Cementitious Materials Baseline Testing

Stabilization and solidification of the sediment and riverbank soil will be conducted by adding cementitious materials (PC and BFSC). Admixture is the blend of cementitious materials. Grout is the mixture of those admixture materials and water. The TS will use Type 1L PC and grade 100 BFSC, consistent with the materials proposed for use during full-scale ISS implementation. Prior to admixture preparation, the PC and BFSC will be analyzed for the following contaminants that have ROD (EPA 2017) Table 17 groundwater cleanup level (individual analytes are specified in the QAPP [Appendix B of the Work Plan]: metals (EPA Method 6020B), SVOCs (including PAHs; EPA Method 8270E, VOCs (EPA Method 8260D), PCBs (EPA Method 8082A), pesticides (EPA Method 8081B), herbicides (EPA Method 8151A), perchlorate (EPA Method 6850), C10-C12 aliphatic hydrocarbons (Washington EPH), and cyanide (ASTM D7511). The PC and BFSC will also be analyzed for dioxin/furans (EPA Method 1613B).

5.2 Phase I Grout Composition Testing

Samples from three locations (ISSTS-001, ISSTS-10, and ISSTS-11) will be used for Phase I grout composition testing to determine optimal W/C and BFSC to PC ratios to be used in Phase II grout dosage testing (Section 5.3) and Phase III, IV, and V leachability testing (Section 5.4). The following parameters will be used during Phase I grout composition testing:

- Constant grout dosage rate of 10% for sediment samples and 8% for riverbank soil samples (based on wet weight of sediments/riverbank soils and dry weight of admixture)
- Variable grout W/C ratios (0.8:1, 1:1, and 1.2:1)
- Variable admixture BFSC/PC ratios (0:100, 30:70, 60:40, and 90:10)

After blending grout and sediment/riverbank soil at the specified ratios, each mixture will be poured into cylindrical molds (2″ × 4″ cylinders for unconfined compressive strength [UCS] testing and 3″ × 6″ cylinders for permeability testing). The filled mold will be tamped to eliminate air, and the top surface will be leveled with a stainless-steel spatula and capped with a plastic air-tight lid. Samples will be cured under sealed conditions at room temperature until further testing.[4] As discussed in Section 3.3 of the Work Plan, during Phase I grout composition testing, each mold will undergo UCS testing and permeability testing after a 28-day cure time. If needed to inform final cure times and physical properties during implementation, replicate molds may be tested again for UCS and permeability after a 56-day cure time.

In addition to strength and permeability testing, the ISS-treated materials will be visually observed for the presence of DNAPL, formation of precipitates, gels, or other supernatants during setting. Observations will be recorded and photographed.

UCS testing will be performed in accordance with ASTM D2166 and permeability testing will be performed in accordance with ASTM D5084. Since the treated sediment/riverbank soil will likely have very low permeability, elevated hydraulic gradients may be required during permeability tests; care will be taken to maintain sufficient consolidation pressure to maintain close contact between the flexible membrane and the sides of the cylindrical sample.

5.3 Phase II Grout Dosage Testing

Variable grout dosage rates (dry weight of admixture to wet weight of sediment/riverbank soil) will be tested using the selected grout blend(s) described in Section 5.2.[5] The range of grout dosage rates evaluated for sediment and riverbank soil are different due to the higher moisture content and fines content in sediment, which may affect the strength and permeability.

- For sediment, the grout dosages will be 4%, 8%, 12%, 16%, and 20%.
- For riverbank soil, the grout dosages will be 6%, 8%, and 10%.

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[4] Note that similar methodologies will be followed while creating each of the cylinders to be tested during strength, permeability, and leachability testing.

[5] One set of BFSC/PC and W/C ratios will be selected for sediments, and one set of BFSC/PC and W/C ratio will be selected for soils. The selected BFSC/PC and W/C ratios may be the same or different for sediments and soils and will be based on performance in 28-day strength and permeability testing.

- UCS will be tested at 2-to-5-day, 7-day, 14-day, and 28-day intervals following mixing.
- Permeability will be tested after 7 days and again after 28 days.

UCS testing will be performed in accordance with ASTM D2166 and permeability testing will be performed in accordance with ASTM D5084. A visual assessment for the presence of DNAPL will be conducted before and after UCS testing, and the samples will be photographed. If any free-phase DNAPL, formation of precipitates, gels, or other supernatants during setting are visually apparent, their presence will be recorded.

5.4 Phase III, IV, and V Leachability Testing

As described in Section 3.5 of the Work Plan, the following phases of leachability testing will occur:

- One phase of leachability testing (Phase III)for the untreated and treated sediment and riverbank soil samples
- One phase of leachability testing (Phase IV) for treated sediment samples

Phase IV leachability testing for sediment may be followed by a third phase of testing (Phase V), if necessary. This section describes the testing and analysis that will be performed during each phase of testing.

5.4.1 Phase III Leachability Testing

The grout blend and dosage(s) that optimally achieve the Phase I selection criteria for grout identified in Section 3.4 of the Work Plan will be selected to advance for leachability testing at EGL in Portland, Oregon. In Phase III, untreated and treated sediment and riverbank soil will be evaluated by a single time point batch extraction test (i.e., modified SPLP, EPA Method 1312M) to document changes in leachability due to the selected grout blend and dosage(s) and to narrow down the number of grout blend and dosage(s), if appropriate, for further leaching tests in Phase IV. Under EPA Method 1312M, a solid sample is submerged in DI water at a liquid to solid mass ratio of 20 to 1. Method 1312 will be followed except as noted below (a schematic of EPA Method 1312M is presented as Figure A-4, and the modified EPA Method 1312M standard operating procedure (SOP) is included in Attachment B-1 of the QAPP):

- The SPLP procedure will be conducted under static conditions, meaning the extraction vessels will not be agitated. This modification will allow for direct comparison of leachability in untreated and treated sediment and riverbank soil.
- To simulate potential leaching from pre-ISS sediments and riverbank soil, untreated sediment and riverbank soil samples will be packed into a cylindrical sample holder such that the top surface of the untreated sample is flat, allowing leaching of dissolved-phase COCs from the top surface of the sample. Similarly, to simulate potential leaching from a post-ISS treatment zone, treated samples will not be crushed prior to SPLP testing. Instead, treated cylinders will

be cured in the cylindrical sample holder. This test design will only allow for leaching of COCs from the top face of the test samples. The top surface area for diffusion of COCs will be the same for the untreated and treated samples, allowing direct comparison of COC leaching for all test samples.
- The samples contained in the cylindrical holder will be submerged in water.
- Leachate concentrations could potentially be biased high due to the presence of DNAPL in the sample. To avoid DNAPL impacting the measured leachate concentrations, leachate samples with visual signs of DNAPL or sheen may be filtered using a ceramic filter (capillary barrier) to exclude DNAPL in the aqueous phase samples (Gefell et al. 2018). The laboratory will note whether any leachate sample has a visible sheen or DNAPL before filtration and will confirm that those samples do not have a visible sheen or DNAPL after filtration.

The leachate from each test will be submitted for the following analyses:

- PAHs (EPA Method 1625), SVOCs (EPA Method 8270E), VOCs (EPA Method 8260D), metals (EPA Method 6020B), and cyanide (ASTM D7511-12) (individual analytes are specified in the QAPP [Appendix B of the Work Plan])
- TOC (SM 5310C)
- Dissolved organic carbon (DOC; SM 5310C)
- pH (SM 4500H+B)
- ORP (analyzed via probe)
- Specific conductivity (analyzed via probe)

5.4.2 Phase IV Leachability and Advanced Physical Testing

This section discusses the chemical and physical analyses proposed under Phase IV leachability testing.

5.4.2.1 Phase IV – Leachability Testing

Following the Phase III leachability testing, the grout blend and dosage that performed the best (lowest leaching) in Phase III testing will advance to Phase IV leachability testing for the sediment samples based on EPA Leaching Environmental Assessment Framework (LEAF) Method 1315M (modified for organic COCs). Method 1315 will be followed except as noted below (a schematic of EPA Method 1315M is presented as Figure A-5, and the modified EPA Method 1315M SOP is included in Attachment B-1 of the QAPP):

- A polydimethylsiloxane (PDMS) liner insert will be added to the inner perimeter of the extraction vessel to maintain a concentration gradient that leads to a constant diffusive flux of COCs from the sample or cylinder being tested (EPRI 2009; ITRC 2011; van der Sloot 2009; Gentry et al. 2014; Grubb et al. 2020).

- The PDMS liner will act as a sink for the target organic COCs to prevent those compounds from reaching their equilibrium aqueous concentrations during any of the proposed leaching intervals.
- Leaching duration will follow the standard Method 1315 procedure for leaching intervals (9 intervals, 63 cumulative leach days). Leachability will be evaluated in terms of the organic COC mass released during each interval by combining the aqueous concentrations with the mass of organic COCs extracted from the PDMS liner insert.

The water bath from each test will be submitted for the following analyses:

- PAHs (EPA Method 1625), VOCs (EPA Method 8260D), metals (EPA Method 6020B), and cyanide (ASTM D7511-12) (individual analytes are specified in the QAPP [Appendix B of the Work Plan])
- TOC (SM 5310C)
- DOC (SM 5310C)
- pH (SM 4500H+B)
- ORP (via probe)
- Specific conductivity (via probe)
- The PDMS liner extraction will be analyzed for PAHs (EPA Method 8270E) and VOCs (EPA Method 8260D) (individual analytes are specified in the QAPP [Appendix B of the Work Plan]). Since metals (EPA Method 6020B) and cyanide (ASTM D7511-12) are not sorbed by the PDMS liner, mass released for metals and cyanide during each interval will be determined from aqueous concentrations. An aliquot of water (approximately 100 milliliters [mL]) will be removed from the container and filtered with a polyethersulfone syringe filter for analysis of metals and cyanide.

5.4.2.2 Phase IV – Equilibrium Aqueous Concentration Assessment

Following completion of Method 1315M leachability tests, the treated sediment will be used to estimate equilibrium aqueous concentrations using the following methods:

- Treated sediment cylinders will be removed from the last Method 1315M reaction vessels and placed in new vessels containing water without PDMS liners.
- Treated sediment cylinders will be crushed before placement into the equilibration test containers to expedite equilibration.
- It is expected that the solids will also contain some DNAPL, so the equilibrium concentration in the water within the vessel should also approximate the effective solubility of detectable DNAPL chemical components.
- Aliquots of water (approximately 150 mL each) will be removed from the container after periods of 1 week, 2 weeks, 4 weeks, and 8 weeks for analysis of PAHs (EPA Method 1625), VOCs (EPA Method 8260D), metals (EPA Method 6020B), and cyanide (ASTM D7511-12). The

water will also be analyzed for TOC (SM 5310C), DOC (SM 5310C), ORP (via probe), specific conductivity (via probe), and pH (SM 4500H+B).

- The collected aliquots of water could potentially be biased high due to the presence of DNAPL in the sample. To avoid DNAPL impacting the measured water concentrations, if any sheen or DNAPL is visible on or in the water, the water sample may be filtered using a ceramic filter (capillary barrier) to exclude DNAPL (Gefell et al. 2018). The laboratory will note whether any water sample has a visible sheen or DNAPL before filtration and will confirm that those samples do not have a visible sheen or DNAPL after filtration.
- It is expected that the aqueous concentrations will approach equilibrium within 8 weeks (Eberhardt and Grathwohl 2002; Grubb et al. 2020). However, if concentrations continue to increase notably throughout the duration of the test (i.e., concentrations do not reach equilibrium), a mathematical approach may be used to estimate the asymptotic maximum concentrations representing the equilibrium aqueous concentration.

5.4.2.3 Phase IV – Microscale Characterization and Pore Size Distribution Measurement

The treated sediment cylinders that undergo Phase IV leachability testing and an untreated sediment sample may also be submitted for the following analyses:

- SEM: SEM will be used to visually observe the microstructures developed in treated sediment that undergo Phase IV leachability testing compared to an untreated sediment sample. This technique has been used to characterize microscale characterization of clay minerals and cement treated soils (Estabragh et al. 2017; Horpibuksuk 2012; Malliou et al. 2007; Shanti et al. 2014; Solanki and Zaman 2012; van der Sloot 2009). SEM sample preparation and analysis will be performed at RC Imaging and Analyses (Portland, Oregon). The untreated sediment sample will be freeze-dried and carefully broken into small aggregates. If necessary, the samples will be sieved through a stainless-steel mesh to collect the aggregate fraction. The treated cylinders will be carefully broken from the center into small fragments using a chisel. The small broken fragments of the treated sediment cylinders will be freeze-dried or oven-dried to completely remove water with minimum disturbance so as to not damage the pore structure of the sample or cylinder. All samples will be coated with gold before SEM analysis to prevent charge buildup on specimen surface. Then, the samples will be placed on SEM sampler holders. SEM images will be taken from different angles at different levels of magnification in the range of approximately 1,000× to 30,000× to provide the necessary imagery to show microstructures developed inside and outside of the samples. SEM images of untreated sediment and treated sediment cylinders will be compared to assess how the selected grout blend and dosage influences the development of the microstructures, which may potentially affect leachability of the COCs.
- MIP:

  - Porosity
  - Pore size distribution
  - Pore volume

  MIP will be conducted in accordance with ASTM D4404-18 to evaluate porosity, pore size distribution, and pore volume of treated sediment that undergo Phase IV leachability testing and an untreated sediment sample. These data will be utilized to assess how the selected grout blend and dosage influences the porosity, pore size distribution, and pore volume, which may affect leachability of COCs from the untreated sediment and treated sediment cylinders. The specimens for MIP will be prepared in a similar manner as SEM analysis. The specimens of treated sediment cylinders will be cut into small cubes of approximately 1 cm^3 size using a chisel. Those will be immersed into the liquid nitrogen to freeze and then dried using a freeze-dryer. The dried specimen will be placed in the apparatus of the MIP.

The treated sediment cylinders that undergo Phase IV leachability testing will also be submitted for the following analysis:

- Dean-Stark testing (API RP40), which provides the following information:
  - Pore fluid saturations (DNAPL and water)
  - Grain density
  - Porosity
- Visual assessment for the presence of DNAPL. If any free-phase DNAPL is visually apparent, its presence will be recorded and photographed.

5.4.3 Phase V Leachability Testing

In Phase V, the most promising (lowest leachability) sediment/grout from Phase IV may be advanced for column testing in which treated sediments will be placed in columns with simulated cover material on top of the treated sediments to evaluate COC concentrations within the cover layer and the potential for movement of COCs into the cover layer and associated concentrations if movement occurs. The need for Phase V testing will be determined after reviewing the Phase IV test results. NW Natural will determine whether additional Phase V testing is warranted in coordination with EPA and DEQ based on the Phase IV testing results.

5.5 DNAPL Analysis

If a pure DNAPL sample of sufficient volume is successfully separated from sediment as discussed in Section 3.2.3, the sample will be analyzed for DNAPL density (ASTM D1481) and viscosity (ASTM D445). In addition, the extracted DNAPL will be tested for total petroleum hydrocarbons (TPH; NWTPHDx), alkylated PAHs (EPA Method 8270E-SIM), and BTEX (EPA Method 8260D). If sufficient volume of DNAPL is successfully collected, the sample will also be analyzed for interfacial tension

(ASTM D971) and wettability (Cohen and Mercer 1993). Although these analyses are not directly related to testing ISS effectiveness or performance, these data could be used to further enhance overall site characterization and support the evaluations of leachability. Prior attempts to separate DNAPL from sediment at the Project Area were unsuccessful, so if a DNAPL sample is collected, its volume is likely to be small. Therefore, the final list of DNAPL analyses will depend on the volume of DNAPL successfully collected, if any.

6 Field Sampling Schedule

The TS sampling program for sediment locations is projected to begin as soon as possible after EPA approval of the Work Plan. The field sampling program for the sediment locations is expected to be completed within 30 working days. The two riverbank borings are anticipated to be collected in summer 2023. The actual start and end dates for the sampling event will depend on EPA approval of the project plans and coordination with subcontractors. Other conditions that may affect the sampling schedule are weather, contractor availability, and equipment availability. Additional information regarding overall TS schedule is presented in Section 4 of the Work Plan.

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Tables

Table A-1
Sampling Locations and Depth Intervals

Sample Location	Media	Estimated Target Depth Interval (Feet Below Mudline/Ground Surface)	Targeted Materials	Easting (X)	Northing (Y)
ISSTS-001	In-water Sediment	0 - 4	Fine-grained sediments containing visible PTW-NAPL	7623605.42	705868.79
ISSTS-002		4 - 8	Even split of fine-grained and coarse-grained sediments containing visible PTW-NAPL	7623909.4	705763.02
ISSTS-003		0 - 4	Fine-grained sediments containing visible PTW-NAPL	7624555.66	705332.78
ISSTS-004		4 - 8	Coarse-grained sediments containing visible PTW-NAPL	7624629.05	705300.94
ISSTS-10	Riverbank Soil (Angled Riverbank Borings)	0 - DOC[1]	Entire length of target boring depth	7624637.47	705152.38
ISSTS-11		0 - DOC[1]	Entire length of target boring depth	7623179.28	705957.87

Notes:

1. The DOC in each of the Riverbank Soil boring locations will be determined by the co-located angled riverbank borings currently being collected consistent with the EPA approved *Final Revised Additional Depth of Contamination Characterization Addendum within the Gasco Sediments Site Project Area* (Anchor QEA 2023). Riverbank borings will be advanced at a 20-degree angle consistent with the riverbank angled borings collected to delineate DOC.

Selected sample depth intervals may be located outside of the estimated targeted depth intervals if necessary to obtain sediments with the targeted material characteristics for each location. In addition, selected depth intervals may not be continuous (e.g., selected depth intervals in a given core could be 0.8-2.2 feet and 2.7-3.9 feet) if materials that do not meet target characteristics are present intermittently throughout the core. To meet bench scale treatability study objectives, obtaining samples with targeted materials is more important than sampling specific depth intervals.

The sediment or riverbank soil volume required to complete the proposed bench scale treatability study testing may require multiple cores or borings to be collected at each location. If multiple co-located cores or borings are collected, the selected sample depth intervals from each core or boring may differ in order to meet the target characteristics (e.g., selected depth intervals in one core could be 0.8 to 3.4 feet, and its co-located core could be 1.5 to 3.1 feet).

At each Riverbank Soil boring location, the composite soil sample will be created by collecting material equally from across the full length of the soil borings.

DOC: depth of contamination
EPA: U.S. Environmental Protection Agency
MGP: manufactured gas plant
NAPL: nonaqueous phase liquid
PTW: principal threat waste
PTW-NAPL: source material containing visual mobile nonaqueous phase liquid
XY Coordinates are in North American Datum of 1983 (HARN91) Oregon State Plane North, International Feet

Table A-2
Laboratory Pilot Study Sample Volume Requirements

Sample Location	Study Component	Volume Required (Liter)	Volume Required (Gallon)
ISSTS-001	Baseline Testing	13.0	3.4
	Phase I Grout Composition Testing	20.9	5.5
	Phase II Grout Dosage Testing	11.4	3.0
	Leachability Testing (Phase III and IV)	9.6	2.5
	Total	54.9	14.5
ISSTS-002	Baseline Testing	13.0	3.4
	Phase II Grout Dosage Testing	11.4	3.0
	Leachability Testing (Phase III and IV)	9.6	2.5
	Total	34.0	9.0
ISSTS-003	Baseline Testing	13.0	3.4
	Phase II Grout Dosage Testing	11.4	3.0
	Leachability Testing (Phase III and IV)	9.6	2.5
	Total	34.0	9.0
ISSTS-004	Baseline Testing	13.0	3.4
	Phase II Grout Dosage Testing	11.4	3.0
	Leachability Testing (Phase III and IV)	9.6	2.5
	Total	34.0	9.0
ISSTS-010	Baseline Testing	3.9	1.0
	Phase I Grout Composition Testing	20.9	5.5
	Phase II Grout Dosage Testing	6.8	1.8
	Leachability Testing (Phase III)	1.6	0.4
	Total	33.2	8.8
ISSTS-011	Baseline Testing	3.9	1.0
	Phase I Grout Composition Testing	20.9	5.5
	Phase II Grout Dosage Testing	6.8	1.8
	Leachability Testing (Phase III)	1.6	0.4
	Total	33.2	8.8

Table A-3
Sample Identification

Sample Type	Study Component	Identification Template	Example Identification
Untreated sediment/soil	Bulk Sediment or Soil Analyses	ISSTS-XXX_YYMMDD	ISSTS-001_221110
	Soil Hydrogeologic Characteristic Testing	ISSTS-XXX_ZZZFT_YYMMDD	ISSTS-005_020FT_221110
	Phase III Leachability Testing	ISSTS-XXX_YYMMDD_Ph3	ISSTS-001_221110_Ph3
Treated sediment/soil	Phase I Grout Composition Testing and Phase II Grout Dosage Testing	ISSTS-XXX_YYMMDD_G##-#_D##	ISSTS-001_221110_G01-A_D07 ISSTS-001_221117_G03-C_D14
	Phase III Leachability Testing	ISSTS-XXX_YYMMDD_G##-#_Ph3	ISSTS-001_221110_G01-A_Ph3
	Phase IV Leachability Testing	ISSTS-XXX_YYMMDD_G##-#_Ph4_D##	ISSTS-001_221110_G01-A_Ph4_D07
	Microscale Characterization and Pore Size Distribution Measurement	ISSTS-XXX_YYMMDD_G##-#_Ph4	ISSTS-001_221110_G01-A_Ph4
	Phase IV Equilibrium Aqueous Phase Testing	ISSTS-XXX_YYMMDD_G##-#_EqAq_D##	ISSTS-001_221110_G01-A_EqAq_D07 ISSTS-001_221110_G03-C_EqAq_D14
Extracted DNAPL		ISSTS-XXX_YYMMDD_DNAPL	ISSTS-001_221110_DNAPL

Notes:
XXX: These three characters identify the sample location (e.g., 003).
YYMMDD: These six characters identify the year (YY), month (MM), and day (DD).
ZZZFT: These five characters identify the sample depth (in feet) for the solid hydrogeologic characteristic testing that will be performed.
D##: For tests that will be performed on the same sample over time, these three characters represents the date the sample was collected (e.g., day 7, day 14).
G##-#: Each grout blend with be given a unique number and dosage will be given a unique letter, as shown in Tables A-4a and A-4b.
DNAPL: dense nonaqueous phase liquid
EqAq: equilibrium aqueous
Ph3: Phase III
Ph4: Phase IV

Table A-4a
Grout Blend Unique Identification Numbers

Grout Blend Number	W/C Ratio	BFSC/PC Ratio
01	0.8	90/10
02	1	90/10
03	1.2	90/10
04	0.8	60/40
05	1	60/40
06	1.2	60/40
07	0.8	30/70
08	1	30/70
09	1.2	30/70
10	0.8	0/100
11	1	0/100
12	1.2	0/100

Notes:

BFSC/PC: blast furnace slag cement to Portland cement

W/C: water to cement

Table A-4b
Grout Dosage Unique Identification Letters

Dosage Letter	Dosage[1]
A	4%
B	6%
C	8%
D	10%
E	12%
F	16%
G	20%

Note:

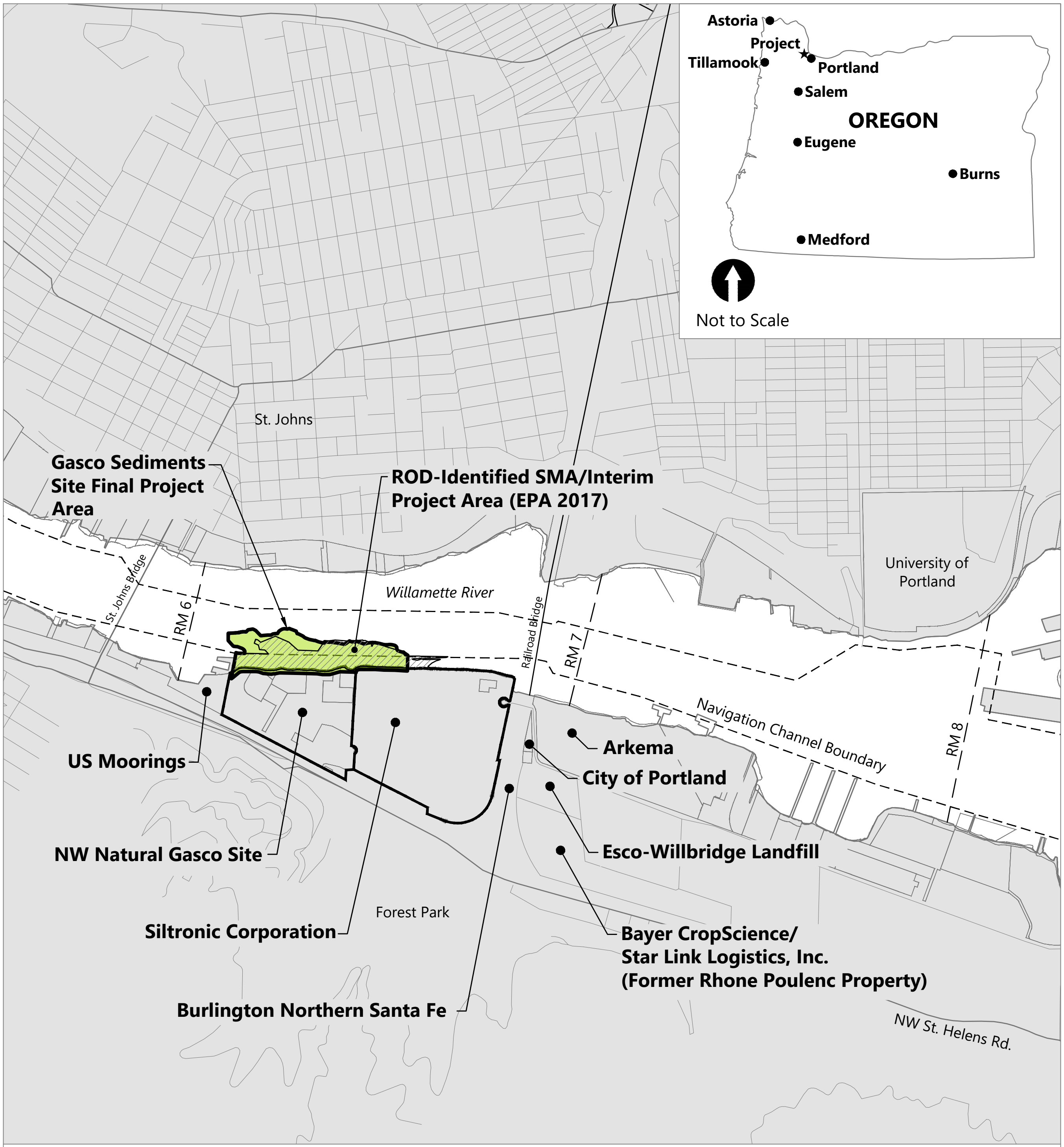
1. Dry weight of admixture to wet weight of sediment/soil.

Table A-5
Summary of Analyses

Media	Sample Type	Baseline Testing	Phase I Grout Component Testing	Phase II Grout Dosage Testing	Phase III Leachability Testing	Phase IV Leachability Testing	Phase IV Equilibrium Aqueous Phase Testing	Phase IV Advanced Physical Testing
		FSP Section 5.1.1 (Sediment) FSP Section 5.1.2 (Soil)	FSP Section 5.2	FSP Section 5.3	FSP Section 5.4.1	FSP Section 5.4.2.1	FSP Section 5.4.2.2	FSP Section 5.4.2.3
Sediment Samples (ISSTS-001, ISSTS-002, ISSTS-003, ISSTS-004)	**Untreated Samples**	COCs with a ROD Table 17 CUL (SVOCs [including PAHs], VOCs, metals, cyanide, pesticides, PCBs, C10-C12 aliphatic hydrocarbons, and herbicides), dioxins/furans, permeability, grain size, bulk density, TOC, total solids, moisture content, Atterberg Limits, and porosity	N/A	N/A	Subset of COCs with a ROD Table 17 CUL (SVOCs [including PAHs], VOCs, metals, and cyanide), TOC, DOC, pH, and ORP	N/A	N/A	SEM, MIP, DNAPL analyses, if able (see Section 5.5)
	Treated Samples	N/A	Strength, Permeability	Strength, Permeability		COCs with a ROD Table 17 CUL (SVOCs [including PAHs], VOCs, metals, cyanide), C10-C12 aliphatic hydrocarbons, TOC, DOC, pH, and ORP	COCs with a ROD Table 17 CUL (SVOCs [including PAHs], VOCs, metals, cyanide, C10-C12 aliphatic hydrocarbons), TOC, DOC, pH, and ORP	SEM, MIP, porosity, Dean-Stark
Soil Samples (ISSTS-010, ISSTS-011)	**Untreated Samples**	COCs with a ROD Table 17 CUL (SVOCs [including PAHs], VOCs, metals, cyanide, pesticides, PCBs, C10-C12 aliphatic hydrocarbons, herbicides), dioxins/furans, permeability, grain size, bulk density, TOC, total solids, moisture content, Atterberg Limits, porosity, sulfate, and chloride Additionally, one grab every 20 feet of core will be analyzed for hydrogeologic characteristics (porosity, grain size, and bulk density)	N/A	N/A		N/A	N/A	SEM, MIP, DNAPL analyses, if able (see Section 5.5)
	Treated Samples	N/A	Strength, Permeability	Strength, Permeability				SEM, MIP, porosity, Dean-Stark

Notes:
COC: contaminant of concern
CUL: cleanup level
DNAPL: dense nonaqueous phase liquid
DOC: dissolved organic carbon
EPA: U.S. Environmental Protection Agency
FSP: *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan*
ISS: in situ stabilization and solidification
LEAF: Leaching Environmental Assessment Framework
MIP: mercury intrusion porosimetry
N/A: not applicable
ORP: oxidation reduction potential
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
ROD: *Record of Decision – Portland Harbor Superfund Site, Portland, Oregon*
SEM: scanning electron microscopy
SPLP: synthetic precipitation leaching procedure
SVOC: semivolatile organic compound
TBD: to be determined
TOC: total organic carbon
VOC: volatile organic compound

Figures



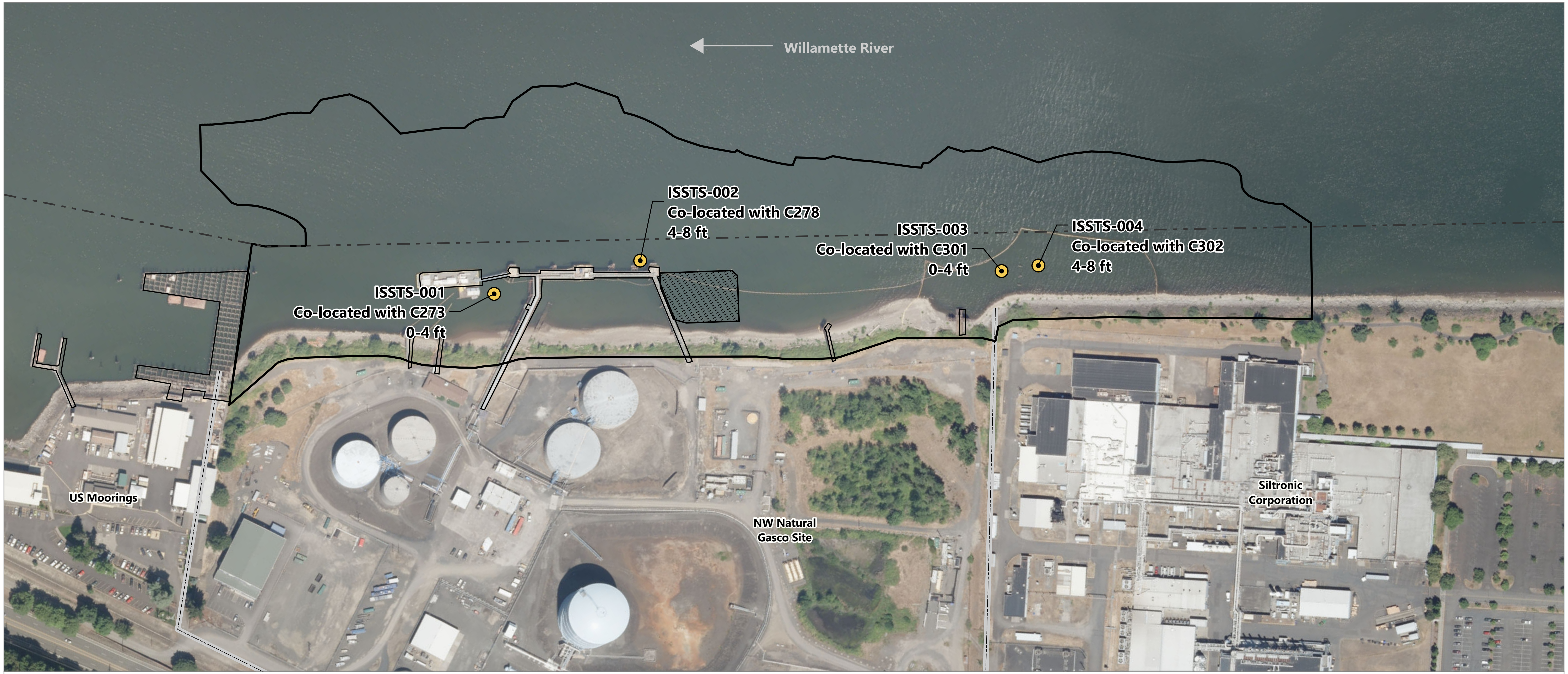
HORIZONTAL DATUM: Oregon State Plane North Zone, NAD83, International Feet.

NOTE: All locations are approximate.

Publish Date: 2023/02/14 2:05 PM | User: hmerrick
Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Sediments_Pre-Remedial Design_Report Drafting\0029-RP-015 (Vicinity Map-In Situ Stab_Solid Study FSP).dwg Figure A-1

Figure A-1
Vicinity Map

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan
Gasco Sediments Cleanup Action



LEGEND:

- ⊙ Proposed In-water Sediment Sample Locations
- ▤ Gasco Early Action Removal Action Pilot Cap
- ☐ Structures
- ⌜⌟ Navigation Channel
- ▭ Gasco Sediments Site Final Project Area
- ╌ Property Line

NOTES:

1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

0 230
Feet

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Figure A-2

Proposed In-water Sediment Bench Scale Treatability Study Sample Locations

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan
Gasco Sediments Cleanup Action

LEGEND:

- ● Proposed Riverbank Soil Sample Location
- ▦ Gasco Early Action Removal Action Pilot Cap
- ☐ Structures
- ⌜⌟ Navigation Channel
- ▭ Gasco Sediments Site Final Project Area
- ┄ Property Line

NOTES:
1. Arrow indicates direction of flow of river.
2. Horizontal datum is NAD83 (HARN 91) Oregon State Plane North, International Feet.
3. Vertical datum is City of Portland (COP), Feet.
4. Aerial imagery from City of Portland 2018.

DOC: Depth of Contamination
ISS: In Situ Stabilization and Solidification

0 230
Feet

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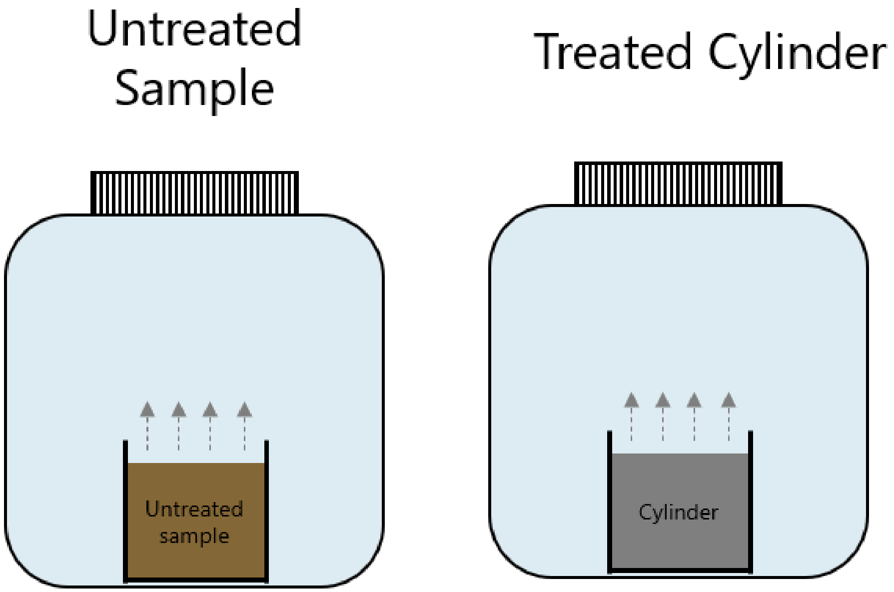
Figure A-3

Proposed Riverbank Soil Bench Scale Treatability Study Sample Locations

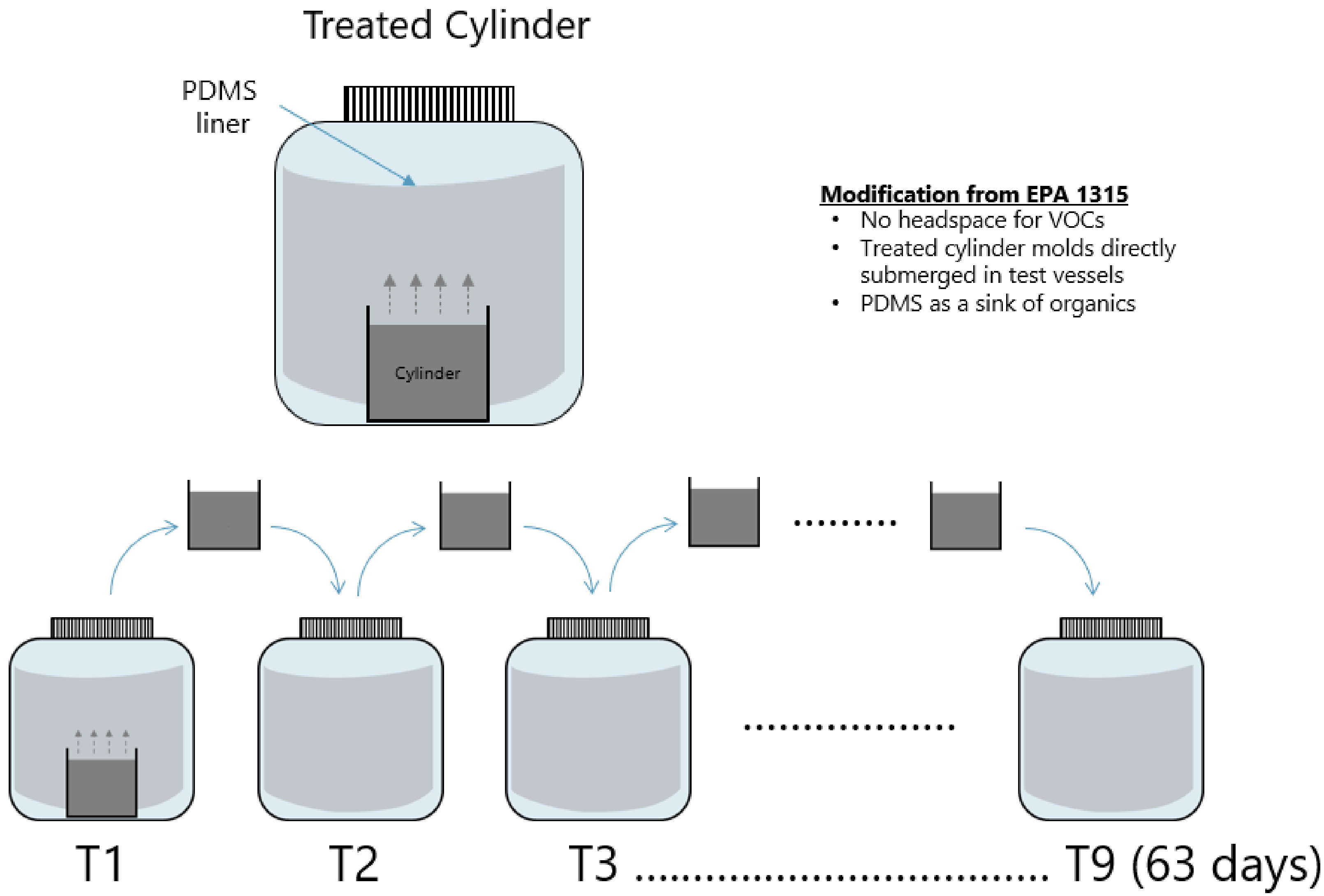
Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan
Gasco Sediments Cleanup Action



Modifications from EPA Method 1312:

- Testing will be conducted under static conditions.
- Untreated samples and treated cylinders will not be crushed prior to testing.
- Untreated samples and treated cylinders will be inserted into a cup so that leaching is limited to the open face of the cup. This will allow for direct comparison of leachability from untreated samples and treated cylinders.

Figure A-4
Modified EPA Method 1312M



Modification from EPA 1315
- No headspace for VOCs
- Treated cylinder molds directly submerged in test vessels
- PDMS as a sink of organics

Figure A-5
Modified EPA Method 1315
Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan
Gasco Sediments Cleanup Action

Attachment A

Field Forms

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Sediment Core Collection Log

Page __ of __

Job:

Job No:

Field Staff:

Contractor:

Vertical Datum:

Station ID:

Attempt No.

Date:

Logged By:

Horizontal Datum:

Field Collection Coordinates:

Lat/Northing:

Long/Easting:

A. Water Depth

DTM Depth Sounder:

DTM Lead Line:

B. Water Level Measurements

Time:

Tide Height:

Source:

C. Mudline Elevation

Recovery Measurements (prior to cuts)

Core Collection Recovery Details:

Core Accepted: Yes / No

Core Tube Length:

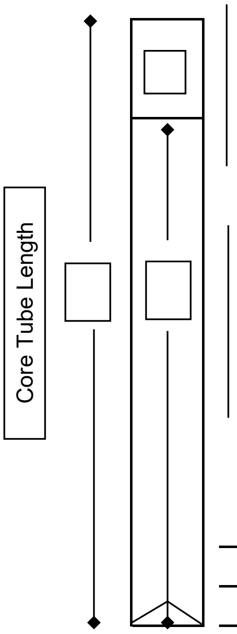
Drive Penetration:

Headspace Measurement:

Recovery Measurement:

Recovery Percentage:

Total Length of Core To Process:



Sections To Process:

A:

B:

C:

D:

Drive Notes:

Core Field Observations and Description:

Sediment type, moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota

Notes:

Sediment Core Processing Log

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Job:

Job No.

No. of Sections:

Drive Length:

Recovery:

% Recovery:

Notes:

Station ID:

Date/Time:

Core Logged By:

Attempt #:

Type of Core ☐ Mudmole ☐ Vibracore ☐ Diver Core

Diameter of Core (inches)

Core Quality ☐ Good ☐ Fair ☐ Poor ☐ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	PID	Sample	Summary Sketch

Page_____ of ______

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LOG OF EXPLORATORY BORING

CLIENT/PROJECT NAME________________________________ BORING #________________

PROJECT NUMBER____________________________________ DATE BEGAN______________

GEOLOGIST/ENGINEER_________________________________ DATE COMPLETED_____________

DRILLING CONTRACTOR________________________________ TOTAL DEPTH_________________

DRILLING METHOD___________________________________ SHEET______OF_______

HOLE DIAMETER____________________________________

		SAMPLING DATA								Field location of boring			
OTHER*	WELL OR PIEZOMETER DETAILS	SAMPLING METHOD	SAMPLE NUMBER	FID / PID (ppm)	RECOVERY (feet)	BLOWS / 6 INCHES	DEPTH SAMPLED	DEPTH IN FEET	SOIL GROUP SYMBOL (USCS)	LITHOLOGIC DESCRIPTION	GRVL %	SND %	SLT %
								1					
								2					
								3					
								4					
								5					
								6					
								7					
								8					
								9					
								0					
								1					
								2					
								3					
								4					
								5					
								6					
								7					
								8					
								9					
								0					

Remarks:

Appendix B
Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan

May 19, 2023
Gasco Sediments Cleanup Action

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan

Prepared for U.S. Environmental Protection Agency, Region 10,
and Oregon Department of Environmental Quality

May 2023
Gasco Sediments Cleanup Action

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan

Prepared for
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1200 Sixth Avenue
Seattle, Washington 98101

Oregon Department of Environmental Quality
Northwest Region Portland Office
2020 SW 4th Avenue, Suite 400
Portland, Oregon 97201

Prepared by
Anchor QEA, LLC
6720 S Macadam Avenue, Suite 300
Portland, Oregon 97219

On Behalf of
NW Natural
250 SW Taylor Street
Portland, Oregon 97204

APPROVAL PAGE

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U.S. Environmental Protection Agency, Region 10

Cindy Fields, Quality Assurance Manager Designee

Signature: ______________________ Date: ______________

Oregon Department of Environmental Quality

Wes Thomas, Project Manager

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NW Natural

Robert J. Wyatt, Director, Legacy Environmental Programs

Signature: ______________________ Date: May 19, 2023

Anchor QEA, LLC

Ryan Barth, Project Manager

Signature: ______________________ Date: May 19, 2023

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Delaney Peterson, Project Quality Assurance Manager

Signature: ______________________ Date: May 19, 2023

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Chidi Umeh	Operations Director	CorEnvirons, LLC
Rick Hugo	Sole Proprietor	RC Imaging and Analyses
Stella Cuenco	Data Validator	Laboratory Data Consultants, Inc.

The Anchor QEA Project Quality Assurance Manager is responsible for maintaining the official, approved *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan*.

TABLE OF CONTENTS

TABLES

FIGURE

ATTACHMENT

Attachment 1	Standard Operating Procedures
Attachment 2	Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Data Management Plan

ABBREVIATIONS

ASTM	ASTM International
CCV	continuing calibration verification
COC	chain of custody
DQO	data quality objective
DNAPL	dense nonaqueous phase liquid
EPA	U.S. Environmental Protection Agency
FC	Field Coordinator
FSP	*Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan*
HAZWOPER	Hazardous Waste Operations and Emergency Response
ISS	in situ stabilization and solidification
LEAF	Leaching Environmental Assessment Framework
MD	matrix duplicate
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NAPL	nonaqueous phase liquid
NIST	National Institute of Standards and Technology
OPR	ongoing precision and recovery sample
OSHA	Occupational Safety and Health Administration
PDMS	polydimethylsiloxane
QA	quality assurance
QAPP	*Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan*
QC	quality control
RL	reporting limit
RPD	relative percent difference
SOP	standard operating procedure
SPLP	synthetic precipitation leaching procedure
TS	treatability study
Work Plan	*Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan*

1 Introduction

This *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan* (QAPP) has been prepared as Appendix B to the *Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (Work Plan), which has been prepared under the *Administrative Settlement Agreement and Order on Consent* (EPA 2009a; CERCLA Docket No. 10-2009-0255) and *Statement of Work – Gasco Sediments Site* (EPA 2009b). The Work Plan and associated appendices summarize the proposed in situ stabilization and solidification (ISS) bench scale treatability study (TS) for the Shallow, Intermediate, and Riverbank Regions (i.e., nearshore) including the top of the riverbank of the Gasco Sediments Site Project Area (Project Area) and the associated field sampling and laboratory methodologies to achieve the primary objectives of the study.

This QAPP establishes the quality assurance (QA) objectives for conducting sampling and evaluation activities described therein. The analytical methods and QA procedures described here will be followed by NW Natural and its contractors during sample collection activities described in the Work Plan. The goal of this QAPP is to ensure that data of sufficiently high quality are generated to support the project data quality objectives (DQOs; DQOs are included in Section 2.4). This QAPP will address project management responsibilities; sampling and analytical procedures; assessment and oversight; and data reduction, validation, and reporting.

This QAPP was prepared following U.S. Environmental Protection Agency's (EPA's) *Guidance for Quality Assurance Project Plans* (EPA 2002). Analytical QA/quality control (QC) procedures were also developed based on the analytical protocols and QA guidance of EPA's *Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods* (EPA 1986) and the EPA Contract Laboratory Program National Functional Guidelines for Data Review (EPA 2020a, 2020b, 2020c).

1.1 Purpose and Objectives

The purpose of this QAPP is to establish the QA objectives for conducting sampling and analytical activities described in the Work Plan. The analytical methods and QA procedures described here will be followed by NW Natural and its contractors during sample collection activities described in the Work Plan and the associated *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan* (FSP; Appendix A of the Work Plan). The objective of this QAPP is to ensure that data of sufficiently high quality are generated to support the project DQOs. This QAPP will address project management responsibilities; sampling and analytical procedures; assessment and oversight; and data reduction, validation, and reporting.

1.2 Document Organization

EPA guidance (EPA 2002) specifies four groups of information that must be included in a QAPP (Project Management, Data Generation and Acquisition, Assessment and Oversight, and Data Validation and Usability). Each group comprises several QAPP elements. EPA's guidance provides a suggested outline for the QAPP elements. However, the guidance indicates that certain elements may not be applicable to a given project and that the elements need not be presented in the order presented in the guidance.

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

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

2 Project Management

This section describes the rationale for conducting the investigation studies, identifies the studies to be performed and their respective schedules, outlines project DQOs and criteria, lists training and certification requirements for sampling personnel, and describes documentation and record keeping procedures.

2.1 Project Organization

Responsibilities of the team members, as well as Laboratory Project Managers, are described in Section 2 of the FSP (Appendix A of the Work Plan). Contact information for each member of the project is provided in Table B-1. The independent investigation being undertaken by NW Natural, as described in this QAPP and the associated FSP (Appendix A of the Work Plan), was developed with informal, but detailed, consultation with EPA. All material EPA comments and suggestions were considered by NW Natural and incorporated into this plan. A project organizational chart showing the relationships and lines of communication among project participants is presented in Figure B-1.

2.2 Problem Definition/Background

The Work Plan describes the investigations that will be performed as part of the TS at the Project Area. A detailed project overview, site description, project figures, and supporting field sampling details are provided in the Work Plan and the FSP (Appendix A of the Work Plan). See Sections 1 through 3 of the Work Plan for the objectives and sampling design rationale. Sampling methods are described in Section 3 of the FSP. Sampling details are included in Tables A-1 and A-2 of the FSP. The TS sampling event is being implemented to collect additional data to inform the design of the ISS of the nearshore to address both short- and long-term risks in the Project Area and integrate with source control requirements to assure short- and long-term effectiveness.

2.3 Project/Task Description and Schedule

Sampling activities described in the Work Plan and FSP (Appendix A of the Work Plan) will be initiated following EPA approval. The TS sampling activities are currently estimated to occur winter 2022 or early 2023 contingent on meeting the current EPA approval timeline for the Work Plan. See Section 3 of both the Work Plan and FSP for descriptions of the specific tasks to be conducted. Work Plan Figures 2-3 and 2-4 show sampling locations. The sampling schedule is discussed in FSP Section 6. The laboratories are expected to deliver data within 30 days of sample receipt and level 4 data packages within 15 days of data receipt. Data validation will commence immediately after level 4 reports are received and is expected to be completed within 30 days.

2.4 Data Quality Objectives and Criteria

The DQOs for this project are to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality to achieve the project objectives described in the Work Plan and FSP (Appendix A of the Work Plan). The quality of the laboratory data is assessed by precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity (see Section 3.4).

2.5 Special Training Requirements/Certifications

For sample preparation tasks, it is important that field personnel are trained in standardized data collection requirements so that the data collected are consistent among the field crew. Field personnel must be fully trained in the collection and processing of subsurface sediment and soil core samples, decontamination protocols, visual inspections, and chain-of-custody (COC) procedures. Training for staff will be provided through on-the-job training and attendance at internal and external seminars and workshops on relevant subject matter. The Anchor QEA Field Coordinator (FC) will be responsible for ensuring that staff and any contractors have the necessary training required to conduct the field investigation procedures described in the Work Plan, FSP (Appendix A of the Work Plan), and this QAPP.

In addition, the 29 Code of Federal Regulations 1910.120 Occupational Safety and Health Administration (OSHA) regulations require training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health. Sampling personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course and 8-hour refresher courses, as necessary, to meet OSHA regulations. Anchor QEA's project Health and Safety Officer, David Templeton, is responsible for the completion and retention of HAZWOPER certification. In addition, all sampling personnel will have basic training in boat safety for the over-water work. Certifications will be maintained in Anchor QEA's project files.

2.6 Documentation and Records

This project will require central project files to be maintained at Anchor QEA for a minimum of 10 years. Project records will be stored and maintained in a secure manner. The Project QA Manager will be responsible for maintaining and providing updated copies of the most current approved version of the QAPP. Updates will be distributed to appropriate personnel electronically. Each project team member is responsible for filing necessary project information or providing it to the person responsible for the filing system. Individual team members may maintain files for individual tasks but must provide such files to the central project files upon completion of each task. Hard copy documents will be kept on file at Anchor QEA or at a document storage facility throughout the duration of the project, and electronic data will be maintained in the Anchor QEA central database and backed up regularly as part of routine file maintenance.

2.6.1 Field Records

Documents generated during the field effort are controlled documents that become part of the project file. Field documents may be generated electronically or recorded on hard copies in the field. Field team members will keep a daily record of significant events, observations, and measurements on field logs developed specifically for each activity. The field logs will be the main source of documentation for field activities and will be maintained by the FC. The sampling documentation will contain information on each sample collected and will include, at a minimum, the following information:

- Project name
- Field personnel on site
- Facility visitors
- Weather conditions
- Field observations
- Maps and/or drawings
- Sample collection date and time
- Sampling method and description of activities
- Identification or serial numbers of instruments or equipment used
- Deviations from the Work Plan, FSP (Appendix A of the Work Plan), or QAPP
- Conferences associated with field sampling activities

Entries for each day will begin on a new form. The person recording information must enter the date and time and initial each entry. Additional specific field reporting requirements and checklists for each study are defined in the Work Plan and FSP (Appendix A of the Work Plan). In general, sufficient information will be recorded during each sampling event so that reconstruction of the event can occur without relying on the memory of the field personnel.

The field forms will be either collected electronically or on water-resistant, durable paper to prevent deterioration of the project record due to adverse field conditions. Hard copy notes will be taken in indelible, waterproof blue or black ink. Errors will be corrected by drawing a single line through the error, writing in the correct information, then dating and initialing the change. Each form will be marked with the project name, number, and date. The field forms will be scanned into Anchor QEA's project file directory as convenient during the sampling event or upon completion of each sampling event.

Sample collection tables are included in the FSP and will be used to inform proposed coordinates of each location, the sampling scheme, and whether any QC samples are to be collected.

2.6.2 Preparation and Analytical Chemistry Records

The laboratories will retain preparation and analytical data records. Additionally, Anchor QEA will retain them in central project files. For chemical analyses, the data reporting requirements will include those items necessary to complete data validation, including copies of raw data. The laboratories will prepare a detailed laboratory data package documenting the activities associated with the sample analyses. Level 4 laboratory data packages will be submitted for all laboratory data except for geotechnical and dense nonaqueous phase liquid (DNAPL) mobility data. Stage 2B validations will be conducted on all data submitted in Level 4 data packages. As standard practice, laboratories prepare either Level 2 or Level 4 data packages, and level 4 packages contain information necessary to perform a Stage 4 data validation per EPA guidelines (EPA 2009c); however; no Stage 4 validations are planned. Stage 4 validations may be conducted if issues with the data arise that may be confirmed or disproved by a higher level of validation. Stage 1 validations will be conducted on geotechnical and DNAPL mobility data. The laboratory data reports will include, but are not limited to, the following information:

- **Project Narrative.** This summary, in the form of a cover letter, will discuss problems (if any) encountered during any aspect of sample receipt, preparation, and analyses. This summary will discuss, but not be limited to, sample receipt, sample storage, QC deviations, and any other analytical difficulties. Problems encountered, actual or perceived, and their resolutions will be documented in as much detail as appropriate.
- **COC Records.** Legible copies of the COC forms will be provided as part of the data package. This documentation will include the time of receipt and condition of the samples received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented on a sample receipt form. The form must include sample shipping container temperatures measured at the time of sample receipt.
- **Sample Results.** The data package will summarize the results for each sample analyzed. The summary will include the following information when applicable:
  - Field sample identification code and the corresponding laboratory identification code
  - Sample matrix
  - Date of sample preparation
  - Date and time of analysis
  - Weight and/or volume used for analysis
  - Final dilution or concentration factor for the sample
  - Identification of the instrument used for analysis
  - Method detection and reporting limits (RLs) accounting for sample-specific factors (e.g., dilution and total solids)
  - Analytical results with reporting units identified
  - Data qualifiers and their definitions

- **QA/QC Summaries.** This section contains the results of the laboratory QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results. No recovery or blank corrections will be made by the laboratory. The required summaries include, but are not limited to, the following:
    - **Calibration Data Summary.** This summary will report the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent relative standard deviation, percent difference, and retention time for each analyte will be listed, as appropriate. Results for standards used to quantify instrument sensitivity will be documented.
    - **Instrument Performance Checks.** Ion abundances and the ranges of acceptable criteria will be reported for gas chromatography/mass spectrometry methods. Mass calibration atomic mass unit and percent relative standard deviation values will be reported for inductively coupled plasma/mass spectrometry methods.
    - **Internal Standard Area Summary.** Internal standard areas will be reported for each sample analyzed, as appropriate.
    - **Method Blank Analysis.** The method blank analyses associated with each sample and the concentration of compounds of interest identified in these blanks will be reported.
    - **Surrogate Spike Recovery.** Surrogate spike recovery results for organic analyses will be reported for each sample. The names and concentrations of the compounds added, percent recoveries, and range of acceptable recoveries will be reported.
    - **Matrix Spike Recovery.** The names and concentrations of analytes added, percent recoveries, and range of acceptable recoveries will be listed. The relative percent difference (RPD) for matrix spike duplicate (MSD) analyses will be reported.
    - **Matrix Duplicate.** This summary will include the RPD or difference value for matrix duplicate (MD) analyses, as appropriate to the sample concentrations.
    - **Laboratory Control Sample.** The name and concentration of analytes added, percent recoveries, and range of acceptable recoveries will be listed. The RPD values for laboratory control sample duplicate analyses will be included.
    - **Relative Retention Time.** This summary will include a report of the relative retention time of each analyte detected in the samples for both primary and confirmatory analyses.
- **Original Data.** Legible copies of the original data generated by the laboratory will include the following:
    - Identification of preparation method used and cleanup logs, as appropriate
    - Instrument specifications and analysis logs for instruments used on days of calibration and analysis

  - Original printouts of full-scan chromatograms and quantitation reports for gas chromatography and/or gas chromatography/mass spectrometry samples, blanks, calibrations, spikes, replicates, and reference materials
  - Reconstructed ion chromatograms for samples, standards, blanks, spikes, replicates, and reference materials
  - Enhanced spectra of detected compounds with associated best-match spectra for each sample
  - Instrument outputs for inorganic analyses, including calibrations and sample analyses
  - Calculation worksheets

Instrument data shall be fully restorable at the laboratory from electronic backup. The laboratory will be required to maintain records relevant to project analyses for a minimum of 5 years. Data validation reports will be maintained in the central project files with the analytical data reports.

2.6.3 Data Reduction

Data reduction is the process by which original data (analytical measurements) are converted or reduced to a specified format or unit to facilitate analysis of the data. Data reduction requires that aspects of sample preparation that could affect the test result (such as sample volume analyzed or dilutions required) be taken into account in the final result. Data reduction is the laboratory analyst's responsibility, and final results are subjected to further review by the Laboratory Project Manager, the Project Manager, the Project QA Manager, and independent reviewers. Data reduction may be performed manually or electronically. If performed electronically, software used must be demonstrated to be true and free from error.

3 Data Generation and Acquisition

Data generation and acquisition begins with the development of the rationale for locating and selecting environmental samples for analysis and ends with the generation and reporting of analytical data for those samples by the analytical laboratories.

3.1 Sampling Design

The sampling design including the rationale for locating and selecting environmental samples for analyses is detailed in the FSP (Appendix A of the Work Plan).

3.2 Sampling Methods and Handling Requirements

Sample collection procedures are described in detail in the FSP (Appendix A of the Work Plan). Sampling procedures are generally consistent with EPA protocols or other approved sample collection standards established for the site.

3.3 Sample Preparation and Analytical Methods

Analytical methods for chemical and physical analyses are listed in Tables B-2 through B-5, corresponding to the sample and analytical programs described in Section 5 of the FSP (Appendix A of the Work Plan). Sample preparation standard operating procedures (SOPs) for the modified synthetic precipitation leaching procedure (SPLP) and modified Leaching Environmental Assessment Framework (LEAF) methods are included in Attachment 1.

In completing analyses for this project, the laboratories are expected to meet the following minimum requirements:

- Adhere to the methods outlined in this QAPP, including methods referenced for each analytical procedure.
- Follow documentation, custody, and sample tracking procedures.
- Notify the Project QA Manager of any QA/QC problems when they are identified.
- Provide a detailed discussion of any modifications made to approved analytical methods.
- Deliver Adobe PDF and electronic data as specified.
- Meet reporting requirements for deliverables.
- Meet turnaround times for deliverables.
- Implement QA/QC procedures, including the DQOs, laboratory QA requirements, and performance evaluation testing requirements.
- Allow laboratory and data audits to be performed, if deemed necessary.

Analytical methods and RLs for sediment, aqueous/elutriate, and PDMS samples are presented in Tables B-2 through B-5. Table B-6 presents the field and laboratory QA/QC sample frequency requirements (e.g., field duplicates, matrix spikes (MSs), and laboratory control samples).

3.4 Data Quality Objectives

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. Physical and geotechnical data will be evaluated by reviewing results in the context of the parameters they were prepared under to ensure they meet expectations. These parameters are presented on Table B-7 and discussed in greater detail in the following sections.

3.4.1 Precision

Precision is the ability of an analytical method or instrument to reproduce its own measurement. It is a measure of the variability or random error in sample collection and laboratory analyses.
ASTM International (ASTM) recognizes the following two levels of precision (ASTM 2002):

1. Repeatability: the random error associated with measurements made by a single test operator on identical aliquots of test material in a given laboratory, with the same apparatus, under constant operating conditions
2. Reproducibility: the random error associated with measurements made by different test operators in different laboratories, using the same method but different equipment to analyze identical samples of test material

In the laboratory, "within-batch" precision is measured using replicate sample or QC analyses and is expressed as the RPD between the measurements. The "batch-to-batch" precision is determined from the variance observed in the analysis of standard solutions or laboratory control samples from multiple analytical batches.

Field precision will be evaluated by the collection of field duplicates analyses at a frequency of 1 per 20 samples collected. Field chemistry duplicate precision will be screened against an RPD of 50% for all analyses and matrices. Data qualification based on field duplicate precision will be at the discretion of the data validator. The equation used to express precision is as follows:

Equation 1

$$\text{RPD} = \frac{(\text{C}_1 - \text{C}_2) \times 100\%}{(\text{C}_1 + \text{C}_2)/2}$$

where:

RPD = relative percent difference
C_1 = larger of the two observed values
C_2 = smaller of the two observed values

Precision measurements can be affected by the nearness of a chemical concentration to the RL, where the percent error (expressed as RPD) increases. In cases where either the parent or duplicate result is less than five times the RL, results will be evaluated by the difference with a control limit of ± RL for aqueous sample matrices and ± 2 times the RL for solid sample matrices.

3.4.2 *Accuracy*

Accuracy is a measure of the closeness of an individual measurement (or an average of multiple measurements) to the true or expected value. Accuracy is evaluated by calculating percent recovery results from analyses of laboratory control samples, standard reference materials, surrogate standards, and standard solutions. In addition, matrix-spiked samples, laboratory control samples (e.g., blank spikes and reference materials), and surrogate spikes are also analyzed, which provide accuracy or bias information in the actual sample matrix. Accuracy measurements will be carried out at a minimum frequency of 1 per 20 samples analyzed, with the exception of surrogates, which will be added to all samples. Accuracy is expressed as percent recovery of the measured value, relative to the true or expected value. If a measurement process produces results for which the result is not the true or expected value, the process is said to be biased. Bias is discussed further in Section 3.4.6.

Laboratory accuracy will be evaluated against quantitative spike recovery performance criteria provided by the laboratory and shown in Table B-7. Accuracy can be expressed as a percentage of the true or reference value or as a percent recovery in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

Equation 2

$$\%R = 100\% \times (S - U)/C_{sa}$$

where:

$\%R$ = percent recovery
S = measured concentration in the spiked aliquot
U = measured concentration in the unspiked aliquot
C_{sa} = actual concentration of spike added

MS recovery values become distorted when the sample concentration is greater than four times the spike concentration. No data will be qualified in these instances, regardless of percent recovery values.

Field accuracy will be controlled by adherence to sample collection procedures outlined in the Work Plan and the FSP (Appendix A of the Work Plan).

3.4.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. For the site, the list of analytes has been identified to provide a comprehensive assessment of the known and potential contaminants.

3.4.4 Comparability

Comparability expresses the confidence with which one dataset can be evaluated in relation to another dataset. For this program, comparability of data will be established through the use of standard analytical methodologies and reporting formats and common traceable calibration and spike materials.

3.4.5 Completeness

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

Equation 3

$$\mathrm{C} = \frac{\text{(Number of acceptable data points) x 100}}{\text{(Total number of data points)}}$$

where:

C = Completeness (%)

The DQO for completeness for components of this project is 95%. Data that have been qualified as estimated because QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been rejected will not be considered valid for the purpose of assessing completeness.

3.4.6 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Bias can be either inherent in a method of analysis (e.g., extraction efficiency) or caused by an artifact of the measurement system (e.g., contamination). Bias assessments for environmental measurements are made using personnel, equipment, and spiking materials or reference materials as independent as possible from those used in the calibration of the measurement system. Analytical laboratories utilize several quality control measures to eliminate analytical bias, including systematic analyses of method blanks, laboratory control samples, and independent calibration verification standards. When possible, bias assessments should be based on analysis of spiked samples or matrix-matched reference samples rather than spiked blanks so that the effect of the matrix on recovery is incorporated into the assessment. A documented spiking protocol and consistency in following that protocol are important to obtaining meaningful data quality estimates. Because bias can be positive or negative and because several types of bias can occur simultaneously, only the net or total bias can be evaluated in a measurement.

3.4.7 Sensitivity

Analytical sensitivities must be consistent with or lower than the target limits listed in Tables B-2 through B-4 to demonstrate compliance with this QAPP.

The method detection limit (MDL) is defined as the minimum concentration at which a given target analyte can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The limit of detection is the smallest amount or concentration of a substance that must be present in a sample in order to be detected at a 99% confidence level. Laboratory practical quantitation limits, limits of quantitation, or RLs are defined as the lowest level that produces a quantitative result within specified limits of precision and accuracy during routine laboratory operating conditions. Laboratory MDL and RL results (Tables B-2 through B-4) will be used to evaluate the method sensitivity and/or applicability prior to the acceptance of a method for this program.

The sample-specific MDLs and RLs will be reported by the laboratories and will take into account factors relating to the sample analysis that might decrease or increase the MDLs and RLs (e.g., dilution factor, percent moisture, and sample aliquot weight or volume). In the event that the MDL and RL are elevated for a sample due to matrix interferences and subsequent dilution or reduction in the sample aliquot, the data will be evaluated by Anchor QEA and the laboratory to determine if an alternative course of action is required or possible. The sample-specific MDL and RL will be the value recorded in the project database.

3.5 Quality Assurance and Quality Control

Field and laboratory activities must be conducted in such a manner that the results meet specified quality objectives and are fully defensible. Guidance for QA/QC is derived from the protocols developed for EPA's *Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods* (EPA 1986), the EPA Contract Laboratory Program (EPA 2020a, 2020b, 2020c), and the cited methods.

3.5.1 Field Quality Control

Anchor QEA personnel will identify and label samples in a consistent manner to ensure that field samples are traceable, and labels provide the information necessary for the laboratory to properly conduct the required analyses. Samples will be placed in appropriate containers and preserved for shipment to the laboratory.

3.5.1.1 Sample Containers

The analytical laboratories will provide certified pre-cleaned sample containers (Tables B-8 and B-9) with the exceptions of the geotechnical analyses. The laboratories will maintain documentation certifying the cleanliness of bottles and the purity of preservatives provided.

Geotechnical samples will be collected in clean sample containers for disturbed samples.

3.5.1.2 Sample Identification and Labels

Each sample will have an adhesive plastic or waterproof paper label affixed to the container and will be labeled at the time of collection. The following information will be recorded on the container label:

- Project name
- Sample identification
- Date and time of sample collection
- Preservative type (if applicable)
- Required analyses
- Sampler’s name or initials

Samples will be uniquely identified with a sample identification that, at a minimum, specifies sample matrix, sample number, sample location, and type of sample. Specific sample nomenclature is described in the FSP.

3.5.1.3 Sample Custody and Shipping Requirements

Samples are considered to be in one’s custody if they are in the following: 1) the custodian’s possession or view; 2) a secured location (under lock) with restricted access; or 3) a container that is secured with official seals such that the sample cannot be reached without breaking the seals.

COC procedures will be followed for the samples throughout the collection, handling, and analysis process. The principal document used to track possession and transfer of samples is the COC form. Each sample will be represented on a COC form the day it is collected. Data entries will be made using indelible ink pen. Corrections will be made by drawing a single line through the error, writing in the correct information, then dating and initialing the change. Blank lines or spaces on the COC form will be lined out, dated, and initialed by the individual maintaining custody.

A COC form will accompany each cooler of samples sent to the analytical laboratories. Each person who has custody of the samples will sign the COC form and establish that the samples were not left unattended unless properly secured. Copies of COC forms will be retained in the project files.

Filled sample containers for chemistry and physical analyses will be stored in coolers containing ice to maintain the samples at 2°C to 6°C until delivery to the analytical laboratories.

Samples will be shipped to the analytical laboratory no later than the day after collection. Samples collected on Friday may be held until the following Monday for shipment provided that this does not jeopardize any hold time requirements (Tables B-8 and B-9). Specific sample shipping procedures are as follows:

- Each cooler or container with the samples for analysis will be hand-delivered, couriered, or shipped the same day as collection or via overnight delivery to the appropriate analytical laboratory. In the event that Saturday delivery is required, the FC will contact the analytical laboratory before 3:00 p.m. on Friday to ensure that the laboratory will be staffed to receive samples on a Saturday and is aware of the number of containers shipped and the airbill tracking numbers for those containers. Following shipment, the FC will confirm the samples have been received and are in good condition.
- Coolant ice will be sealed in separate zip-top plastic bags and placed in the shipping containers. Plastic bags will be doubled for overnight shipping.
- Individual sample containers will be placed in a sealable plastic bag, packed to prevent breakage, and transported in a sealed ice chest or other suitable container.
- Glass bottles and jars will be separated in the shipping container by shock-absorbent material (e.g., bubble wrap) to prevent breakage.
- The shipping containers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container, and consultant’s office name and address) to enable positive identification.
- COC forms will be enclosed in a plastic bag and placed inside of the cooler.
- A minimum of two signed and dated COC seals will be placed on adjacent sides of each cooler prior to shipping.
- Each cooler will be wrapped securely with packing tape and will be clearly labeled with the laboratory’s shipping address and the consultant’s return address.

Upon transfer of sample possession to the analytical laboratory, the person transferring custody of the sample container will sign the COC form. Upon receipt of samples at the laboratory, the shipping container seals will be broken, and the receiver will sign the COC forms and record the condition of the samples and any discrepancies encountered on a sample receipt form.

3.5.1.4 Field Quality Assurance Sampling

Field QA procedures will consist of following procedures for acceptable practices for collecting and handling of samples. Adherence to these procedures will be complemented by periodic and routine equipment inspection.

Field QA samples will be collected along with the environmental samples. Field QA samples are useful in identifying possible problems resulting from sample collection or sample processing in the field. The collection of field QA samples includes equipment rinsate blanks and field duplicates as specified in Table B-7. Deionized water will be used for the rinsate blanks, and they will be collected at a frequency of one per collection method per sampling event. If decontamination procedures are not adequate, additional rinsate blanks will be collected after procedures have been modified. Adequacy of decontamination procedures will be evaluated by rinsate blank chemistry results. Results will be compared to associated samples, and the Project QA Manager's best professional judgment will be used to evaluate whether decontamination procedures should be modified. Field duplicate samples will be collected at a frequency of one per sampling event or 1 in 20 samples collected, whichever is more frequent.

Field QA samples will also include the collection of additional sample volume or mass to ensure that the laboratory has sufficient sample to run the program-required analytical QA/QC (MD/MS/MSD) samples for analysis as specified in Table B-6. Additional sample volume or mass to meet this requirement will be collected at a frequency of one per sampling event or 1 in 20 samples processed, whichever is more frequent. The sample collection team will confirm with the laboratory the appropriate extra volume or mass required for these analyses. The samples designated for MD/MS/MSD analyses should be clearly marked on the COC.

Field QA samples will be documented on the field forms and verified by the Project QA Manager or designee.

3.5.2 Laboratory Quality Control

Laboratory QC procedures, where applicable, include initial and continuing instrument calibrations, standard reference materials, laboratory control samples, matrix replicates, MSs, surrogate spikes (for organic analyses), and method blanks. Table B-6 lists the frequency of analysis for laboratory QA/QC samples, and Table B-7 summarizes the DQOs for precision, accuracy, and completeness.

An analyst will review the results of the QC samples from each analytical batch immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the batch and reanalysis or re-extraction does not correct the exceedance, the Project QA Manager will be contacted and alternative corrective action (e.g., method modifications followed by reprocessing the affected samples) will be explored prior to processing a subsequent group of samples.

Analytical results will be evaluated to the MDLs, and results detected between MDLs and RLs will be qualified as estimated (J-flagged) by the laboratories. Results below detection will be reported to the RLs and qualified as non-detects (U-flagged) by the laboratories.

3.5.2.1 Laboratory Instrument Calibration and Frequency

An initial calibration will be performed on each laboratory instrument to be used prior to analyses, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet method control criteria. A calibration verification sample will be analyzed following each initial calibration and will meet method criteria prior to analysis of samples. Continuing calibration verifications (CCVs) will be analyzed at required frequencies to track instrument performance. The frequency of CCVs varies with method. For gas chromatography/mass spectrometry methods, one will be analyzed every 12 hours. For gas chromatography, metals, and inorganic methods, 1 will be analyzed for every 10 field samples analyzed and at the end of each run. If the CCV is out of control, the analysis must come to a halt until the source of the control failure is eliminated or reduced enough to meet control specifications. Project samples analyzed while instrument calibration was out of control will be reanalyzed.

Instrument blanks or continuing calibration blanks provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately prior to or right after the CCV as applicable to the method.

3.5.2.2 Laboratory Duplicates

Laboratory duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Laboratory duplicates are subsamples of the original sample that are prepared and analyzed as a separate sample. For high-resolution mass spectrometry analyses, laboratory duplicates will be analyzed to assess laboratory precision. An MSD, ongoing precision and recovery sample (OPR) duplicate, or lab control sample duplicate may be analyzed in lieu of a laboratory duplicate.

3.5.2.3 Matrix Spikes and Matrix Spike Duplicates

Analyses of MS samples provide information on the extraction efficiency of the method on the sample matrix, as well as any interferences introduced by the sample matrix. By performing duplicate MS analyses, information on the precision of the method is also provided.

3.5.2.4 Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at every stage of sample preparation and analysis. The method blank results must be less than the RL of each target analyte. If a laboratory method blank exceeds this criterion for any analyte, and the analyte is detected in any of the samples and is less than five times the concentration found in the blank (10 times for common contaminants), analyses must stop, and the source of contamination must be eliminated or reduced.

3.5.2.5 Laboratory Control and Ongoing Precision and Recovery Samples

Laboratory control samples and OPRs are analyzed to assess possible laboratory bias at the stages of sample preparation and analysis. The laboratory control sample is a matrix-dependent spiked sample prepared at the time of sample extraction along with the preparation of the sample, method blank, and MS. The laboratory control sample and OPR will provide information on the accuracy of the analytical process and, when analyzed in duplicate, will provide precision information as well.

3.5.2.6 Laboratory Deliverables

Data packages will be checked for completeness immediately upon receipt from the laboratory to ensure that data and QA/QC information requested in Section 2.6.2 are present.

3.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Testing, inspection, and maintenance of field and laboratory equipment are important determinants of the quality of sampling and analysis results.

3.6.1 Field Instruments/Equipment

In accordance with the QA program, Anchor QEA shall maintain an inventory of field instruments and equipment. The frequency and types of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment.

The Anchor QEA FC will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. The equipment maintenance information will be documented in the instrument's calibration log. The frequency of maintenance is dependent on the type and stability of the equipment, the methods used, the intended use of the equipment, and the recommendations of the manufacturer. Detailed information regarding the maintenance procedures and frequency of equipment maintenance is provided in specific manufacturer's instruction manuals.

Maintenance records will be verified prior to each sampling event. The FC will be responsible for verifying that required maintenance has been performed prior to using the equipment in the field.

The worker or subcontractor responsible for navigation will confirm proper operation of the navigation equipment daily. This verification may consist of internal diagnostics or visiting a location with known coordinates to confirm the coordinates indicated by the navigation system. The winch line and grab sampler will be inspected daily for fraying, jaw misalignment, loose connections, and any other applicable mechanical problems. All equipment will be operated and maintained according to manufacturer specifications. Any problems will be noted in the field logbook and corrected prior to continuing sampling operations.

3.6.2 Laboratory Instruments/Equipment

In accordance with the QA program, the laboratory shall maintain an inventory of instruments and equipment, and the frequency of maintenance will be based on the manufacturer's recommendations and previous experience with the equipment.

The laboratory preventative maintenance program, as detailed in the laboratory QA Manual, is organized to maintain proper instrument and equipment performance and to prevent instrument and equipment failure during use. The program considers instrumentation, equipment, and parts that are subject to wear, deterioration, or other changes in operational characteristics; the availability of spare parts; and the frequency at which maintenance is required. Any equipment that has been overloaded or mishandled, gives suspect results, or has been determined to be defective will be taken out of service, tagged with the discrepancy noted, and stored in a designated area until the equipment has been repaired. After repair, the equipment will be tested to ensure that it is in proper operational condition. The client will be promptly notified in writing if defective equipment casts doubt on the validity of analytical data. The client will also be notified immediately regarding any delays due to instrument malfunctions that could impact holding times.

Laboratories will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. Maintenance records will be checked according to the schedule on an annual basis and recorded by the responsible individual. The Laboratory Manager, or designee, shall be responsible for verifying compliance with the preventative maintenance program.

3.7 Instrument Calibration

Proper calibration of equipment and instrumentation is an integral part of the process that provides quality data. Instrumentation and equipment used to generate data must be calibrated at a frequency that ensures sufficient and consistent accuracy and reproducibility.

3.7.1 Field Instrument/Equipment Calibration

Field equipment will be calibrated prior to each sampling event according to manufacturer’s recommendations and using manufacturer’s calibration standards. The equipment, calibration, and maintenance information will be documented in the instrument calibration log. The frequency of calibration is dependent on the type and stability of the equipment, the methods used, the intended use of the equipment, and the recommendations of the manufacturer. Detailed information regarding the calibration and frequency of equipment calibration is provided in specific manufacturer’s instruction manuals.

Equipment that fails calibration or becomes inoperable during use will be removed from service and tagged (time and date of action) to prevent inadvertent use. Such equipment will be satisfactorily recalibrated or repaired and tagged (date and time of return to service) prior to use.

A post-survey calibration check may be performed at the end of each day’s activities to confirm that the instrument functioned properly throughout the day. The instrument will also be checked during the day if erratic or suspect readings are observed.

3.7.2 Laboratory Instrument/Equipment Calibration

As part of their QC program, laboratories perform two types of calibrations. A periodic calibration is performed at prescribed intervals (i.e., balances, drying ovens, refrigerators, and thermometers), and operational calibrations are performed daily, at a specified frequency, or prior to analysis (i.e., initial calibrations) according to method requirements. Calibration procedures and frequency are discussed in the laboratory QA Manual. Calibrations are discussed in the laboratory SOPs for analyses.

The Laboratory Manager will be responsible for ensuring that the laboratory instrumentation is calibrated in accordance with specifications. Implementation of the calibration program shall be the responsibility of the respective laboratory department supervisors. Recognized procedures (EPA, ASTM, or manufacturer's instructions) shall be used when available.

Physical standards (i.e., weights or certified thermometers) shall be traceable to nationally recognized standards such as the National Institute of Standards and Technology (NIST). Chemical reference standards shall be NIST standard reference materials or vendor-certified materials traceable to these standards.

The calibration requirements for each method and respective corrective actions are written in the laboratory SOPs and/or the laboratory's QA Manual for each instrument or analytical method in use. Calibrations shall be preserved on electronic media.

3.8 Inspection/Acceptance Requirements for Supplies and Consumables

Inspection and acceptance of field supplies, including laboratory-prepared sampling bottles, will be the responsibility of the FC. Primary chemical standards and standard solutions will be used in this project in the field and laboratory and will be traceable to documented, reliable, commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

3.9 Data Management

Field data sheets will be checked for completeness and accuracy by the FC prior to delivery to the Project QA Manager. Data generated in the field will be documented electronically or on hard copy and loaded directly into the database or provided to the Project QA Manager, who will coordinate data entry into the database. Manually entered data will be checked by a second party. Field documentation will be filed in the main project file after data entry and checking are complete.

Laboratory data will be loaded directly into the database or provided to the Project QA Manager in the EQuIS electronic format. Laboratory data that is electronically provided and loaded into the database will undergo a check against the laboratory hard copy data. Data will be validated or reviewed manually, and qualifiers (if assigned) will be entered manually. The accuracy of manually entered data will be verified. Data tables and reports will be exported from EQuIS to Microsoft Excel tables. The *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Data Management Plan* (Attachment 2) outlines how the data will be handled from planning, field, and post-field work. The process for archiving and retrieving the data and the responsible individuals are also included in the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Data Management Plan*.

4 Assessment and Oversight

Once data are received from the laboratory, a number of QC procedures will be followed to provide an accurate evaluation of the data quality. Specific procedures will be followed to assess data precision, accuracy, and completeness.

4.1 Field and Laboratory Audits/Inspections

Laboratory and field performance audits or inspections consist of on-site reviews of QA systems and equipment for sampling, calibration, and measurement. Laboratory audits will not be conducted as part of this study. However, laboratory audit reports will be made available to the Project QA Manager upon request. Apex, ARI, Enthalpy, and ALS are NELAC-certified laboratories that undergo regular audits as part of their certification procedures. Audits are conducted no more than 2 years apart. The laboratory is required to have written procedures addressing internal QA/QC. These procedures have been submitted, and the Project QA Manager will review them to ensure compliance with this QAPP. The laboratory must ensure that personnel engaged in preparation and analysis tasks have appropriate training. As part of the audit process, the laboratory will provide written details of any method modifications planned for the consultant’s review.

Planned and documented performance inspections will be conducted for field operations to assess the accuracy of the measurement systems and to determine the effectiveness of QA/QC procedures and compliance with the QAPP. Field performance inspections should be conducted by the FC.

A field inspection is not planned but may be scheduled at the discretion of the Project QA Manager to observe and review field procedures and documentation from sample collection through packaging and shipment to the laboratories. If the Project QA Manager determines it necessary, additional inspections may be scheduled over the course of the field program. The Project Manager will be responsible for identifying an appropriate schedule of inspections prior to commencement of investigation activities.

Field inspections may be performed by the FC in accordance with written procedures or checklists. The field inspection will involve the review and evaluation of (as appropriate) implementation of approved work procedures, sampling procedures, sampling documentation; labeling, packaging, storage, and shipping of samples; completion of field records; QC compliance; subcontractor performance; and field change documentation. Field records will also be reviewed to verify that field-related activities are performed and documented in accordance with the QAPP. Items to be reviewed include, but are not limited to, field activity logs, collection forms, custody transfer forms and/or chain-of-custody forms, field measurement logs, and waste inventory logs. The FC may impose stop work order at any time if activities being conducted are determined to compromise the integrity of the program.

Preliminary results of the inspections will be reviewed with the Project Manager to ensure that deficiencies adversely affecting data quality are immediately corrected. Inspection findings will be reviewed to determine the cause of any noncompliance issues identified, schedule corrective action to prevent recurrence, evaluate the impact of the findings on completed work, and notify the FC and the Project QA Manager in an email communication of action taken or planned. The findings of the field inspection, as well as any corrective actions, will be reported to EPA as part of the Monthly Progress Reports and the Sediment Sampling and Analysis Report. The FC and the Project QA Coordinator will be responsible for verifying and documenting completion of the corrective action.

4.2 Response and Corrective Actions

The following sections identify the responsibilities of key project team members and actions to be taken in the event of an error, problem, or non-conformance to protocols identified in this document.

4.2.1 Field Activities

The FC will be responsible for correcting equipment malfunctions during the field sampling effort. The Project QA Manager will be responsible for resolving situations identified by the FC that may result in non-compliance with this QAPP. Corrective measures will be immediately documented in the field logbook.

4.2.2 Laboratory

The laboratory is required to comply with its SOPs. The Laboratory Project Manager will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP. Laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

The Laboratory Project Manager will be notified if any QC sample result grossly exceeds the project-specified control limits and standard corrective actions do not resolve the anomaly. If the anomaly cannot be corrected, the Laboratory Project Manager will document the corrective action taken and relay this to the Project QA Manager in a timely manner, and possible additional corrective actions will be discussed. If the anomaly cannot be corrected by additional measures, the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be described in the case narrative and submitted with the data package.

4.3 Reports to Management

QA reports to management include verbal status reports, written reports on field sampling activities and laboratory processes, data validation reports, data summary reports, and field and laboratory inspection and/or audit reports. These reports shall be prepared in coordination with the project team.

5 Data Validation and Usability

Laboratory data will be provided in both PDF and electronic format, as applicable. Once data are received from the laboratory, QC procedures will be followed to provide an accurate evaluation of the data quality. The data will be validated in accordance with the EPA National Functional Guidelines for Data Review (EPA 2020a, 2020b) project-specific DQOs (Table B-7), analytical method criteria, and the laboratory's internal performance standards based on their SOPs.

5.1 Data Review, Validation, and Verification

During the validation process, analytical data will be evaluated for method and laboratory QC compliance, and their validity and applicability for program purposes will be determined. Based on the findings of the validation process, data validation qualifiers may be assigned. The validated project data, including qualifiers, will be entered into the project database, thus enabling this information to be retained or retrieved as needed.

5.2 Validation and Verification Methods

Data verification includes signed entries by the field and laboratory technicians on field data sheets and laboratory datasheets, respectively; review for completeness and accuracy by the FC and Laboratory Project Manager; review by the Project QA Manager for outliers and omissions; and the use of QC criteria to accept or reject specific data. Data will be entered into the EQuIS database, and a data file will be generated. A verification of the database file will be performed. One hundred percent of manually entered qualifiers will be verified. Any errors found will be corrected in the database.

Laboratory data will be reviewed and verified to determine whether DQOs have been met and that appropriate corrective actions have been taken, when necessary. The Project QA Manager or designee will be responsible for the final review of the data generated from analyses of samples.

The first level of review will take place in the laboratory as the data are generated. The laboratory department manager or designee will be responsible for ensuring that the data generated meet minimum QA/QC requirements and that the instruments were operating under acceptable conditions during data acquisition. DQOs will also be assessed at this point by comparing the results of QC measurements with pre-established criteria as a measure of data acceptability.

With the exceptions of the geotechnical and NAPL mobility data, Stage 2B validations will be conducted on all data by Anchor QEA (or a subcontractor), in accordance with EPA National Functional Guidelines for Data Review (EPA 2020a, 2020b) and this QAPP, Stage 1 validations will be conducted on geotechnical and NAPL mobility data. Chemical and physical data will be reviewed with regard to the following, as appropriate to the particular analysis:

- Data completeness
- Holding times
- Instrument performance checks
- Initial calibrations
- Continuing calibrations
- Column confirmation results
- Equipment blanks
- Method blanks
- Surrogate recoveries
- Detection limits
- RLs
- Laboratory control samples
- Field and laboratory duplicates
- MS/MSD samples
- Standard reference material results
- Interference check samples
- Serial dilutions

The results of the data validation, including text assigning qualifiers in accordance with the EPA National Functional Guidelines for Data Review (EPA 2020a, 2020b) and a tabular summary of qualifiers, will be generated by the validator and submitted to the Project QA Manager for final review and confirmation of the validity of the data.

5.3 Reconciliation with User Requirements

The Project QA Manager will review data after each survey to determine if DQOs have been met. If data do not meet the project's specifications, the Project QA Manager will review the outliers and determine if the problem is due to calibration/maintenance, sampling techniques, or other factors and will then suggest corrective action. If problems cannot be corrected by retraining, revision of techniques, or replacement of supplies or equipment, the DQOs will be reviewed for feasibility. If specific DQOs are not achievable, the Project QA Manager will consult with EPA and recommend appropriate modifications to either the laboratory or to the program requirements.

6 References

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EPA, 2009a. *Administrative Settlement Agreement and Order on Consent*. Gasco Sediments Site, Portland Harbor Superfund Site, Portland, Multnomah County, Oregon. CERCLA Docket No. 10-2009-0255. September 2009.

EPA, 2009b. *Statement of Work – Gasco Sediments Site*. U.S. Environmental Protection Agency Region 10. September 9, 2009.

EPA, 2009c. *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*. Office of Solid Waste and Emergency Response. EPA 540-R-08-005. January 2009.

EPA, 2020a. *National Functional Guidelines for Organic Superfund Methods Data Review*. Office of Superfund Remediation and Technology Innovation. United States Environmental Protection Agency. EPA-540-R-20-005. November 2020.

EPA, 2020b. *National Functional Guidelines for Inorganic Superfund Methods Data Review*. Office of Superfund Remediation and Technology Innovation. United States Environmental Protection Agency. EPA-540-R-20-006. November 2020.

Tables

Table B-1
Project Contact List

QAPP Recipients	Title	Organization	Telephone Number	Email Address
—	Emergency Response Team	EPA Region 10	(206) 553-4973	—
Ryan Barth	Project Manager	Anchor QEA, LLC	(206) 903-3334	rbarth@anchorqea.com
Nik Bacher	Field Coordinator	Anchor QEA, LLC	(206) 903-3376	nbacher@anchorqea.com
Laurel Menoche	Database Manager	Anchor QEA, LLC	(360) 715-2705	lmenoche@anchorqea.com
Delaney Peterson	QA/QC Manager	Anchor QEA, LLC	(360) 715-2707	dpeterson@anchorqea.com
Darwin Thomas	Laboratory Project Manager	Apex Laboratories, LLC	(503) 718-2323	dthomas@apex-labs.com
Mark Harris	Laboratory Project Manager	ALS Environmental (Kelso, Washington)	(360) 501-3376	mark.harris@alsglobal.com
Shelly Fishel	Laboratory Project Manager	Analytical Resources, LLC.	(206) 695-6210	shelly.fishel@arilabs.com
James Fox	Laboratory Project Manager	Enthalpy Analytical (El Dorado Hills, California)	(916) 673-1520	james.fox@enthalpy.com
Dimitri Vlassopoulos	Laboratory Project Manager	Environmental Geochemistry Laboratory (EGL)	(503)-972-5015	dvlassopoulos@anchorqea.com
Allison Ferrara	Construction Testing Operations Manager	Thielsch Engineering	(401)-467-6454	aferrara@thielsch.com
Nate Melaro	Director of Operations	ds+A1	(412) 823-7600	nmelaro@geotechnics.net
Joe Tomei	Lab Director	Geotesting Express	(978) 635-0424	jtomei@geotesting.com
Brett Elliott	Laboratory Project Manager	Core Laboratories	(713) 328-2503	Brett.Elliott@corelab.com
Chidi Umeh	Operations Director	CorEnvirons, LLC	(832)659-0968	chidi.umeh@corenvirons.com
Rick Hugo	Sole Proprietor	RC Imaging and Analyses	(503)-477-0953	rc_imanalysis@yahoo.com
Stella Cuenco	Data Validator	Laboratory Data Consultants, Inc.	(760) 827-1140	scuenco@lab-data.com

Notes:

—: not applicable

EPA: U.S. Environmental Protection Agency

QAPP: *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan*

Table B-2
Solids Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[4]	MRL[4]
Geotechnical			
Grain size	ASTM D6913 and D7928	—	—
Specific Gravity	ASTM D854	—	—
Moisture Content	ASTM D2216	—	—
Atterberg limits	ASTM D4318	—	—
Bulk density	ASTM D7263	—	—
Permeability	ASTM D5084	—	—
Unconfined Compressive Strength	ASTM D2166	—	—
Conventionals			
Total Solids (%)	SM 2540 G	0.10	0.10
Total Organic Carbon (%)	EPA 9060A mod	0.10	0.20
Chloride (mg/kg)	USEPA 300.0	10.0	10.0
Cyanide (mg/kg)	ASTM D7511	0.05	0.10
Perchlorate (mg/kg)	USEPA 6850	0.00003	0.001
Sulfate (mg/kg)	USEPA 300.0	10.0	10.0
Metals (mg/kg)			
Aluminum	EPA 6020B	25.0	50.0
Arsenic	EPA 6020B	0.50	1.00
Cadmium	EPA 6020B	0.10	0.20
Chromium	EPA 6020B	0.50	1.00
Copper	EPA 6020B	1.00	2.00
Iron	EPA 6020B	25.0	50.0
Lead	EPA 6020B	0.10	0.20
Manganese	EPA 6020B	0.50	1.00
Vanadium	EPA 6020B	1.00	2.00
Zinc	EPA 6020B	2.00	4.00
Volatile Organic Compounds (µg/kg)			
1,1-Dichloroethene (1,1-DCE)	EPA 8260D	12.5	25.0
Benzene	EPA 8260D	5.0	10.0
Chlorobenzene	EPA 8260D	12.5	25.0
cis-1,2-Dichloroethene (cis-DCE)	EPA 8260D	12.5	25.0
Ethylbenzene	EPA 8260D	12.5	25.0
Tetrachloroethene (PCE)	EPA 8260D	12.5	25.0
Toluene	EPA 8260D	25.0	50.0
Trichloroethene (TCE)	EPA 8260D	12.5	25.0

Table B-2

Solids Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[4]	MRL[4]
Vinyl Chloride	EPA 8260D	12.5	25.0
m,p-Xylene	EPA 8260D	25.0	50.0
o-Xylene	EPA 8260D	12.5	25.0
Total Xylenes[5]	—	37.5	75.0
PAHs (µg/kg)			
2-Methylnaphthalene	EPA 8270E	2.67	5.33
Acenaphthene	EPA 8270E	1.33	2.67
Acenaphthylene	EPA 8270E	1.33	2.67
Anthracene	EPA 8270E	1.33	2.67
Benzo(a)anthracene	EPA 8270E	1.33	2.67
Benzo(a)pyrene	EPA 8270E	2.00	4.00
Benzo(b)fluoranthene	EPA 8270E	2.00	4.00
Benzo(g,h,i)perylene	EPA 8270E	1.33	2.67
Benzo(k)fluoranthene	EPA 8270E	2.00	4.00
Chrysene	EPA 8270E	1.33	2.67
Dibenzo(a,h)anthracene	EPA 8270E	1.33	2.67
Fluoranthene	EPA 8270E	1.33	2.67
Fluorene	EPA 8270E	1.33	2.67
Indeno(1,2,3-cd)pyrene	EPA 8270E	1.33	2.67
Naphthalene	EPA 8270E	2.67	5.33
Phenanthrene	EPA 8270E	1.33	2.67
Pyrene	EPA 8270E	1.33	2.67
cPAHs (BaP eq)[5,6,7]	—	—	—
Total PAHs[5,6,8]	—	—	—
Semivolatile Organic Compounds (µg/kg)			
2,4,5-Trichlorophenol	EPA 8270E	6.67	13.3
Bis(2-ethylhexyl)phthalate	EPA 8270E	20.0	40.0
Pentachlorophenol	EPA 8270E	13.3	26.7
PCB Aroclors (µg/kg)			
Aroclor 1016	EPA 8082A	5.00	10.0
Aroclor 1221	EPA 8082A	0.67	1.3
Aroclor 1232	EPA 8082A	0.67	1.3
Aroclor 1242	EPA 8082A	0.67	1.3
Aroclor 1248	EPA 8082A	0.67	1.3

Table B-2

Solids Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[4]	MRL[4]
Aroclor 1254	EPA 8082A	0.67	1.3
Aroclor 1260	EPA 8082A	0.67	1.3
Aroclor 1262	EPA 8082A	0.67	1.3
Aroclor 1268	EPA 8082A	0.67	1.3
Total PCB Aroclors[5,6]	—	—	—
Dioxin/Furans (ng/kg)			
2,3,7,8-TCDD[6]	EPA 1613B	0.27	0.5
1,2,3,7,8-PeCDD[6]	EPA 1613B	0.61	2.5
1,2,3,4,7,8-HxCDD	EPA 1613B	0.71	2.5
1,2,3,6,7,8-HxCDD	EPA 1613B	0.67	2.5
1,2,3,7,8,9-HxCDD	EPA 1613B	0.69	2.5
1,2,3,4,6,7,8-HpCDD	EPA 1613B	0.66	2.5
OCDD	EPA 1613B	1.85	5.0
2,3,7,8-TCDF	EPA 1613B	0.26	0.5
1,2,3,7,8-PeCDF	EPA 1613B	0.72	2.5
2,3,4,7,8-PeCDF	EPA 1613B	0.74	2.5
1,2,3,4,7,8-HxCDF	EPA 1613B	0.92	2.5
1,2,3,6,7,8-HxCDF	EPA 1613B	0.77	2.5
1,2,3,7,8,9-HxCDF	EPA 1613B	0.74	2.5
2,3,4,6,7,8-HxCDF	EPA 1613B	0.77	2.5
1,2,3,4,6,7,8-HpCDF	EPA 1613B	0.89	2.5
1,2,3,4,7,8,9-HpCDF	EPA 1613B	0.77	2.5
OCDF	EPA 1613B	0.15	5.0
2,3,7,8-TCDD eq (2005 WHO TEQ)[3]	—	—	—
Low Resolution Pesticides (µg/kg)			
2,4'-DDD	EPA 8081B	0.50	1.0
2,4'-DDE	EPA 8081B	0.50	1.0
2,4'-DDT	EPA 8081B	0.50	1.0
4,4'-DDD	EPA 8081B	0.50	1.0
4,4'-DDE	EPA 8081B	0.50	1.0
4,4'-DDT	EPA 8081B	0.50	1.0
DDx[4]	—	—	—
Herbicides (µg/kg)			
2,4-D (2,4-Dichlorophenoxyacetic acid)	EPA 8151A	7.70	50.0
2,4,5-TP (Silvex)	EPA 8151A	2.40	50.0

Table B-2
Solids Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method	MDL[4]	MRL[4]
Extractable Petroleum Hydrocarbons (mg/kg)			
C10-C12 Aliphatics	WAEPH	0.128	0.200

Notes:

1. The Riverbank Soil/Sediment Cleanup Levels are presented in ROD Table 17.
2. The Sediment RALs and PTW Threshold Values are presented in Table 21 of the ROD.
3. These values were presented in EPA's *Explanation of Significant Differences* (ESD; EPA 2018), which is not yet finalized. The cPAH value is the ESD PTW-highly toxic threshold, and the total PAHs value is the ESD Site-Wide RAL.
4. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
5. Total xylenes, cPAH (BaP eq), total PAHs, total PCBs, and DDx are calculated values; therefore, there are no MDLs or MRLs for these parameters.
6. The naphthalene threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 contaminants of concern containing groundwater cleanup levels cannot be reliably contained.
7. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
8. Total PAH is the sum of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

—: not applicable
µg/kg: micrograms per kilogram
ASTM: ASTM International
BaP Eq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: U.S. Environmental Protection Agency
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
ng/kg: nanograms per kilogram
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PTW: principal threat waste
RAL: remedial action level
ROD: *Record of Decision – Portland Harbor Superfund Site* (EPA 2017)
SM: Standard Method
WAEPH: Washington State Department of Ecology Extractable Petroleum Hydrocarbons

Table B-3
SPLP and LEAF Aqueous Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method[1]	MDL[2]	MRL[2]
Conventionals			
Conductivity	probe	—	—
ORP	probe	—	—
pH (SU)	SM 4500H+B	0.1	0.1
Cyanide (mg/L)	ASTM D7511-12	0.0025	0.0050
DOC (mg/L)	SM 5310C	1.00	1.00
TOC (mg/L)	SM 5310C	1.00	1.00
Perchlorate (mg/L)	USEPA 6850	0.025	0.10
Metals (mg/L)			
Aluminum	EPA 6020B	5.00	10.0
Arsenic	EPA 6020B	0.05	0.10
Cadmium	EPA 6020B	0.02	0.04
Chromium	EPA 6020B	1.0	2.0
Copper	EPA 6020B	1.0	2.0
Iron	EPA 6020B	5.00	10.0
Lead	EPA 6020B	0.10	0.20
Manganese	EPA 6020B	0.50	1.0
Mercury	EPA 6020B	0.04	0.08
Vanadium	EPA 6020B	1.0	2.0
Zinc	EPA 6020B	2.0	4.0
VOCs (µg/L)			
1,1-Dichloroethene	EPA 8260D	0.200	0.400
Benzene	EPA 8260D	0.100	0.200
Chlorobenzene	EPA 8260D	0.250	0.500
cis-1,2-Dichloroethene	EPA 8260D	0.200	0.400
Ethylbenzene	EPA 8260D	0.250	0.500
m,p-Xylene	EPA 8260D	0.500	1.00
o-Xylene	EPA 8260D	0.250	0.500
Tetrachloroethene	EPA 8260D	0.200	0.400
Toluene	EPA 8260D	0.500	1.00
Trichloroethene	EPA 8260D	0.200	0.400
Vinyl chloride	EPA 8260D/SIM	0.010	0.020
Total Xylenes	—	0.750	1.50
Polycyclic Aromatic Hydrocarbons (µg/L)[2]			
2-Methylnaphthalene	EPA 1625	0.00356	0.005
Acenaphthene	EPA 1625	0.000576	0.005
Acenaphthylene	EPA 1625	0.000834	0.005
Anthracene	EPA 1625	0.00104	0.005
Benzo(a)anthracene	EPA 1625	0.000316	0.005
Benzo(a)pyrene	EPA 1625	0.00055	0.005
Benzo(b)fluoranthene	EPA 1625	0.00255	0.005
Benzo(g,h,i)perylene	EPA 1625	0.000708	0.005

Table B-3
SPLP and LEAF Aqueous Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Analytical Method[1]	MDL[2]	MRL[2]
Benzo(k)fluoranthene	EPA 1625	0.00142	0.005
Chrysene	EPA 1625	0.00217	0.005
Dibenz(a,h)anthracene	EPA 1625	0.000903	0.005
Fluoranthene	EPA 1625	0.00137	0.005
Fluorene	EPA 1625	0.000802	0.005
Indeno(1,2,3-c,d)pyrene	EPA 1625	0.000856	0.005
Naphthalene	EPA 1625	0.00735	0.0125
Phenanthrene	EPA 1625	0.00399	0.0125
Pyrene	EPA 1625	0.000705	0.005
cPAHs (BaP eq)[3]	—	—	—
Semivolatile Organic Compounds (µg/L)			
2,4,5-Trichlorophenol	EPA 8270E	0.050	0.100
Bis(2-ethylhexyl)phthalate	EPA 8270E	0.200	0.400
Pentachlorophenol	EPA 8270E	0.100	0.200

Notes:

1. Samples will be prepared following modified EPA Methods 1312 for SPLP and 1315 for LEAF.
2. Actual MDLs and QLs may vary based on sample aliquot size, moisture content, and required dilution factor.
3. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
4. Total PAH is the sum of 2-methylnaphthalene, acenapthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

—: not applicable
µg/kg: micrograms per kilogram
ASTM: ASTM International
BaPEq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
DDD: dichlorodiphenyldichloroethane
DDE: dichlorodiphenyldichloroethene
DDT: dichlorodiphenyltrichloroethane
DOC: dissolved organic carbon
EPA: U.S. Environmental Protection Agency
LEAF: leaching environmental assessment framework
MDL: method detection limit
mg/kg: milligrams per kilogram
mg/L: milligrams per liter
MRL: method reporting limit
ng/kg: nanograms per kilogram
ORP: oxidation-reduction potential
PCB: polychlorinated biphenyl
SM: Standard Method
SPLP: synthetic preparation leaching procedure
TOC: total organic carbon

Table B-4
LEAF PDMS Liner Analytes, Methods, and Targeted Reporting Limits

Parameter	Recommended Preparation and Analytical Method[1]	MDL[2]	MRL[2]
Volatile Organic Compounds (µg/kg)			
1,1-Dichloroethene (1,1-DCE)	EPA 8260D	12.5	25.0
Benzene	EPA 8260D	5.0	10.0
Chlorobenzene	EPA 8260D	12.5	25.0
cis-1,2-Dichloroethene (cis-DCE)	EPA 8260D	12.5	25.0
Ethylbenzene	EPA 8260D	12.5	25.0
Tetrachloroethene (PCE)	EPA 8260D	12.5	25.0
Toluene	EPA 8260D	25.0	50.0
Trichloroethene (TCE)	EPA 8260D	12.5	25.0
Vinyl Chloride	EPA 8260D	12.5	25.0
m,p-Xylene	EPA 8260D	25.0	50.0
o-Xylene	EPA 8260D	12.5	25.0
Total Xylenes[3]	—	37.5	75.0
Polycyclic Aromatic Hydrocarbons (µg/kg)			
2-Methylnaphthalene	EPA 8270E	2.67	5.33
Acenaphthene	EPA 8270E	1.33	2.67
Acenaphthylene	EPA 8270E	1.33	2.67
Anthracene	EPA 8270E	1.33	2.67
Benzo(a)anthracene	EPA 8270E	1.33	2.67
Benzo(a)pyrene	EPA 8270E	2.00	4.00
Benzo(b)fluoranthene	EPA 8270E	2.00	4.00
Benzo(g,h,i)perylene	EPA 8270E	1.33	2.67
Benzo(j)+(k)Fluoranthene	EPA 8270E	2.00	4.00
Chrysene	EPA 8270E	1.33	2.67
Dibenz(a,h)anthracene	EPA 8270E	1.33	2.67
Fluoranthene	EPA 8270E	1.33	2.67
Fluorene	EPA 8270E	1.33	2.67
Indeno(1,2,3-c,d)pyrene	EPA 8270E	1.33	2.67
Naphthalene[3]	EPA 8270E	1.33	2.67
Phenanthrene	EPA 8270E	1.33	2.67
Pyrene	EPA 8270E	1.33	2.67
cPAHs (BaP eq)[3,4,5]	—	—	—
Total PAHs[3,4,6]	—	—	—

Table B-4
LEAF PDMS Liner Analytes, Methods, and Targeted Reporting Limits

Notes:
1. Samples will be prepared following modified EPA Method 1315 for LEAF.
2. Actual MDLs and RLs may vary based on sample aliquot size, moisture content, and required dilution factor.
3. Total xylenes, cPAH (BaP Eq), total PAHs, total PCBs, and DDx are calculated values; therefore, there are no MDLs or MRLs for these parameters.
4. The naphthalene threshold value was developed for the ROD based on feasibility-level harborwide assumptions that are not applicable at the site. NW Natural is performing a site-specific capping demonstration evaluation to determine if any of the ROD Table 17 contaminants of concern containing groundwater cleanup levels cannot be reliably contained.
5. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
6. Total PAH is the sum of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

—: not applicable
µg/kg: micrograms per kilogram
ASTM: ASTM International
BaP Eq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: U.S. Environmental Protection Agency
LEAF: leaching environmental assessment framework
MDL: method detection limit
mg/kg: milligrams per kilogram
MRL: method reporting limit
ng/kg: nanograms per kilogram
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PDMS: polydimethylsiloxane
PTW: principal threat waste
RAL: remedial action level
ROD: *Record of Decision – Portland Harbor Superfund Site* (EPA 2017)
SM: Standard Method

Table B-5
Advanced Physical Testing and DNAPL Analytes and Methods

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
Advanced Physical Testing			
Scanning Electron Microscopy	—	—	—
Mercury Intrusion Porosimetry	ASTM D4404	—	—
Dean Stark Tests			
Pore fluid saturations (NAPL and water)	API RP40	—	—
Grain density	API RP40	—	—
Porosity	API RP40	—	—
DNAPL Tests		—	—
DNAPL extraction via centrifuge	Core Labs SOP	—	—
DNAPL density	ASTM D1481	—	—
DNAPL viscosity	ASTM D445	—	—
Wettability (droplet method)	Cohen and Mercer 1993	—	—
Interfacial tension	ASTM D971	—	—
Volatile Organic Compounds (μg/kg)			
Benzene	EPA 8260D	5.0	10.0
Ethylbenzene	EPA 8260D	12.5	25.0
Toluene	EPA 8260D	25.0	50.0
m,p-Xylene	EPA 8260D	25.0	50.0
o-Xylene	EPA 8260D	12.5	25.0
Total Xylenes[2]	—	37.5	75.0
PAHs and Alkylated PAHs (μg/kg)			
trans-Decalin	EPA 8270E-SIM	0.03	5.0
cis-Decalin	EPA 8270E-SIM	0.50	5.0
Naphthalene	EPA 8270E-SIM	0.40	5.0
1-Methylnaphthalene	EPA 8270E-SIM	0.40	5.0
2-Methylnaphthalene	EPA 8270E-SIM	0.40	5.0
Biphenyl	EPA 8270E-SIM	0.30	5.0
2,6-Dimethylnaphthalene	EPA 8270E-SIM	0.40	5.0
Acenaphthylene	EPA 8270E-SIM	0.30	5.0
Acenaphthene	EPA 8270E-SIM	0.50	5.0
Dibenzofuran	EPA 8270E-SIM	0.40	5.0
2,3,5-Trimethylnaphthalene	EPA 8270E-SIM	0.40	5.0
Fluorene	EPA 8270E-SIM	0.50	5.0
Benzo(b)thiophene	EPA 8270E-SIM	0.40	5.0
Phenanthrene	EPA 8270E-SIM	0.90	5.0
Anthracene	EPA 8270E-SIM	0.05	5.0
Carbazole	EPA 8270E-SIM	0.70	5.0

Table B-5

Advanced Physical Testing and DNAPL Analytes and Methods

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
1-Methylphenanthrene	EPA 8270E-SIM	0.50	5.0
Fluoranthene	EPA 8270E-SIM	1.40	5.0
Dibenzothiophene	EPA 8270E-SIM	0.70	5.0
Pyrene	EPA 8270E-SIM	1.00	5.0
Benzo(a)anthracene	EPA 8270E-SIM	1.40	5.0
Chrysene	EPA 8270E-SIM	0.70	5.0
Benzo(b)fluoranthene	EPA 8270E-SIM	0.80	5.0
Benzo(j)fluoranthene	EPA 8270E-SIM	0.70	5.0
Benzo(k)fluoranthene	EPA 8270E-SIM	0.80	5.0
Benzofluoranthenes, Total	EPA 8270E-SIM	3.00	10.0
Benzo(e)pyrene	EPA 8270E-SIM	0.60	5.0
Benzo(a)pyrene	EPA 8270E-SIM	1.00	5.0
Indeno(1,2,3-cd)pyrene	EPA 8270E-SIM	0.40	5.0
Dibenzo(a,h)anthracene	EPA 8270E-SIM	0.70	5.0
Benzo(g,h,i)perylene	EPA 8270E-SIM	0.50	5.0
Perylene	EPA 8270E-SIM	0.40	5.0
Benzo(b)naphtho(2,1-d)thiophene	EPA 8270E-SIM	5.00	5.0
C1-Decalins	EPA 8270E-SIM	0.50	5.0
C2-Decalins	EPA 8270E-SIM	0.50	5.0
C3-Decalins	EPA 8270E-SIM	0.50	5.0
C4-Decalins	EPA 8270E-SIM	0.50	5.0
C1-Naphthalenes	EPA 8270E-SIM	0.40	5.0
C2-Naphthalenes	EPA 8270E-SIM	0.40	5.0
C3-Naphthalenes	EPA 8270E-SIM	0.40	5.0
C4-Naphthalenes	EPA 8270E-SIM	0.40	5.0
C1-Fluorenes	EPA 8270E-SIM	0.50	5.0
C2-Fluorenes	EPA 8270E-SIM	0.50	5.0
C3-Fluorenes	EPA 8270E-SIM	0.50	5.0
C1-Dibenzothiophenes	EPA 8270E-SIM	0.70	5.0
C2-Dibenzothiophenes	EPA 8270E-SIM	0.70	5.0
C3-Dibenzothiophenes	EPA 8270E-SIM	0.70	5.0
C4-Dibenzothiophenes	EPA 8270E-SIM	0.70	5.0
C1-Phenanthrenes/Anthracenes	EPA 8270E-SIM	0.90	5.0
C2-Phenanthrenes/Anthracenes	EPA 8270E-SIM	0.90	5.0
C3-Phenanthrenes/Anthracenes	EPA 8270E-SIM	0.90	5.0
C4-Phenanthrenes/Anthracenes	EPA 8270E-SIM	0.90	5.0
C1-Fluoranthenes/Pyrenes	EPA 8270E-SIM	1.00	5.0

Table B-5
Advanced Physical Testing and DNAPL Analytes and Methods

Parameter	Recommended Analytical Method	MDL[1]	MRL[1]
C2-Fluoranthenes/Pyrenes	EPA 8270E-SIM	1.00	5.0
C3-Fluoranthenes/Pyrenes	EPA 8270E-SIM	1.00	5.0
C4-Fluoranthenes/Pyrenes	EPA 8270E-SIM	1.00	5.0
cPAHs (BaP eq)[2,3]	—	—	—
Total PAHs[2,4]	—	—	—
Total Petroleum Hydrocarbons (mg/kg)			
Diesel range organics	NWTPHDx	2.34	5.00
Oil range organics	NWTPHDx	2.99	10.0

Notes:

1. MDLs and MRLs will vary based on sample aliquot size and dilutions required.
2. Total xylenes, cPAH (BaP Eq) and total PAHs are calculated values; therefore, there are no MDLs or MRLs for these parameters.
3. Total cPAH is the sum of benzo(a)pyrene equivalent concentrations, calculated by multiplying the cPAHs by their respective potency factors. cPAHs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, and dibenzo(a,h)anthracene.
4. Total PAH is the sum of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

API: American Petroleum Institute
ASTM: ASTM International
BaPEq: benzo(a)pyrene equivalent
cPAH: carcinogenic polycyclic aromatic hydrocarbon
DNAPL: dense nonaqueous phase liquid
MDL: method detection limit
MRL: method reporting limit
NAPL: nonaqueous phase liquid
NWTPHDx: Northwest Total Petroleum Hydrocarbons - Diesel Range Extended method
PAH: polycyclic aromatic hydrocarbon
SIM: select ion monitoring

Table B-6
Field and Laboratory Quality Control Sample Analysis Frequency

Analysis Type	Rinsate Blanks	Field Duplicates	Initial Calibration	Ongoing Calibration	LCS/SRM[2]	Duplicates	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
Geotechnical and Dean Stark Analyses	—	—	—	—	—	—	—	—	—	—
pH/ORP	—	—	Daily	—	—	—	—	—	—	—
Total Solids	—	1 per 20 samples	Daily	—	—	1 per 20 samples	—	—	—	—
Total Organic Carbon/ Dissolved Organic Carbon	—	1 per 20 samples	As needed[1]	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	—	1 per 20 samples	—
Chloride/Sulfate	—	1 per 20 samples	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	—	1 per 20 samples	—
Cyanide/Perchlorate	1 per collection event	1 per 20 samples	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	—	1 per 20 samples	—
Metals	1 per collection event	1 per 20 samples	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	—	1 per 20 samples	—
VOCs[3]	1 per collection event	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
SVOCs/PAHs	1 per collection event	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
PCB Aroclors	1 per collection event	1 per 20 samples	As needed[1]	1 per 10 samples	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
EPH/TPH	—	1 per 20 samples	As needed[1]	1 per 10 samples	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Pesticides	1 per collection event	1 per 20 samples	As needed[1]	1 per 10 samples	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Herbicides	1 per collection event	1 per 20 samples	As needed[1]	1 per 10 samples	1 per 20 samples	—	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Dioxin/Furans	1 per collection event	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	1 per 20 samples	—[4]	—[4]	1 per 20 samples	Every sample
High Resolution PAHs	1 per collection event	1 per 20 samples	As needed[1]	Every 12 hours	1 per 20 samples	1 per 20 samples	—[4]	—[4]	1 per 20 samples	Every sample

Notes:

1. Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.
2. When a standard reference material is available, it may be used in lieu of an LCS.
3. Trip blanks will be collected at a rate of one per cooler containing VOC sample aliquots.
4. Isotope dilution is required by method.

—: not applicable
EPH: extractable petroleum hydrocarbon
LCS: laboratory control sample
NAPL: nonaqueous phase liquid
ORP: oxidation-reduction potential
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
SRM: standard reference material
SVOC: semivolatile organic compound
TPH: total petroleum hydrocarbon
VOC: volatile organic compound

Table B-7
Data Quality Objectives

Parameter	Precision (Duplicate RPD)	Accuracy (Spike Recoveries)	Completeness
Soils, Sediments, LEAF PDMS Liners, and DNAPL			
Geotechnical and Dean Stark Analyses	—	—	95%
Total Solids	± 20% RPD	—	95%
TOC	± 25% RPD	70 to 130% R	95%
Cyanide	± 25% RPD	70 to 130% R	95%
Perchlorate	± 25% RPD	70 to 130% R	95%
Anions	± 25% RPD	70 to 130% R	95%
VOCs	± 35% RPD	50 to 150% R	95%
Metals	± 25% RPD	70 to 130% R	95%
PAHs	± 35% RPD	50 to 150% R	95%
SVOCs	± 35% RPD	50 to 150% R	95%
PCB Aroclors	± 35% RPD	50 to 150% R	95%
EPH/TPH	± 35% RPD	50 to 150% R	95%
Dioxin/Furans	± 35% RPD	50 to 150% R	95%
Pesticides	± 35% RPD	50 to 150% R	95%
Herbicides	± 35% RPD	50 to 150% R	95%
Waters and Elutriates			
pH/ORP	± 20% RPD	—	95%
Cyanide	± 25% RPD	75 to 125% R	95%
TOC/DOC	± 25% RPD	75 to 125% R	95%
Metals	± 25% RPD	75 to 125% R	95%
VOCs	± 30% RPD	60 to 140% R	95%
PAHs	± 30% RPD	60 to 140% R	95%
SVOCs	± 30% RPD	60 to 140% R	95%

Table B-7
Data Quality Objectives

Notes:
--: not applicable
DNAPL: dense nonaqueous phase liquid
EPH: extractable petroleum hydrocarbon
DOC: dissolved organic carbon
ORP: oxidation-reduction potential
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
R: recovery
RPD: relative percent difference
SVOC: semivolatile organic compound
TOC: total organic carbon
TPH: total petroleum hydrocarbon
VOC: volatile organic compound

Table B-8
Guidelines for Solid Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique	Lab[5]
Hydrogeologic Testing					
Specific gravity	100 g	1 gallon in zip-top bags	None	None	Thielsch Engineering, Geotesting Express or GeoTechnics
Grain size	300 g		None	None	
Bulk density	—		None	None	
Baseline Testing of Untreated Sediment, Soil Samples, Blast Furnace Slag Cement, and Portland Cement					
Specific gravity	100 g	1 gallon in zip-top bags	None	None	Thielsch Engineering, Geotesting Express or GeoTechnics
Atterberg limits	100 g		None	None	
Grain size	300 g		None	None	
Bulk density	—	1 gallon in zip-top bags	None	None	
Permeability	—		None	None	
Total Solids	50 g	8 oz glass	None	Cool < 6°C	Apex
Total Organic Carbon (sediment and soil only)	50 g		28 days	Cool < 6°C	
			6 months	Freeze -18°C	
Cyanide	50 g		14 days	Cool 2 to 6°C	
Anions (chloride and sulfate)	50 g		28 days	Cool 2 to 6°C	
Metals	5 g		180 days	Cool < 6°C	
SVOCs/PCB Aroclors/Pesticides	200 g	16 oz glass	14 days until extraction	Cool <6°C	
			1 year until extraction	Freeze -18°C	
			40 days after extraction	Cool <6°C	
VOCs	5 g	40 mL VOA vial with PTFE-lined septum caps (2x)	14 days	Cool 2 to 6°C/ MeOH	
PAHs	30 g	4 oz glass	14 days until extraction	Cool <6°C	
			1 year until extraction	Freeze -18°C	
			40 days after extraction	Cool <6°C	
EPH	30 g	4 oz glass	14 days until extraction	Cool <6°C	ARL
			1 year until extraction	Freeze -18°C	
			40 days after extraction	Cool <6°C	
Perchlorate	50 g	4 oz amber glass	28 days to extraction, 28 days after extraction	Cool <6°C	ALS
Herbicides	100 g	4 oz glass	14 days until extraction	Cool <6°C	
			1 year until extraction	Freeze -18°C	
			40 days after extraction	Cool <6°C	
Dioxin/furans	30 g	4 oz glass	1 year to extraction	Freeze -18°C	Enthalpy
			1 year after extraction		
Phase I and II Grout Testing					
Permeability	—	Glass jars (untreated)/cylinder molds (treated)	None	None	Thielsch Engineering, Geotesting Express or GeoTechnics
Unconfined Compressive Strength	—	Glass jars (untreated)/cylinder molds (treated)	None	None	

Table B-8
Guidelines for Solid Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique	Lab[5]
Phase IV and V PDMS Testing					
PAHs	100 g	16 oz glass	14 days until extraction	Cool <6°C	Apex or Alpha
			1 year until extraction	Freeze -18°C	
			40 days after extraction	Cool <6°C	
VOCs	5 g	40 mL VOA vial with PTFE-lined septum caps (2x)	14 days	Cool 2 to 6°C/ MeOH	
Phase IV Advanced Physical Testing (MIP, SEM, Dean Stark, and DNAPL Testing)					
VOCs[2]	5 g	40 mL VOA vial with PTFE-lined septum caps (2x)	14 days[3]	Cool 2 to 6°C/ MeOH	Apex
PAHs, TPH[2]	60 g	4 oz glass	14 days until extraction[3]	Cool <6°C	ARL
			1 year until extraction[3]	Freeze -18°C	
			40 days after extraction[3]	Cool <6°C	
Scanning Electron Microscopy	—	Glass jars (untreated)/cylinder molds (treated)	None	Cool < 6°C	RC imaging and Analyses
Pore fluid saturations (NAPL and water)	—	Glass jars (untreated)/cylinder molds (treated)	None	Cool < 6°C	CorEnvirons or Core Labs
Grain density	—	Glass jars (untreated)/cylinder molds (treated)	None	Cool < 6°C	
Porosity	—	Glass jars (untreated)/cylinder molds (treated)	None	Cool < 6°C	
Mercury Intrusion Porosimetry	—	Glass jars (untreated)/cylinder molds (treated)	None	Cool < 6°C	
DNAPL extraction via centrifuge	—	Glass jars (treated)[4]	None	Cool < 6°C	
DNAPL density	—				
DNAPL viscosity	—				
Wettability (droplet method)	—				
Interfacial tension	—				

Notes:

1. Container size, type, and sample size required may change based on program and laboratory guidance and container availability.
2. DNAPL requires less sample mass and sample size will depend upon material available for analyses.
3. Holding times do not apply to product (DNAPL) samples.
4. Jar size will be determined in the field based on the amount of DNAPL-sediment available for centrifuging.
5. The selected laboratories that will be used for analytical testing are subject to change pending laboratory availability. All laboratories used during the treatability study will adhere to the data quality requirements outlined in the QAPP.

—: not applicable
Aq: aqueous
DNAPL: dense nonaqueous phase liquid
EPH: extractable petroleum hydrocarbons
g: gram
L: liter
LEAF: leaching environmental assessment framework
MeOH: methanol
NAPL: nonaqueous phase liquid
oz: ounce
PAH: polycyclic aromatic hydrocarbon
PDMS: polydimethylsiloxane
PCB: polychlorinated biphenyl
SPLP: synthetic preparation leaching procedure
SVOCs: semivolatile organic compounds
TPH: total petroleum hydrocarbon
VOCs: volatile organic compounds

Table B-9
Guidelines for Aqueous Sample Handling and Storage

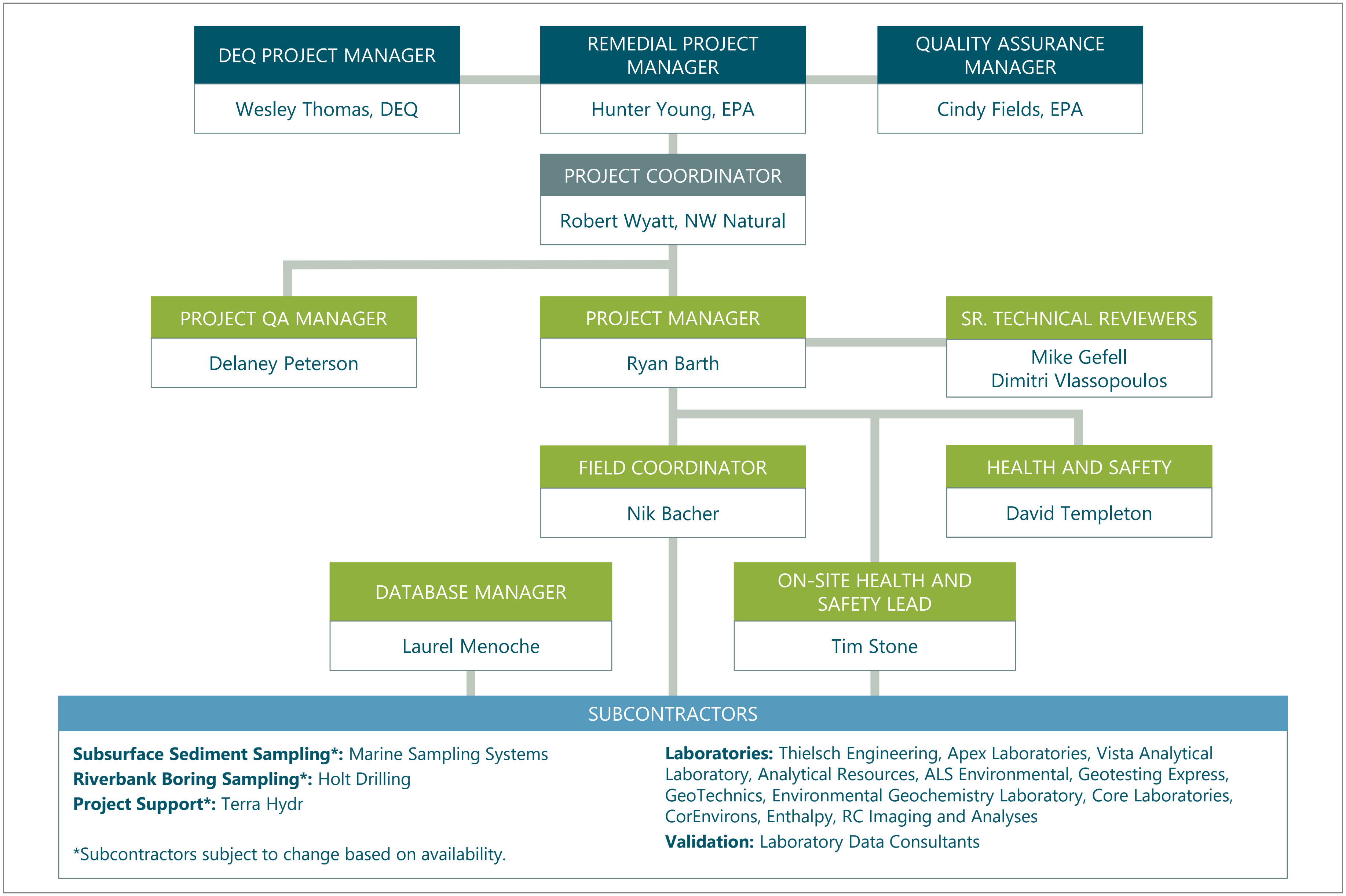
Parameter	Sample Size	Container Size and Type[1]	Holding Time	Sample Preservation Technique	Lab[2]
Phase III SPLP Leachability Testing					
pH/ORP/conductivity	—	N/A	Immediately	Analyze leachate upon generation	EGL
SPLP (Aq) Cyanide	10 mL	125 mL Brown HDPE	14 days	NaOH to pH>12; 2ºC - 6ºC	EGL/Apex
SPLP (Aq) TOC	40 mL	125 mL HDPE	28 days	H_2SO_4 to pH<2; Cool <6°C	
SPLP (Aq) DOC	40 mL	125 mL HDPE	28 days	Field filter; H_2SO_4 to pH<2; Cool <6°C	
SPLP (Aq) Metals	50 mL	125 mL HDPE	180 days	HNO_3 to pH<2	
SPLP (Aq) SVOCs	1L	2 x 1L Amber glass	7 days to extraction	Cool <2 - 6°C	
			40 days to analysis		
SPLP (Aq) VOCs	40 mL	3 x 40 mL VOA vial	14 days	HCl to pH<2; Cool <6°C	
SPLP (Aq) PAHs	1L	2 x 1L Amber glass	7 days to extraction	Cool <2 - 6°C	EGL/ Enthalpy
			40 days to analysis		
Phase IV and V LEAF Leachability Testing; Phase IV Equilibrium Aqueous Concentration Assessment					
pH/ORP/conductivity	—	N/A	Immediately	Analyze leachate upon generation	EGL
LEAF (Aq) Cyanide	10 mL	125 mL Brown HDPE	14 days	NaOH to pH>12; 2ºC - 6ºC	EGL/Apex
LEAF (Aq) TOC	40 mL	125 mL HDPE	28 days	H_2SO_4 to pH<2; Cool <6°C	
LEAF (Aq) DOC	40 mL	125 mL HDPE	28 days	Field filter; H_2SO_4 to pH<2; Cool <6°C	
LEAF (Aq) Metals	50 mL	125 mL HDPE	180 days	HNO_3 to pH<2	
LEAF (Aq) VOCs	40 mL	3 x 40 mL VOA vial	14 days	HCl to pH<2; Cool <6°C	
LEAF (Aq) PAHs	1L	2 x 1L Amber glass	7 days to extraction	Cool <2 - 6°C	EGL/ Enthalpy
			40 days to analysis		

Table B-9
Guidelines for Aqueous Sample Handling and Storage

Notes:
1. Container size, type, and sample size required may change based on laboratory guidance and container availability.
2. The selected laboratories that will be used for analytical testing are subject to change pending laboratory availability. All laboratories used during the treatability study will adhere to the data quality requirements outlined in the QAPP.

Aq: aqueous
DOC: dissolved organic carbon
EGL: Environmental Geochemistry Laboratory
EPH: extractable petroleum hydrocarbon
HDPE: high-density polyethylene
L: liter
mL: milliliter
ORP: oxidation-reduction potential
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PTFE: polytetrafluoroethylene (Teflon)
QAPP: *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan*
SPLP: synthetic precipitation leaching procedure
SVOC: semivolatile organic compound
TOC: total organic carbon
VOA: volatile organic analysis
VOC: volatile organic compound

Figure



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Laurel Menoche

ON-SITE HEALTH AND SAFETY LEAD

Tim Stone

SUBCONTRACTORS

Subsurface Sediment Sampling*: Marine Sampling Systems
Riverbank Boring Sampling*: Holt Drilling
Project Support*: Terra Hydr

*Subcontractors subject to change based on availability.

Laboratories: Thielsch Engineering, Apex Laboratories, Vista Analytical Laboratory, Analytical Resources, ALS Environmental, Geotesting Express, GeoTechnics, Environmental Geochemistry Laboratory, Core Laboratories, CorEnvirons, Enthalpy, RC Imaging and Analyses

Validation: Laboratory Data Consultants

ANCHOR QEA

Figure B-1
Project Organizational Chart
Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan
Gasco Sediments Cleanup Action

Attachment 1

Standard Operating Procedures

Modified EPA Method 1312 (EPA 1312M)

Scope and Application

This Environmental Geochemistry Laboratory (EGL) standard operating procedure (SOP) is based on U.S. Environmental Protection Agency (EPA) Method 1312 (EPA 1994), *Synthetic Precipitation Leaching Procedure*, which is designed to determine the mobility of both organic and inorganic analytes present in liquids, soils, and wastes. Here, the EPA Method 1312 is modified to allow to compare leaching behaviors between untreated and untreated sediments or soils. Procedures outlined in this SOP will be followed, and any deviations will be noted.

Health and Safety

All laboratory work will be performed in accordance with the EGL *Chemical Hygiene Plan* (CHP) by approved staff. In addition, approved staff will follow the health and safety requirements, procedures, and relevant Safety Data Sheets outlined in the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan* (HASP). This may also include applicable monitoring to ensure that personnel are not exposed above occupational exposure limits and that the action levels outlined in the HASP are followed. Approval to work in the EGL requires orientation to laboratory safety procedures and potential hazards under the guidance of the Laboratory Manager, as specified in the CHP. All staff performing this work must be current on 40-hour HAZWOPER, to include applicable refreshers (within the last 12 months), in addition to being current with medical monitoring (within the last 12 months). Staff performing this work will also have completed heavy metals monitoring and arsenic training.

Potential hazards for the test include exposure to flammable organic solvents (i.e., methanol, acetonitrile, and hexane), nitric acid, volatile organic compounds (VOCs); polycyclic aromatic hydrocarbons (PAHs); semi-volatile organic compounds (SVOCs); polychlorinated biphenyls (PCBs); pesticides; herbicides; arsenic; heavy metals; cyanide; perchlorate; nonaqueous phase liquids (NAPL); and other contaminants in tested samples. Possible routes of exposure to the contaminants potentially encountered on this test include inhalation, dermal contact, and ingestion of dust, mist, gas, vapor, or liquid. Exposure will be minimized by using safe work practices to include performing work in a fully functioning laboratory fume hood and by wearing the appropriate PPE. Required PPE for these chemicals includes nitrile gloves (double gloves to increase protection and minimize cross contamination potential), safety glasses, lab coat, and close-toed shoes. During preparation and processing of extracts and/or eluents/eluates, samples may generate potentially harmful gases when dried in an oven. Workspace ventilation should be appropriately established using a fully functioning laboratory fume hood when the test samples are dried and not left unattended while drying. Throughout the drying laboratory staff will periodically verify that appropriate ventilation is maintained.

Equipment and Supplies

The following is a list of equipment that may be necessary to carry out the procedures contained in this SOP; additional equipment may be required:

- Appropriate protective equipment (nitrile gloves, safety glasses, lab coat, and close-toed shoes)
- Analytical balance of appropriate precision (1/1,000 gram [g])
- Leaching vessel (1-gallon pre-cleaned EPA wide-mouth glass jar with polytetrafluoroethylene [PTFE] liner)
- Stainless-steel stand
- Stainless-steel wire
- Reagent water
- Stainless-steel spatula
- Filtration apparatus
- Glass filter membrane (borosilicate, 0.45-micrometer [µm] pore size)
- Disposable plastic syringe
- Polyethersulfone (PES) membrane syringe filters (0.45 µm pore size)
- Nitric acid (OmniTrace grade)
- High-performance liquid chromatography (HPLC)-grade methanol
- HPLC-grade acetonitrile
- HPLC-grade hexane
- Kimwipe
- Graduated glass cylinders
- Aluminum foil
- pH meter
- pH standard buffer solutions for calibration
- Oxidation-reduction potential (ORP) meter
- ORP standard solution
- Specific conductivity (SC) meter
- SC standard solutions
- Pre-preserved sample bottles for target COCs

Preparation of Untreated Sediment or Soil

1. Gently homogenize the untreated sediment or soil using a stainless-steel spatula prior to testing.
2. Determine the moisture content of the untreated sediment or soil following Anchor QEA EGL's SOP for moisture content measurement. The moisture content of the sample is used to calculate a dry-material mass. A drying oven should be properly ventilated in a fume hood to avoid

laboratory contamination and inhalation hazards of volatile organic compounds when drying heavily contaminated samples.

3. Weigh out a pre-determined mass of the untreated sediment or soil to a leaching vessel and record the exact mass of the sample added.
4. Ensure the sample surface is flat at the bottom of the leaching vessel by gently tapping the leaching vessel to release any air pockets present.

Preparation of Treated Sediment or Soil (Monolithic Sample)

1. Weigh out and record the mass of a cylindrical sample container. The cylindrical sample container should be made of glass, fluoropolymer, or any other material that are chemically inert and less reactive with samples and the COCs.
2. Fill and cure the treated sample in the cylindrical sample container to the pre-determined height.
3. Weigh out and record the mass of the treated sample added. If the sample container surface area is not already provided by the sample container manufacturer, measure the top surface area of the sample.
4. Attach a stainless-steel wire harness to the sample container.
5. Carefully place the cylindrical sample container (filled with either untreated sample or treated sample) in the leaching vessel and completely submerge the container. Unlike the standard EPA Method 1312, a treated sample will not be crushed and will be used as is in this method.

Leaching Procedure

1. Label a clean leaching vessel.
2. Fill the leaching vessel with the required volume of reagent water. Record the exact volume of reagent water added. The appropriate volume of reagent water should be determined in advance to completely fill the leaching vessel without headspace after placing the sample. Reagent water should be gently added into leaching vessels to minimize suspension of untreated sediment or soil.
3. The leaching vessel should have an airtight lid to prevent gas exchange with the atmosphere. Headspace should be minimized to limit loss of volatile organic compounds. Grout-treated samples are alkaline materials that can be susceptible to carbonation by absorption of atmospheric carbon dioxide. Close the lid tightly and avoid headspace to minimize carbonation effects on the leaching solution.
4. Cover the leaching vessel with aluminum foil to prevent the photodegradation of target COCs and store the leaching vessel in the dark until the end of the leaching period of 24 hours. This leaching test will be statically performed not to suspend untreated samples.

5. At the end of leaching period, prepare sample bottles and collect appropriate volumes of the leachate samples for the following analyses (in this order to minimize volatilization of the COCs):
    a. VOCs
    b. PAHs
    c. SVOCs
    d. Dissolved organic carbon (DOC)
    e. Total organic carbon (TOC)
    f. Cyanide
    g. Dissolved metals
    h. ORP
    i. pH
    j. Conductivity
6. Filter the leaching solution through a 0.45 µm pore size glass membrane using a filter apparatus for VOCs, PAHs, SVOCs, and DOC analysis.
7. Filter the leaching solution through a 0.45 µm pore size nylon or PES syringe filter using a disposable syringe for dissolved metals.
8. Immediately preserve and store the samples of the leaching solution for chemical analysis. Preserve all analytical samples in a manner that is consistent with the determinative chemical analyses to be performed. Make sure that the sample containers for analyses of VOCs, PAHs, and SVOCs do not have headspace.
9. Measure ORP, pH, and conductivity within 15 minutes of leaching vessel sampling to minimize changes due to oxygen and carbon dioxide absorption. When alkaline materials such as cement-treated samples are tested, carbon dioxide adsorption in the leaching solution can be enhanced.
10. Pack and ship the samples under chain of custody to an approved analytical laboratory for analysis.

Quality Assurance/Quality Control

All sample containers and glassware must be prewashed with a metal-free detergent and rinsed with 0.01 molar nitric acid, reagent water, and HPLC-grade methanol, acetonitrile, and hexane to remove background contaminants. A procedural blank of the leaching test is prepared, sampled, and analyzed with each batch of test samples.

Project Closeout

Sample materials and contaminated disposable PPE will be disposed of in a manner consistent with the management of Investigation-Derived Waste presented in Section 4.4 of the *In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan*. Contaminated equipment and non-disposable PPE will be decontaminated using appropriate practices as contained in the HASP.

Reference

EPA (Environmental Protection Agency), 1994. *Method 1312: Synthetic Precipitation Leaching Procedure*. Part of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

Standard Operating Procedure Approval Page

This standard operating procedure, **Modified EPA Method 1312**, has been reviewed by the laboratory managers and is approved for use in the Environmental Geochemistry Laboratory.

Signature: Date: May 19, 2023
Grace Weatherford, Laboratory Project Manager

Signature: Date: May 19, 2023
Masakazu Kanematsu, Laboratory Operations Manager

Modified EPA Method 1315 (EPA 1315M)

Scope and Application

This Environmental Geochemistry Laboratory (EGL) standard operating procedure (SOP) is based on U.S. Environmental Protection Agency (EPA) Method 1315 (EPA 2013), a semi-dynamic tank leaching procedure used to determine the rate of mass transport from either monolithic materials (e.g., concrete, bricks, tiles) or compacted granular materials (e.g., soils, sediments, fly ash) as a function of time using deionized water as the leaching solution. A potential issue with mass transport-based leaching tests such the EPA Method 1315 identified by the Interstate Technology and Regulatory Council (ITRC 2011) is the possibility of creating suppressed release rates for organic contaminants in the leachate as concentrations increase over time and reach effective solubility. Therefore, the original EPA Method 1315 is not suitable to characterize the leaching of organic contaminants. Here, EPA Method 1315 is modified to be applicable to determine diffusive flux (mass transfer rate per unit surface area) of organic contaminants of concern (COCs) as well as inorganic contaminants leached from granular samples and monolithic samples. The modified EPA 1315 (i.e., EPA Method 1315M) has one major modification from the original EPA Method 1315: a polydimethylsiloxane (PDMS) liner insert is deployed in the inner perimeter of the leaching vessel to maintain a concentration gradient that leads to a constant diffusive flux of an organic COC from the sample tested. The PDMS liner insert acts as an infinite sink to prevent aqueous concentrations of organic COCs from reaching their effective solubility during any leaching interval. Procedures outlined in this SOP will be followed, and any deviations will be noted.

Health and Safety

All laboratory work will be performed in accordance with the EGL *Chemical Hygiene Plan* (CHP) by approved staff. In addition, approved staff will follow the health and safety requirements, procedures, and relevant Safety Data Sheets outlined in the *In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan* (HASP). This may also include applicable monitoring to ensure that personnel are not exposed above occupational exposure limits and that the action levels outlined in the HASP are followed. Approval to work in the EGL requires orientation to laboratory safety procedures and potential hazards under the guidance of the Laboratory Manager, as specified in the CHP. All staff performing this work must be current on 40-hour HAZWOPER, to include applicable refreshers (within the last 12 months), in addition to being current with medical monitoring (within the last 12 months). Staff performing this work will also have completed heavy metals monitoring and arsenic training.

Potential hazards associated with the test include exposure to flammable organic solvents (i.e., methanol, acetonitrile, and hexane), nitric acid, volatile organic compounds (VOCs); polycyclic aromatic hydrocarbons (PAHs); semi-volatile organic compounds (SVOCs); polychlorinated biphenyls

(PC); pesticides; herbicides; arsenic; heavy metals; cyanide; perchlorate; nonaqueous phase liquids (NAPL); and other contaminants in tested samples. Possible routes of exposure to the chemicals and contaminants potentially encountered on this test include inhalation, dermal contact, and ingestion of dust, mist, gas, vapor, or liquid. Exposure will be minimized by using safe work practices to include performing work in a fully functioning laboratory fume hood and by wearing the appropriate PPE. Required PPE for these chemicals includes nitrile gloves (double gloves to increase protection and minimize cross contamination potential), safety glasses, lab coat, and close-toed shoes. During preparation and processing of extracts and/or eluents/eluates, samples may generate potentially harmful gases when dried in an oven. Workspace ventilation should be appropriately established using a fully functioning laboratory fume hood when the test samples are dried and not left unattended while drying. Throughout the drying laboratory staff will periodically verify that appropriate ventilation is maintained.

Equipment and Supplies

The following is a list of equipment that may be necessary to carry out the procedures contained in this SOP; additional equipment may be required:

- Appropriate protective equipment (nitrile gloves, safety glasses, lab coat, and close-toed shoes)
- Analytical balance of appropriate precision (1/1,000 gram [g])
- Leaching vessel (2-liter pre-cleaned EPA wide-mouth glass jar with polytetrafluoroethylene [PTFE] cap liner)
- Stainless-steel stand
- Stainless-steel wire
- Cylindrical sample container (made of a material chemically inert and less reactive with samples and the COCs)
- Reagent water
- Stainless-steel spatula
- Filtration apparatus
- Glass filter membrane (borosilicate, 0.45-micrometer [µm] pore size)
- Disposable syringe
- Polyethersulfone (PES) membrane syringe filters (0.45 µm pore size)
- Fiberglass cloth
- PDMS elastomer
- 1-liter pre-cleaned EPA wide-mouth glass jar for PDMS liner insert cleaning
- Nitric acid (OmniTrace grade)
- High-performance liquid chromatography (HPLC)-grade methanol
- HPLC-grade acetonitrile
- HPLC-grade hexane

- Stainless-steel tweezer
- Kimwipes
- Graduated cylinders
- Aluminum foil
- pH meter
- pH standard buffer solutions for calibration
- Oxidation-reduction potential (ORP) meter
- ORP standard solution
- Specific conductivity (SC) meter
- SC standard solutions
- Pre-preserved sample bottles for target COCs

Preparation of Untreated Sediment or Soil

1. Gently homogenize the untreated sediment or soil using a stainless-steel spatula prior to testing.
2. Determine the moisture content of the untreated sediment or soil following Anchor QEA EGL's SOP for moisture content measurement. The moisture content of the sample is used to calculate a dry-material mass. A drying oven should be properly ventilated in a fume hood to avoid laboratory contamination and inhalation hazards of volatile organic compounds when drying heavily contaminated samples.
3. Weigh out and record the mass of a cylindrical sample container. The cylindrical sample container should be made of glass, fluoropolymer, or any other material that are chemically inert and less reactive with samples and the COCs. The sample container needs to fit inside the leaching vessel.
4. Fill the cylindrical sample container with the untreated sediment or soil to a pre-determined height and record the mass of the sample added. The sample depth in the cylindrical sample container must be higher than at least 5 centimeters (cm). A minimum height of 5 cm in the direction of mass transfer is required. If the sample container surface area is not already provided by the sample container manufacturer, measure the top surface area of the sample.
5. Ensure the sample surface is flat by gently tapping the container on the bench to release any air pockets present.
6. Attach a stainless-steel wire harness to the sample container.

Preparation of Treated Sediment or Soil (Monolithic Sample)

1. Weigh out and record the mass of a cylindrical sample container. The cylindrical sample container should be made of glass, fluoropolymer, or any other material that are chemically inert and less reactive with samples and the COCs.

2. Fill and cure the treated sample in the cylindrical sample container to the pre-determined height.
3. Weigh out and record the mass of the treated sample added. If the sample container surface area is not already provided by the sample container manufacturer, measure the top surface area of the sample.
4. Attach a stainless-steel wire harness to the sample.

Preparation of PDMS Liner Insert

1. The method to prepare the PDMS liner insert is described in detail in US Patent No. 9,885,647.
2. Wash scissors and a glass cutting board with HPLC-grade hexane and methanol.
3. Bake twice a fiberglass cloth (approximately 35 × 45 cm) in a kiln for 4 hours at 400°C to burn off any residual organic contaminants from the surface of the cloth.
4. Stretch the fiberglass cloth over a 30.5 × 38.1 cm glass cutting board.
5. Mix the PDMS elastomer with the curing agent in a clean glass jar.
6. Deposit 60 milliliters (mL) of the mixture of the PDMS elastomer and the curing agent immediately and spread evenly across the surface of the fiberglass cloth.
7. Dry the PDMS-coated fiberglass cloth at 40°C for 10 minutes to cure.
8. Peel off the PDMS-coated fiberglass cloth from the glass cutting board surface.
9. Trim edges of the cloth to prepare the PDMS liner insert.
10. Cut the PDMS liner insert in half to yield two liner inserts, each approximately 12.5 × 36 cm in size.
11. Record the exact dimensions and mass of each PDMS liner before placing them into the leaching vessels.
12. Wrap the PDMS liner inserts individually in clean aluminum foil and store in a large Mylar bag to prevent contamination from other laboratory activities.
13. Transfer one clean PDMS liner insert into a 100 mL glass vial. Add 50 mL of methanol and 50 mL of acetonitrile without headspace and gently agitate for 16 hours to extract organic COCs. This sample is shipped to an analytical lab for sample analysis and used as a method blank to check background contamination.

Leaching Procedure

1. Prepare four replicates of the leaching test setup for different analytes listed below.
2. Label clean leaching vessels.
3. Fill the leaching vessel with approximately 1.8 liter of reagent water. Record the exact volume of reagent water added. The appropriate volume of reagent water should be determined in advance to completely fill the leaching vessel without headspace after placing the sample.

4. Carefully place the cylindrical sample container (filled with either untreated sample or treated sample) in the leaching vessel and completely submerge the container. Minimize the suspension of untreated sediment or soil in leaching solution.
5. The leaching vessel should have an airtight lid to prevent gas exchange with the atmosphere. Headspace should be minimized to limit loss of volatile organic compounds. Ground-treated samples are alkaline materials that can be susceptible to carbonation by absorption of atmospheric carbon dioxide. Close the lid tightly and avoid headspace to minimize carbonation effects on the leaching solution.
6. Cover the leaching vessel with aluminum foil to prevent photodegradation of target COCs and store the leaching vessel at room temperature in the dark until the end of the leaching interval.
7. Prior to the end of the leaching interval, prepare a vessel for the next leaching interval. The schedule of leaching solution renewals and interval durations are summarized in Table 1. This leaching test will be statically performed not to disturb exposed surface areas of untreated samples.
8. At the end of each leaching period, prepare sample bottles and collect samples of the leaching solution from the four replicate leaching vessels for the following analyses (in this order):
   a. VOCs
   b. PAHs
   c. SVOCs
   d. Pesticides
   e. Herbicides
   f. PCBs
   g. Dissolved organic carbon (DOC)
   h. Total organic carbon (TOC)
   i. Cyanide
   j. Perchlorate
   k. Dissolved metals
   l. ORP
   m. pH
   n. Conductivity
9. Filter the leaching solution through a 0.45 µm pore size glass membrane using a filter apparatus for VOCs, PAHs, SVOCs, pesticides, herbicides, PCBs, and DOC.
10. Filter the leaching solution through a 0.45 µm pore size nylon or PES syringe filter using a disposable syringe for dissolved metals.
11. Immediately preserve and store the samples of the leaching solution for chemical analysis. Preserve all analytical samples in a manner that is consistent with the determinative chemical analyses to be performed. Make sure that the sample containers for analyses of VOCs, PAHs, and SVOCs do not have headspace.

12. Retrieve the PDMS liner inserts from the leaching vessels for analyses of the target organic contaminants. Gently wipe residual leaching solution on the surface of PDMS liner insert using Kimwipes and collect in a 100 mL glass vial. Add 50 mL of methanol and 50 mL of acetonitrile to completely fill the vial without headspace, cap, and gently agitate for 16 hours to extract.
13. Measure ORP, pH, and conductivity within 15 minutes of leaching vessel exchange to avoid neutralization of the solution due to exposure to oxygen and carbon dioxide, especially when alkaline materials such as cement treated samples are tested.
14. Ship the water samples and the glass vials containing the solvents and the PDMS liner insert to an analytical lab under chain of custody for sample analysis.
15. At the end of the leaching interval (Table 1), carefully remove the test sample containers from the leaching vessels. Allow any liquid to drain from the surface of the sample containers into the leaching vessel for approximately 15 seconds.
16. Measure and record the masses of the samples. The change in sample mass between intervals is an indication of the potential absorption of eluent by the matrix (mass gain) or erosion of the matrix (mass loss). For cement-treated test samples, mass gain may also be indicative of carbonate precipitation if the vessel is not tightly sealed and carbon dioxide is absorbed from the atmosphere.
17. Place the samples into the new leaching vessels filled with clean reagent water.
18. Cover the new leaching vessel with the airtight lid and place in a safe and dark location until the end of the leaching interval (repeat step 5).
19. Collect all subsequent leaching solutions by repeating the leaching vessel exchange and leaching processing procedures (steps 6 to 17) until all intervals have been collected.

Table 1
Schedule of Leaching Solution Renewals and Interval Duration

Interval Label	Interval Duration (h)	Interval Duration (d)	Cumulative Leaching Time (d)
T01	2.0 ± 0.25	—	0.08
T02	23.0 ± 0.5	—	1.0
T03	23.0 ± 0.5	—	2.0
T04	—	5.0 ± 0.1	7.0
T05	—	7.0 ± 0.1	14.0
T06	—	14.0 ± 0.1	28.0
T07	—	14.0 ± 0.1	42.0
T08	—	7.0 ± 0.1	49.0
T09	—	14.0 ± 0.1	63.0

Quality Assurance/Quality Control

All sample containers and glassware must be prewashed with a metal-free detergent and rinsed with 0.01 molar nitric acid, reagent water, and HPLC-grade methanol, acetonitrile, and hexane to remove background contaminants. A procedural blank of the leaching test is prepared, sampled, and analyzed with each batch of test samples. The blank leaching vessels will be kept throughout the entire leaching test period, and samples (i.e., leaching solution and PDMS liner inserts) in the blank leaching vessel will be collected one time only at the end of the 10th time step.

Project Closeout

Sample materials and contaminated disposable PPE will be disposed of in a manner consistent with the management of Investigation-Derived Waste presented in Section 4.4 of the *In Situ Stabilization and Solidification Bench Scale Treatability Study Field Sampling Plan*. Contaminated equipment and non-disposable PPE will be decontaminated using appropriate practices as contained in the HASP.

References

EPA (U.S. Environmental Protection Agency), 2013. *Method 1315: Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure*. Revision 0. January 2013.

ITRC (Interstate Technology and Regulatory Council), 2011. *Development of Performance Specifications for Solidification/Stabilization*. July 2011.

Standard Operating Procedure Approval Page

This standard operating procedure, **Modified EPA Method 1315**, has been reviewed by the laboratory managers and is approved for use in the Environmental Geochemistry Laboratory.

Signature: ______________________ Date: May 19, 2023

Grace Weatherford, Laboratory Project Manager

Signature: ______________________ Date: May 19, 2023

Masakazu Kanematsu, Laboratory Operations Manager

Attachment 2

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Data Management Plan

May 19, 2023
Gasco Sediments Cleanup Action

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Data Management Plan

Prepared for U.S. Environmental Protection Agency, Region 10,
and Oregon Department of Environmental Quality

May 2023
Gasco Sediments Cleanup Action

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Data Management Plan

Prepared for
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Oregon Department of Environmental Quality
Northwest Region Portland Office
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On Behalf of
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250 SW Taylor Street
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TABLE OF CONTENTS

ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chain of custody
DMP	*Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Data Management Plan*
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ICP	inductively coupled plasma
ISS	in situ stabilization and solidification
JPEG	Joint Photographic Experts Group
PDF	portable document format
QA	quality assurance
QC	quality control
RPD	relative percent difference
SOW	*Statement of Work – Gasco Sediments Site*
QAPP	*Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan*
SSF	Standard Storage Format
TIFF	Tagged Image File Format
Work Plan	*Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan*

1 Introduction

This *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Data Management Plan* (DMP) provides the data management process and procedures for the performance of work activities associated with data collection and reporting for the in situ stabilization and solidification (ISS) bench scale treatability study for the Gasco Sediments Site located on the Willamette River adjacent to the NW Natural Gasco and Siltronic Corporation properties in Portland, Oregon. This DMP has been prepared under the *Administrative Settlement Agreement and Order on Consent* (Docket No. Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] 10-2009-0255) and *Statement of Work – Gasco Sediments Site* (SOW; EPA 2009).

The procedures and policies described in this DMP are consistent with the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 Code of Federal Regulations 300).

1.1 Project Background

NW Natural is conducting an ISS bench scale treatability study within the Gasco Sediments Site. This DMP describes the data management procedures to support sediment remedial design and is Attachment 2 to the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Quality Assurance Project Plan* (QAPP).

The *Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (Work Plan) has been prepared under the Administrative Settlement Agreement and Order on Consent (Docket No. CERCLA 10-2009-0255) and SOW (EPA 2009). The Work Plan summarizes the proposed ISS bench scale treatability study for the Shallow, Intermediate, and Riverbank Regions (i.e., nearshore), including the top of the riverbank of the Gasco Sediments Site Project Area and the associated field sampling and laboratory methodologies to achieve the primary objectives of the study.

1.2 Data Management Objectives

This DMP describes the management of data resulting from ISS bench scale treatability study field investigations conducted under work plans and QAPPs approved by the U.S. Environmental Protection Agency (EPA). This DMP may be revised, amended, and updated as the ISS bench scale treatability study field investigations and/or remedial design process evolves and additional remedial design investigations and/or activities are identified. DMP revisions will be transmitted to EPA in a redline/strikethrough format for review.

2 Personnel

2.1 Project Personnel

Responsibilities of the team members, as well as laboratory project managers, are described in Section 2.1 of the QAPP. Project roles specific to implementation of this DMP are described in Section 2.3 of this document.

The Anchor QEA Project Quality Assurance (QA) Manager and the Anchor QEA Database Manager will manage field and laboratory data records, including electronic data deliverables (EDDs). Only trained, authorized data managers have privileges to load and update data in the central database. Only trained, authorized developers have privileges to develop and modify applications and reporting code used in the data management system. Designated staff will be responsible for the storage and security of project hard copy and electronic files. A senior data manager will be responsible for QA of the database and applications. A senior chemist will be responsible for QA of the analytical chemistry data and records.

Project records will be accessible only to approved project personnel.

2.2 Training

Staff involved in data management tasks will have appropriate training in data and document stewardship, including the principles and procedures described herein, and in the systems that are used to manage electronic data. Data management systems comprise both hardware and software, as well as electronic file storage systems. Applications may be commercially or publicly available products or custom software developed by Anchor QEA and are used for data collection, data processing, data storage, data analysis, and data reporting. The data management systems that are used to support this project are described in Section 4. The procedures used during data management are described in Section 5.

Training includes formal academic or professional accreditation coursework, as well as internal training developed by Anchor QEA expressly for its data management systems.

Staff that have access to data-related applications will have been trained in the proper use of those applications. Staff that develop code will have been trained in standard programming techniques and practices. Staff that manage databases will have been trained in the proper use of database-related hardware (database servers) and software.

2.3 Roles and Responsibilities

The data management roles and responsibilities of the staff involved in data-related activities are as follows.

- Project Manager—Responsible for maintaining direct lines of communication between Anchor QEA and NW Natural, implementing activities described in this DMP, producing project deliverables, and performing the administrative tasks needed to ensure timely and successful completion of the work. The (Anchor QEA) Project Manager will provide the overall programmatic guidance to support staff and will ensure that documents, procedures, and project activities meet the objectives contained within this DMP.
- Database Manager—Responsible for data management oversight, including responsibility for database management functions, database quality, data transformations and calculations, applications functionality, and data reporting.
- GIS Manager—Responsible for spatial data management oversight, including coordinate verification, meta-data generation, maintenance of proper project coordinate systems and datums, and spatial data transmittal.
- Database Analyst—Responsible for loading field and laboratory analytical EDDs, performing database quality checks, updating the database as necessary, comparing database records against laboratory hard copy reports, and running reports from the database.
- Field Coordinator—Responsible for the documentation of proper sample collection protocols, sample collection, equipment decontamination, and chain-of-custody (COC) documentation. The Field Coordinator is also responsible for the proper use of field data collection applications and equipment, and the review of field notebooks, COC records, sample labels, and other field-related documentation. In addition, the Field Coordinator is responsible for the review and oversight of project plans and revisions to the plans to maintain proper QA throughout the investigation, field audits, data processing QC, data quality review, and identifying corrective actions.
- Field Team Staff—Responsible for collecting field data including samples for analysis, field measurements, and observations of the study area.
- Project QA Manager—Primary point of contact with the analytical laboratory(ies), responsible for laboratory procurement and monitoring of progress, reviewing laboratory receipt acknowledgments and COCs, and reviewing data for quality issues. In addition, the Project QA Manager is responsible for managing the data validation task, including ensuring that validation of analytical data is conducted and documented according to the requirements of the QAPP, and coordinating the QA/quality control (QC) efforts between Anchor QEA and subcontractors, including analytical laboratories. The Project QA Manager is further responsible for providing qualifiers and any other edits resulting from data validation to the Database Manager or Database Analyst.

- Laboratory Project Manager—Acts as the primary point of contact at a laboratory facility for the Project QA Manager to communicate and resolve sampling, receipt, analysis, and storage issues.

3 Project Documentation and Records

This section describes the types of documentation that will be included for project-specific and historical datasets, the databases that will be used, how the data will be archived, and database input requirements.

3.1 Project Data

This section describes the documentation and record keeping requirements for field-related data collected during the ISS bench scale treatability study, in accordance with the SOW (EPA 2009).

3.1.1 Types of Documents to Be Created or Collected

Field data will be documented and recorded in various ways during the ISS bench scale treatability study. The following list shows the kinds of field documents and records that may be produced during project data-gathering activities (additional information regarding the maintenance of project documents and records is provided in QAPP Section 2.6):

- Airbills
- COC records
- Communication logs/emails
- Corrective action communications
- Documentation of corrective action results
- Deviation forms
- Documentation of internal QA reviews and/or audits
- EDDs
- Field data collection forms
- Sampling notes in bound, waterproof field log books
- Field instrument calibration logs
- GPS files
- Identification of QC samples
- Identification of EPA split samples
- Photographs
- Sampling equipment decontamination records
- Sampling location figures (based on targeted and actual coordinates)

These records will be created in either written (e.g., sampling notes) or electronic formats (e.g., GPS files, measurement instrument/data-logger files, and field databases).

3.1.2 Database for Field Data and Analytical Data

Anchor QEA will maintain field and analytical data in a widely used, commercially available environmental data management system.[1] This system will contain information about locations, field measurements, samples, and laboratory tests and results. Access to the database will be restricted to data management personnel. In general, project personnel will have the ability to view, but not modify, the data. The ability to add or correct data will be granted to only those individuals identified by the Database Manager and trained to perform those tasks.

3.1.3 Project Data File Archives

Original field data documents will be archived in Anchor QEA's project files (e.g., field sheets, hard copy maps, and field log books), and electronic files (e.g., field data collection applications, electronic data logger files, GPS files, and photographs) will be archived on a secured server in a project-dedicated folder and/or on Anchor QEA's SharePoint site using an appropriate file type (e.g., Standard Storage Format [SSF] for GPS files, Tag Image File Format [TIFF] or Joint Photographic Experts Group [JPEG] for photographs, and Excel or InfoPath formats for electronic field forms). In addition, all paper field records will be scanned and stored electronically (as portable document format [PDF] files) with other project electronic files, as indicated above. Documents (including records or documents in electronic form) will be maintained at Anchor QEA offices or at NW Natural for a minimum of 10 years after EPA's notification of completion of work, in accordance with the retention of records section of the SOW (EPA 2009).

3.1.4 Field Electronic Data Deliverables

Field data will be uploaded to the data management system into one or more field EDD formats that are generated from field data collection applications or by transcription from hand-written field forms. Data transferred from written records to field data EDDs will be reviewed against field records prior to being loaded into the database. The EDDs will be checked for valid values and proper format and will be rejected prior to loading if there are errors. The data management system is configured to require that all field samples (normal environmental as well as field QC samples) must be present in the database prior to the loading of laboratory results for those samples to avoid sample identification discrepancies between field and laboratory records.

3.1.5 Laboratory Electronic Data Deliverables

For analytical data, each laboratory will provide an EDD and one copy of a Level IV, contract laboratory program type data package (unless otherwise specified in the QAPP). While each laboratory is responsible for ensuring all data reported in the electronic copy and data package match, as part of data quality review, Anchor QEA will compare a subset of laboratory packages for

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[1] EarthSoft EQuIS Enterprise version 7.0.0, as of the date of this document.

consistency between EDDs and data package reports. The data deliverable will include a summary package that contains, at a minimum, the case narrative, custody documentation, method citations, field and laboratory sample identifiers cross-reference, sample results (including all raw data needed to support those results), preparation and analysis dates, and summary QC forms. The data package will be provided to Anchor QEA as a bookmarked PDF file.

Complete, paginated data packages will contain the following minimum information:

- A narrative addressing any difficulties encountered during sample analysis and a discussion of any exceedances in the laboratory QC sample results
- A cross-referenced table of field and laboratory identification numbers
- Analytical method references
- Definition of any data flags or qualifiers used; a list of valid data flags and qualifiers for use in the EQuIS reporting format will be provided by Anchor QEA following contract award
- A table of contents for the data package similar to the EPA Complete Sample Delivery Group File Audit Checklist
- A COC signed and dated by the laboratory to indicate sample receipt; the temperature of the cooler upon receipt will be noted on the COC or on a sample receipt form; copies of shipping air bills will also be provided, if available
- Results for each field sample, blank and QC sample in units appropriate to the method presented in Form 1s or equivalent; method detection limits, estimated detection limits, and reporting limits will also be provided
- Dilution factors for each sample or analyte
- Calibration data, including raw data; initial calibration curve data, such as linear regression statistics or average relative response factors and percent relative standard deviation; continuing calibration data, such as relative response factors and percent difference data
- Gas chromatography/mass spectrometry and inductively coupled plasma/mass spectrometry tuning data
- Internal standard data
- Surrogate (system monitoring) data
- Inductively coupled plasma (ICP) inter-element correction factors, linear range data, serial dilution data, and interference check sample results
- Copies of laboratory notebook pages or preparation logs showing sample preparation documentation
- Field sample results and raw data (chromatograms and ICP printouts), including dilution data
- Laboratory QC data, including method blank data, laboratory duplicate data reported as relative percent difference (RPD), laboratory control spike data, reported as percent recovery; matrix spike/matrix spike duplicate data reported as percent recovery with RPD calculated; all associated raw data must also be provided

- Copies of phone logs, faxes, and emails associated with the sample set
- Any other data necessary to conclusively confirm the analytical results reported and the overall quality of the data

Anchor QEA has an analytical chemistry EDD specification that will be provided to each laboratory. The specification includes a descriptive memorandum, an EDD template, and a current file of valid reference values. Verification of EDD formatting and completeness will be performed by Anchor QEA data management personnel during upload or by automated EDD checking and loading procedures. Laboratory EDDs that do not meet the EDD specification or contain errors will not be loaded to the database and will be returned to the laboratory for correction and resubmittal.

3.2 Document Retention

Original field data documents (e.g., field sheets, hard copy maps, and field log books) will be archived in Anchor QEA's hard copy project file storage facility or at NW Natural. Electronic files (e.g., field data collection applications, EDDs, electronic data logger files, electronically produced documents, GPS files, and photographs) will be archived on a secured server in a project-dedicated folder using an appropriate, standard file type (e.g., PDF, SSF for GPS files, and TIFF or JPEG for SOW (EPA 2009). Specifically, until 10 years after receipt of EPA's notification of completion of work, NW Natural (and its contractors) shall preserve and retain at least one copy of all records and documents (including records or documents in electronic form) now in its possession or control or which come into its possession or control that relate in any manner to the performance of the sediment remedial design work or the liability of any person under CERCLA with respect to the Gasco Sediments Site, regardless of any internal retention policy to the contrary. Non-identical copies of documents will be maintained for a minimum of 10 years. Documents include hard copy documents, records, and other information in electronic form. Retention standards for documents created by subcontractors will be communicated to the subcontractors during contracting.

4 Data Management Systems

The environmental data management system is composed of a number of hardware and software components, as described here. System hardware includes servers and storage devices, computers and tablets, and networking and internetworking devices. Software includes operating systems, server and data storage applications, user data access and analysis applications, and field data collection applications.

4.1 Hardware

The hardware systems that comprise the data repositories include file servers and database servers. Key elements of these systems, specifically the analytical chemistry database and the GIS, are housed in a physically and electronically secure data center on enterprise-level hardware. The data center is remotely located and equipped with redundant power supplies and internet connections. Access to systems hardware and software in the data center is limited to designated, authorized personnel. File servers used to store and share project documents are either maintained on premises in a physically and electronically secure, dedicated server room or use cloud-based storage systems. Only designated personnel have access to project folders and files on file servers.

The networks within which servers reside are protected by firewalls and more than one level of malware detection and protection software and includes coverage for email servers, networks, and computers.

Computers and tablets used in field activities are dedicated to such activities and are secured by login requirements. Data stored on computers, tablets, GPS devices, and instrument data loggers will be exported and stored in project file servers as soon after each field activity as is practical; USB flash memory devices may be used for intermediate, temporary data storage in the field. Project data will not be commingled with data from other projects. Data will be stored in raw form (in the format in which it was generated) and in EDD formats suitable for loading to the project database.

Some in situ sensors may telemeter data to a third-party vendor. In such cases, these data will be accessible from a password-protected website. Data will be downloaded to the project database or file server for storage.

4.2 Software

4.2.1 Licensed Software

Licenses and active software maintenance agreements, where applicable, are required for all computers used in project work. Operating systems on servers and computers are updated with security and functional patches as provided by vendors after internal evaluation. Licensed applications are used for the database management system and GIS. The relational database management system is Microsoft SQL Server 2017. The data management application is EarthSoft EQuIS Enterprise version 7.0.0 with the Live extension. The GIS is Esri ArcGIS version 10.8.1. The data models and software for these systems are proprietary to the vendor and cannot be shared.

4.2.2 Custom Software

Custom applications will be used in this project. These applications are proprietary and are the intellectual property of Anchor QEA; their source code cannot be distributed. These applications include data loaders and checkers, data manipulation software, data analysis scripts, and field data collection applications.

Source code for data collection, data loading, and data reporting applications undergo several QC steps, including design review, code review, testing, and user acceptance testing. The source codes are version-controlled to track changes.

5 Data Management Procedures

This section describes the procedures for handling and tracking project data and documents.

5.1 Field Data Quality Review

QC checks will be performed as soon after field activities as is practical. The checks and the person responsible for performing them are outlined as follows:

1. Review field records for completeness and accuracy of information reported on field forms or in electronic applications with respect to requirements specified in the QAPP (Field Coordinator).
2. Ensure that corrections are made. For hard copy forms, corrections will be made with a single strikethrough and each corrected entry will be signed or initialed and dated. For electronic data, corrections are made in the application or in the EDD (Field Coordinator).
3. Compare field activities against the QAPP (Field Coordinator).
4. Scan hard copy forms and place scanned forms and electronic files into project-specific folders in the file server (Field Coordinator).
5. Review field records for conformance to standard nomenclature defined in QAPP (Database Manager).
6. Review in situ sensor data logger files for instrument issues (Field Coordinator).
7. Verify GPS coordinates (GIS Manager).
8. Review COCs and laboratory receipt acknowledgments (Project QA Manager).
9. Ensure that project documents are properly saved in project folders (Database Manager).

The Field Coordinator, Database Manager, and Project QA Manager, as appropriate, will be responsible for ensuring that corrections are made in response to issues identified in the steps above.

5.2 Field Data Processing

Procedures for field data collection and creation of field records are described in the QAPP. Management of these data are described as follows.

Field data are processed according to the following general steps. These may be performed after QC checks are completed but may be performed with unverified field data in support of the QC steps outlined in Section 5.1.

1. Send GPS files with coordinates to the GIS team (Field Team).
2. Prepare field EDDs and transmit to the database team. If field forms were used, the Field Team transcribes information to be stored in the central database into specifically formatted, Microsoft Excel field EDD templates. If field data collection applications were used, export the data into the appropriate EDD format (Field Team).

3. Place hard copy files, data logger files, and image files in designated project folders (Field Team).
4. Load field EDDs to the database (Database Analyst).

Field EDDs will include, at a minimum and as specified in the project QAPP, the following items:

- Location information (e.g., location identifier, coordinates [in the appropriate project coordinate system], depth or elevation with units in the appropriate datum)
- Boring/coring information (e.g., date/time, technique, driller, geologist, depths, recoveries, and lithology)
- Sample information (e.g., location, depth[s], sample type, and, if duplicate, the associated normal parent sample)
- For biota samples, collection method, species information, sample preparation (if performed in the field), measurements, counts, and compositing information, as required
- Visual observations
- Field parameter measurements (unless these are provided in a separate data logger file)
- COC/test request information

Anchor QEA's field data collection applications support project-specific location and sample nomenclature and valid values. In addition, electronic forms and field EDDs cannot be created unless all required elements are provided. Anchor QEA's field and laboratory data loaders support detailed checks of locations, valid values, samples, and test requests. Field sample information and test requests must be loaded to the database prior to the loading of laboratory EDDs.

Other types of electronic field data may be collected (e.g., hydrographic survey data, GIS data, aerial photographs, current meter data, and water column profiles). These data will be saved to designated project folders.

5.3 Laboratory Data Processing and Data Validation

The following steps are performed on data received from laboratories or from data validators. COCs, laboratory receipt acknowledgements, laboratory reports and EDDs, and data validation reports and EDDs are stored in designated project files. If any revisions to these files are made, the original files are retained.

1. Coordinate with laboratory regarding schedule, issues, and receipt of data (Project QA Manager).
2. Load laboratory EDDs to the database (Database Analyst).
3. Prepare validation export EDD (Database Analyst).
4. Perform data validation. This step may be performed in-house or sent to a subcontractor for validation (Data Validator).

5. Review validation results. This step is performed regardless of whether validation is performed in-house or by a subcontractor (Project QA Manager).
6. Load validation results (Database Analyst).
7. Review database records against laboratory report for consistency (Database Analyst).
8. Perform any data transformations or processing necessary to support data analysis (Database Analyst).

Anchor QEA's laboratory analytical EDD loader applications can be configured to perform several completeness and quality checks. To assist laboratories with Anchor QEA's EDD requirements, documentation of laboratory EDD specifications is provided to project laboratories during laboratory contracting or before the inception of the project. Analytes, including target, surrogate, and other method-specific QC analytes, as well as matrices and units must be reported as stated in the project QAPP. A laboratory EDD will not be loaded to the database if it does not, at a minimum, match the proper EDD file-naming convention, formatting, valid values, and field sample identifier. Depending on the laboratory and the tests requested, the loader application may require that all analytical reporting requirements have been met before accepting the EDD. Any errors will be communicated to the laboratory by the Project QA Manager or Database Manager, and it is the responsibility of the laboratory to submit a proper EDD. All revisions of EDDs are maintained in designated project folders.

The Project QA Manager will review laboratory data packages for proper formatting and completeness, as specified in the project QAPP. Any errors will be communicated to the laboratory for revision and resubmittal.

Data validation will be performed as required in the project QAPP. The Project QA Manager will be responsible for ensuring that validations are performed properly and at the required frequency and level of evaluation. The Project QA Manager will work with the Database Manager for the preparation and loading of validation EDDs, ensure that validation reviews are performed, and communicate any validation issues to the Data Validator.

The final analytical data quality review is a verification of database records against laboratory and validation reports. This step is performed by the Database Analyst. Issues encountered in this step will be communicated to the Project QA Manager and Database Manager for resolution. When data pass this step, they are ready for evaluation and analysis by project personnel and ready for reporting and transmittal to other parties.

Anchor QEA records the status and workflow of laboratory and data validation deliverables at the sample delivery group level in a custom tracking application, from laboratory receipt acknowledgement to final data quality review by recording the date and person that completed each step in the process.

5.4 Geospatial Data

Geospatial information will be stored in an Esri ArcGIS system. The project coordinate system is the Oregon North Zone state plane in international feet with the High-Accuracy Reference Network (1991) adjusted 1983 North American Datum as the horizontal datum. The vertical datum is the City of Portland datum.[2] Spatial data will be transmitted in the ESRI File Geodatabase format.

The GIS Manager will oversee field-generated coordinate verification procedures and will work with the Database Manager to ensure that accurate, verified coordinates are stored with location information in the project database.

5.5 Imagery

Photographic and videographic image files may be created in this project. Original files, produced by equipment suitable for the quality objectives, will be retained unedited in project folders. Edited files will be stored as revisions.

5.6 Database Modifications

Modifications to the database after final data quality review, while rare, may occur. These may occur after holistic review of the data during evaluations that may reveal issues with the data not detected during the formal data validation process. Potential issues will be discussed with the Project Manager prior to modifying the database. Modifications may occur after data have been transmitted. A project database change log is maintained that records the release or transmittal dates of a dataset and the dates and nature of changes made to the database.

Notification of database modifications to affected parties will be made through email or a memorandum as soon as is practicable.

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[2] https://www.portlandoregon.gov/transportation/article/70676 (viewed May 2019)

6 Data Protection and Security

The information systems that contain and support project data, including field and analytical data as well as other electronic information, include systems within Anchor QEA's offices, in a data center facility, and an off-site storage location for tape backups. The procedures that protect and secure these information systems are described below.

6.1 Computer Systems

Servers in Anchor QEA's facilities are physically secured in locked buildings and rooms, with access limited to authorized personnel. Servers are electronically secured behind firewalls with multiple layers of anti-malware software that protect the firewall, the local area networks, and emails. Servers and networking equipment are connected to battery-based uninterruptable power supplies with automated shutdown procedures in the event of a power outage.

Operating system and third-party software are licensed and maintained with vendor-supplied security patches. Major updates are evaluated and tested, and project managers are consulted regarding the impact of major updates prior to deployment on production servers.

Access to these servers is limited to authorized system administrators through physical locks and through network domain permissions. Access to central data management systems is limited by permissions to authorized project-specific data management personnel.

6.2 Physical Files

Physical files stored on premises or in an off-sight storage facility are physically protected to the extent practicable by security systems and fire prevention systems. Historical documents and images will be protected from light to prevent damage. To the extent practical, physical documents will be scanned, and those scanned documents will be protected through electronic storage backup systems.

6.3 Privacy and Confidentiality

It is not anticipated that the data collected will pose privacy concerns. Once data and documents are reviewed for quality, as described elsewhere in this document, they will be transmitted to EPA. No data generated during this project are considered confidential. Proprietary software used to evaluate data are considered confidential.

7 Data Reporting and Transmittal

Reporting and the submittal of data to EPA will be performed as specified in Section 4 of the Work Plan.

8 References

EPA (U.S. Environmental Protection Agency), 2009. *Statement of Work – Gasco Sediments Site*. U.S. Environmental Protection Agency Region 10. September 9, 2009.

Appendix C

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan

May 19, 2023
Gasco Sediments Cleanup Action

ANCHOR QEA

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan

Provided to U.S. Environmental Protection Agency, Region 10,
and Oregon Department of Environmental Quality

May 2023
Gasco Sediments Cleanup Action

Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan

Prepared for
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Oregon Department of Environmental Quality
Northwest Region Portland Office
2020 SW 4th Avenue, Suite 400
Portland, Oregon 97201

Prepared by
Anchor QEA, LLC
6720 S Macadam Avenue, Suite 300
Portland, Oregon 97219

On Behalf of
NW Natural
250 SW Taylor Street
Portland, Oregon 97204

Certification Page

Ryan Barth

Project Manager

Anchor QEA, LLC

Date: May 19, 2023

Nik Bacher

Field Lead

Anchor QEA, LLC

Date: May 19, 2023

The information in this *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan* has been designed for the *Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (WP) presently contemplated by Anchor QEA, LLC (Anchor QEA). Therefore, this document may not be appropriate if the work is not performed by or using the methods presently contemplated by Anchor QEA. In addition, as the work is performed, conditions different from those anticipated may be encountered and this document may have to be modified. Therefore, Anchor QEA only intends this plan to address currently anticipated activities and conditions and makes no representations or warranties as to the adequacy of the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan* for all conditions encountered.

Health and Safety Plan Acknowledgement Form

Project Number: 000029-02.85

Project Name: Gasco Sediments Cleanup Action

My signature below certifies that I have read and understand the policies and procedures specified in this *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan* (HASP). For non-Anchor QEA employees, this HASP may include company-specific appendices to this plan developed by entities other than Anchor QEA. Non-affiliated personnel may be required to sign the Liability Waiver following this Acknowledgement Form.

Date	Name (print)	Signature	Company

Date	Name (print)	Signature	Company

Site Emergency Procedures

Site Map

Figure A
General Site Location Overview

Emergency Contact Information

Table A
Site Emergency Form and Emergency Phone Numbers*

Category	Information	
Possible Chemicals of Concern	Coal tar pitch volatiles, PAHs, cyanide, metals, VOCs, and H_2S	
Minimum Level of Protection	Modified Level D	
Site(s) Location Address	7900 NW St. Helens Road, Portland, Oregon 97210	
Emergency Phone Numbers		
Ambulance	911	
Fire	911	
Police	911	
Poison Control	(800) 222-1222	
Client Contact	Bob Wyatt, NW Natural	Office: (503) 610-7656 Cell: (503) 860-3451
Project Manager (PM)	Ryan Barth, Anchor QEA	Office: (206) 903-3334 Cell: (206) 719-3605
Field Lead (FL)	Nik Bacher, Anchor QEA	Office: (206) 903-3376 Cell: (206) 351-0951
Site Safety and Health Officer (SSHO)	Tim Stone, Anchor QEA	Office: (503) 670-1108 Cell: (503) 475-9150
Director of Health and Safety	Tim Shaner	Office: (251) 375-5282 Cell: (251) 281-3386
National Response Center	(800) 424-8802	
Oregon Emergency Response System	(800) 452-0311	
EPA Emergency Response Team, Region 10	(206) 553-4973	

Note:
* In the event of any emergency, contact the PM and FL.

Table B
Hospital Information

Category	Information
Hospital Name	Legacy Good Samaritan Hospital and Medical Center
Address	1015 NW 22nd Avenue
City, State	Portland, Oregon
Phone	(503) 413-7711
Emergency Phone	911

Hospital Route Map and Driving Directions

Figure B is a map of the route from the uplands project site (7900 NW St. Helens Road, Portland, Oregon, 97210) to the Legacy Good Samaritan Hospital and Medical Center. Directions are as follows (travel time is approximately 11 minutes):

1. Start out going northwest on NW Saint Helens Rd/US-30 W. (0.08 mi)
2. Make a left turn onto US-30 E. (4.4 mi)
3. Turn right onto NW Nicolai St. (0.07 mi)
4. Turn sharp left to stay on NW Nicolai St. (0.04 mi)
5. Take the 1st right onto NW 23rd Ave. (0.8 mi)
6. Turn left onto NW Lovejoy St. (0.10 mi)
7. Take the 1st left onto NW 22nd Ave.

Directions:

Gasco
7900 NW St. Helens Road
Portland, Oregon

1. Start out going northwest on NW Saint Helens Rd/US-30 W. (0.08 mi)
2. Make a left turn onto US-30 E. (4.4 mi)
3. Turn right onto NW Nicolai St. (0.07 mi)
4. Turn sharp left to stay on NW Nicolai St. (0.04 mi)
5. Take the 1st right onto NW 23rd Ave. (0.8 mi)
6. Turn left onto NW Lovejoy St. (0.10 mi)
7. Take the 1st left onto NW 22nd Ave.

Legacy Good Samaritan Hospital
1015 NW 22nd Avenue
Portland, Oregon

SOURCE: Esri/Delorme World Street Map.

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Publish Date: 2018/10/30 2:32 PM | User: jbigsby
Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Site Remedy\0029-RP-002 (Rte Hsp-1).dwg Figure B

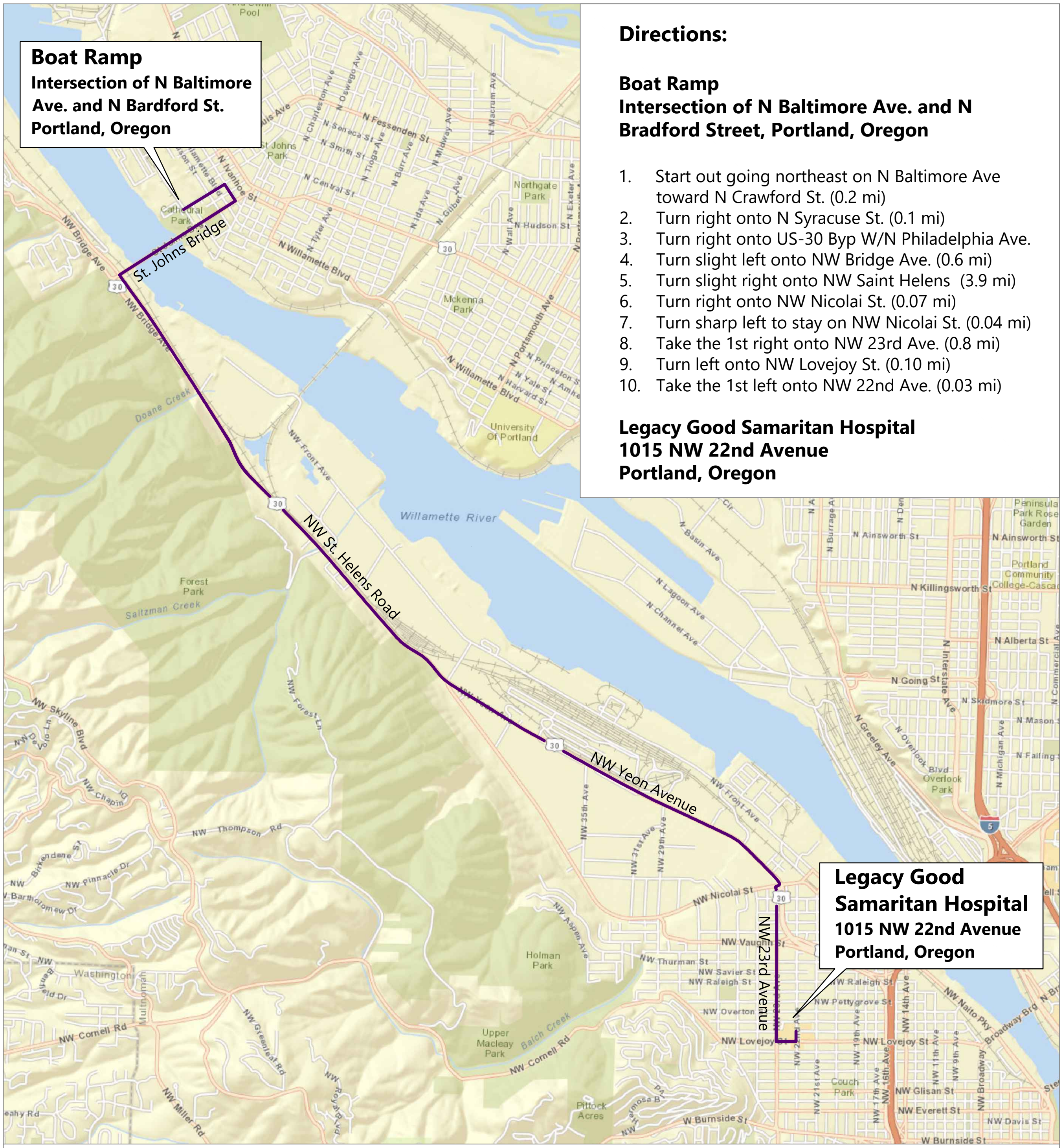
ANCHOR QEA

Figure B
Hospital Route Map from Uplands Site

Health and Safety Plan
Gasco Sediments Cleanup Action

Figure C is a map of the route from the boat launch area at Cathedral Park, St. Johns, Oregon, to the Legacy Good Samaritan Hospital and Medical Center. Directions are as follows (travel time is approximately 15 minutes):

1. Start out going northeast on N Baltimore Ave toward N Crawford St. (0.2 mi)
2. Turn right onto N Syracuse St. (0.1 mi)
3. Turn right onto US-30 Byp W/N Philadelphia Ave.
4. Turn slight left onto NW Bridge Ave. (0.6 mi)
5. Turn slight right onto NW Saint Helens (3.9 mi)
6. Turn right onto NW Nicolai St. (0.07 mi)
7. Turn sharp left to stay on NW Nicolai St. (0.04 mi)
8. Take the 1st right onto NW 23rd Ave. (0.8 mi)
9. Turn left onto NW Lovejoy St. (0.10 mi)
10. Take the 1st left onto NW 22nd Ave. (0.03 mi)



Directions:

Boat Ramp
Intersection of N Baltimore Ave. and N Bradford Street, Portland, Oregon

1. Start out going northeast on N Baltimore Ave toward N Crawford St. (0.2 mi)
2. Turn right onto N Syracuse St. (0.1 mi)
3. Turn right onto US-30 Byp W/N Philadelphia Ave.
4. Turn slight left onto NW Bridge Ave. (0.6 mi)
5. Turn slight right onto NW Saint Helens (3.9 mi)
6. Turn right onto NW Nicolai St. (0.07 mi)
7. Turn sharp left to stay on NW Nicolai St. (0.04 mi)
8. Take the 1st right onto NW 23rd Ave. (0.8 mi)
9. Turn left onto NW Lovejoy St. (0.10 mi)
10. Take the 1st left onto NW 22nd Ave. (0.03 mi)

Legacy Good Samaritan Hospital
1015 NW 22nd Avenue
Portland, Oregon

SOURCE: Esri/Delorme World Street Map.

0 0.75
Miles

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Filepath: K:\Projects\0029-NW Natural Gas Co\Gasco Site Remedy\0029-RP-003 (Rte Hsp-2).dwg Figure C

ANCHOR QEA

Figure C
Hospital Route Map from Boat Launch (Cathedral Park)

Health and Safety Plan
Gasco Sediments Cleanup Action

WorkCare Incident Intervention

Anchor QEA has an additional Incident Intervention resource from WorkCare to help answer questions, alleviate uncertainty and stress in a potential injury situation, and maintain the health and safety of our employees. Incident Intervention is an injury and illness management tool that provides employees with 24 hours a day/7 days a week (24/7) **immediate** telephone access to a member of WorkCare's clinical staff of nurses and physicians who intervene at the time of a workplace injury or illness. Contact information is provided below:

- **Access WorkCare 24/7 from anywhere using the toll-free number: 1-888-449-7787**

At the time of a workplace injury or illness, the employee, manager, or another employee at the scene notifies WorkCare using the toll-free number listed above. The caller provides information on the type of incident, possible cause, and the scope of the situation. With the details of the incident recorded, an experienced nurse or physician provides the following:

- Responsive evaluation of the incident
- Direction on the appropriate course of action
- Consultation with the employee's treating physician to design a quality care treatment plan that meets the needs of the employee and Anchor QEA

All employees are encouraged to use this service should a workplace injury or illness occur.

Key Safety Personnel

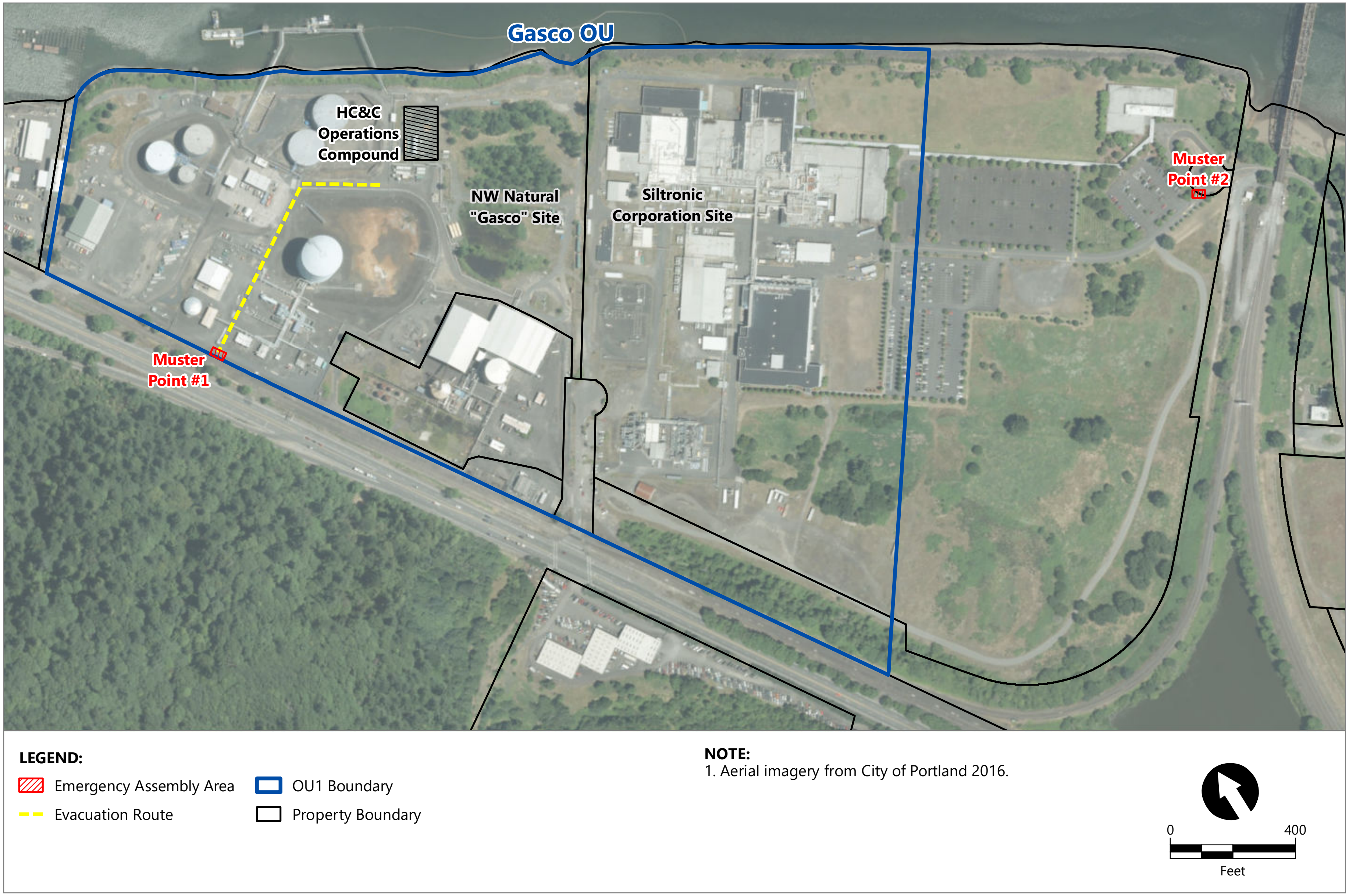
The following people share responsibility for health and safety at the site. See Section 4 of this *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan* (HASP) for a description of the role and responsibility of each.

Client Contact: Bob Wyatt, NW Natural	Office: (503) 860-6451 Cell: (503) 860-6451
Project Manager (PM): Ryan Barth, Anchor QEA	Office: (206) 903-3334 Cell: (206) 719-3605
Field Lead (FL): Nik Bacher, Anchor QEA	Office: (206) 903-3376 Cell: (206) 351-0951
Site Safety and Health Officer (SSHO): Tim Stone, Anchor QEA	Office: (503) 670-1108 Cell: (503) 475-9150
Director of Health and Safety: Tim Shaner	Office: (251) 375-5282 Cell: (251) 281-3386

Emergency Response Procedures

Site communications will be done with either a cell phone or a handheld two-way radio (two-way radios are kept on site and available for use by Anchor QEA staff), and service capabilities of cell phones at on-river locations will be checked daily. If there is an emergency that requires the site to be evacuated (e.g., river flood), the Field Lead (FL) or any other site personnel recognizing the condition will contact other field staff with phones or radios. In the event of an evacuation, personnel will meet at one of the emergency meeting locations depending on the circumstances:

1. **Gasco Uplands Work Area:** Meet at Muster Point 1, the site entrance near the Gasco guard shack, when on the upland portion of the site or when in the Koppers work area (see Figure D).
2. **Work on the Willamette River (On-Water Work Area):** Meet at Muster Point 2, the Cathedral Park Boat Ramp parking lot (see Figure C).



LEGEND:

▨ Emergency Assembly Area

- - Evacuation Route

☐ OU1 Boundary

☐ Property Boundary

NOTE:
1. Aerial imagery from City of Portland 2016.

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ANCHOR QEA

Figure D
Emergency Evacuation Route Map and Emergency Assembly Area
Health and Safety Plan
Gasco Sediments Cleanup Action

Personal Incident Response Procedures

In the event of an emergency, immediate action must be taken by the first person to recognize the event. Use the following steps as a guideline and refer to Figure E:

1. Survey the situation to verify that it is safe for you and the victim. Do not endanger your own life. Do not enter an area to rescue someone who has been overcome unless properly equipped and trained. Verify that all protocols are followed. If applicable, review Safety Data Sheets (SDS) to evaluate response actions for chemical exposures.
2. Call the appropriate emergency number (911, if available) or direct someone else to do this immediately (see Table A). Explain the physical injury, chemical exposure, fire, or release and location of the incident.
3. Have someone retrieve the nearest first aid kit (containing appropriate items for the particular work scope) and Automated External Defibrillator (AED), if available. Note: Only use an AED if you have been properly trained and are currently certified to do so.
4. Decontaminate the victim without delaying life-saving procedures (see Section 8).
5. Administer first aid and cardiopulmonary resuscitation (CPR), if properly trained, until emergency responders arrive.[1]
6. In the event that evacuation is required, the FL must perform a head count to verify that all Anchor QEA personnel are accounted for.
7. Notify the Field Lead (FL) and Project Manager (PM); the PM will notify the client contact. The PM will also contact the Director of Health and Safety. The Director of Health and Safety will facilitate the incident investigation. All client requirements pertinent to personal incident reporting will also be adhered to.
8. Complete the appropriate incident investigation reports.

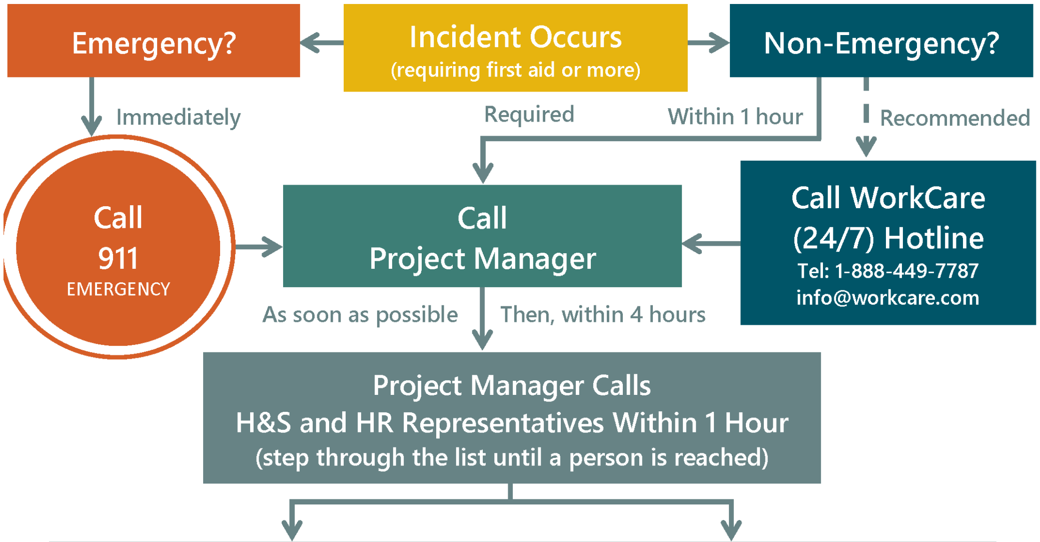
---

[1] Personnel qualified and currently certified in basic first aid or CPR are protected under Good Samaritan policies as long as they only perform the basic tasks that they were taught. Do not perform first aid or CPR tasks if you have not been trained in first aid or CPR.

Figure E
Incident Flowchart

PLAYING IT SAFE

Health and Safety: Incident Flowchart—What To Do If You Are Injured



Incident Occurs
(requiring first aid or more)

Emergency?

Immediately

Call
911
EMERGENCY

Non-Emergency?

Required

Within 1 hour

Recommended

Call WorkCare
(24/7) Hotline
Tel: 1-888-449-7787
info@workcare.com

Call
Project Manager

As soon as possible

Then, within 4 hours

Project Manager Calls
H&S and HR Representatives Within 1 Hour
(step through the list until a person is reached)

H&S Representative

Tim Shaner
Director of Health and Safety
(251) 281-3386 (call or text)
tshaner@anchorqea.com

David Templeton
Principle
(206) 910-4279 (call or text)
dtempleton@anchorqea.com

Ashley Allington
Health and Safety Coordinator
(315) 414-2038
aallington@anchorqea.com

Carl Hughes
Health and Safety Coordinator
(828) 641-9324
chughes@anchorqea.com

HR Representative

Jennifer Cole
Lead HR Business Partner | Northeast Region
O: (315) 453-1775
C: (315) 727-3076 (call or text)
jcole@anchorqea.com

Robin Utley
Senior HR Business Partner | Northwest Region
O: (949) 334-9618
C: (949) 378-9694 (call or text)
rutley@anchorqea.com

Siyu Wang
HR Generalist | Southeast/Southwest Regions
O: (949) 334-9623
C: (408) 896-7181 (call or text)
swang2@anchorqea.com

Paula Carnes
Human Resources Coordinator
(206) 903-3307
pcarnes@anchorqea.com

Joe Williams
Human Resources Coordinator
(206) 709-6886
jwilliams@anchorqea.com

Revised: 1/17/2023

Responsibility is taken, not given. Take responsibility for safety.

ANCHOR QEA

Non-Personal Incident Response Procedures

All incidents including, but not limited to, fire, explosion, property damage, or environmental release will be responded to in accordance with the site-specific HASP. In general, this includes securing the site appropriate to the incident, turning control over to the emergency responders, or securing the site and summoning appropriate remedial personnel or equipment. Anchor QEA will immediately notify the client of any major incident, fire, equipment or property damage, or environmental incident with a preliminary report. A full report will be provided within 72 hours.

Spills and Releases of Hazardous Materials

When required, notify the National Response Center and local state agencies. The following information should be provided to the National Response Center:

- Name and telephone number
- Name and address of incident location
- Time and type of incident
- Name and quantity of materials involved, if known
- Extent of injuries
- Possible hazards to human health or the environment outside the facility
- The emergency telephone number for the National Response Center is (800) 424-8802. If hazardous waste is released or produced through control of the incident, verify the following:
- Waste is collected and contained
- Containers of waste are removed or isolated from the immediate site of the emergency
- Treatment or storage of the recovered waste, contaminated soil or surface water, or any other material that results from the incident or its control is provided
- No waste that is incompatible with released material is treated or stored in the facility until cleanup procedures are completed
- Verify that all emergency equipment used is decontaminated, recharged, and fit for its intended use before operations are resumed

Near-Miss Reporting

All near-miss incidents (i.e., those that could have reasonably led to an injury, environmental release, or other incident) must be reported to the FL and PM immediately, so action can be taken to verify that such conditions that led to the near-miss incident are readily corrected to prevent future occurrences.

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TABLES

FIGURES

APPENDICES

ABBREVIATIONS

AED	automated external defibrillator
ANSI	American National Standards Institute
ASTM	ASTM International
CFR	Code of Federal Regulations
COC	chemical of concern
COVID-19	Coronavirus Disease 2019
CPR	cardiopulmonary resuscitation
CRZ	Contamination Reduction Zone
dBA	A-weighted decibel
dB	decibel
DOT	U.S. Department of Transportation
DPT	direct push technology
EPA	U.S. Environmental Protection Agency
eV	electron volt
EZ	Exclusion Zone/Hot Zone
FL	Field Lead
GFCI	ground-fault circuit interrupter
H:V	horizontal to vertical
H_2S	hydrogen sulfide
HASP	*Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan*
HAZMAT	Hazardous Materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
HC&C	hydraulic control and containment
HEPA	high-efficiency particulate air
ISEA	International Safety Equipment Association
JSA	Job Safety Analysis
Koppers	Koppers Industries, Inc.
kV	kilovolt
LEL	Lower Explosive Limit
LO/TO	lock out/tag out
mg/m^3	milligrams per cubic meter
MHR	maximum heart rate
N/A	not applicable
NIOSH	National Institute for Occupational Safety and Health
NPL	National Priority List

NRR	Noise Reduction Rating
O_2	oxygen
OSHA	Occupational Safety and Health Act or Administration
OV	organic vapor
OVM	organic vapor monitor
PAH	polycyclic aromatic hydrocarbon
PEL	Permissible Exposure Limit
PFD	personal flotation device
PID	photoionization detector
PM	Project Manager
PPE	personal protective equipment
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
SDS	Safety Data Sheet
site	Gasco Sediments Site
SSHO	Site Safety and Health Officer
SZ	Support Zone/Clean Zone
TLV	Threshold Limit Value
TWA	time-weighted average
USCG	U.S. Coast Guard
UV	ultraviolet
VOC	volatile organic compound
WBGT	wet bulb globe temperature

1 Introduction

This *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Health and Safety Plan* (HASP) was prepared on behalf of NW Natural and presents health and safety requirements and procedures that will be followed by Anchor QEA, LLC, personnel and at a minimum by Anchor QEA subcontractors during work activities at the Gasco Sediments Site (the site). This HASP was developed in accordance with Title 29 of the Code of Federal Regulations (CFR), Part 1910.120(b), and will be used in conjunction with Anchor QEA's Corporate Health and Safety Program. See Section 1.1 for HASP modification procedures.

The provisions of this HASP are mandatory for all Anchor QEA personnel assigned to the project. A copy of this HASP must be maintained on site and available for employee review at all times. Anchor QEA subcontractors are also expected to follow the provisions of this HASP unless they have their own HASP that covers their specific activities related to this project. Any subcontractor HASPs must include the requirements set forth in this HASP, at a minimum. All visitors to the work site must also abide by the requirements of this HASP and will attend a pre-work briefing where the contents of this HASP will be presented and discussed.

Personnel assigned to work at the project site will be required to read this plan and must sign the Health and Safety Plan Acknowledgement Form to confirm that they understand and agree to abide by the provisions of this HASP.

Subcontractors are ultimately responsible for the health and safety of their employees. Subcontractors may mandate health and safety protection measures for their employees beyond the minimum requirements specified in this HASP.

The objectives of this HASP are to identify potential physical, chemical, and biological hazards associated with field activities; establish safe working conditions and protective measures to control those hazards; define emergency procedures; and describe the responsibilities, training requirements, and medical monitoring requirements for site personnel.

This HASP prescribes the procedures that must be followed during specific site activities. Significant operational changes that could affect the health and safety of personnel, the community, or the environment will not be made without the prior approval of the Project Manager (PM) and the Site Safety and Health Officer (SSHO).

Issuance of this approved HASP documents that the workplace has been evaluated for hazards. A hazard assessment was performed, and the adequacy of the personal protective equipment (PPE) selected was evaluated as required by 29 CFR 1910.132(d) – Personal Protective Equipment, General Requirements (General Industry); 29 CFR 1910.134 – Respiratory Protection; 29 CFR 1926.28 – Personal Protective Equipment (Construction Industry); and 29 CFR 1926.55 – Gases, Vapors, Fumes, Dusts and Mist, and is duly noted by the signature(s) and date appearing on the certification page of this document.

1.1 Health and Safety Plan Modifications

This HASP will be modified by amendment, if necessary, to address changing field conditions or additional work tasks not already described in this document. Modifications will be proposed by the Field Lead (FL) using the Modification to Health and Safety Plan form included in Attachment A. Modifications will be reviewed by the SSHO or authorized representative and approved by the PM.

2 Site Description and Background Information

2.1 Site Description and Background Information

The Gasco site is a former gasification plant located at 7900 NW St. Helens Road, Portland, Oregon, 97210, and bounded on the northeast by the Willamette River at River Mile 6 and on the southwest by State Highway 30 (St. Helens Road). The site is within the initial study area of the Portland Harbor Superfund Site. It is adjacent to Siltronic Corporation and the U.S. Army Corps of Engineers U.S. Moorings facilities. The site is currently used as a storage facility for liquefied natural gas by NW Natural, as a bulk fuel terminal for Centerline Logistics Corporation (tenant), and a significant portion of the site is undeveloped. The southeastern corner of the site was leased by Koppers Industries, Inc. (Koppers) for several decades as a storage, processing, and distribution facility for coal tar pitch and other related products. Koppers elected to cease operations at the facility and demolished the coal tar pitch buildings/structures/equipment as required under its lease agreement with NW Natural. Koppers completed the demolition and terminated its lease agreement with NW Natural in July 2018.

Anchor QEA has constructed a hydraulic control and containment (HC&C) system in order to achieve groundwater source control at the site and prevent discharge of upland groundwater to the Willamette River. The HC&C system has been installed and is currently in operation and undergoing testing. The HC&C system consists of 21 extraction wells that pump contaminated groundwater to the site treatment system. The treated groundwater is discharged to the river under a National Pollutant Discharge Elimination System permit. Ongoing activities at the site include monitoring well, extraction well, observation well, and piezometer installation; operations and maintenance of the HC&C system; hydrologic data collection; dense nonaqueous phase liquid monitoring and removal.

3 Scope of Work

3.1 Project Scope of Work

This plan addresses health and safety issues associated with the following field tasks:

- Subsurface sediment core collection from a boat
- Advancement of soil borings along the top of the riverbank

4 Authority and Responsibilities of Key Personnel

This section describes the authority and responsibilities of key Anchor QEA project personnel. The names and contact information for the following key safety personnel are listed in the Site Emergency Procedures section at the beginning of this HASP. Should key site personnel change during the course of the project, a new list will be established and posted immediately at the site. The emergency phone number for the site is **911** and should be used for all medical, fire, and police emergencies.

4.1 Project Manager

The PM provides overall direction for the project. The PM is responsible for ensuring that the project meets the client's objectives in a safe and timely manner. The PM is responsible for providing qualified staff for the project and adequate resources and budget for the health and safety staff to carry out their responsibilities during the field work. The PM will be in regular contact with the FL and SSHO to ensure that appropriate health and safety procedures are implemented into each project task.

The PM has authority to direct response operations; the PM assumes total control over project activities but may assign responsibility for aspects of the project to others. In addition, the PM performs the following tasks:

- Oversees the preparation and organization of background review of the project, the Scope of Work, and the field team
- Ensures that the team obtains permission for site access and coordinates activities with appropriate officials
- Briefs the FL and field personnel on specific assignments
- Together with the FL, sees that health and safety requirements are met
- Consults with the SSHO regarding unsafe conditions, incidents, or changes in site conditions or the Scope of Work

4.2 Field Lead

The FL reports to the PM, has authority to direct response operations, and assumes control over on-site activities. The FL will direct field activities, will coordinate the technical and health and safety components of the field program, and is responsible in general for enforcing this site-specific HASP and Corporate Health and Safety Program requirements. The FL will be the primary point of contact for all field personnel and visitors and has direct responsibility for implementation and administration of this HASP. The FL and any other member of the field team have **STOP WORK AUTHORITY**—the authority to stop or suspend work in the event of an emergency, if conditions arise that pose an unacceptable health and safety risk to the field team or environment, or if conditions arise that warrant modifications to this HASP. It is critical that both the FL and PM communicate regularly to proactively identify and address any safety-related concerns that may arise. The following include, but are not necessarily limited to, the functions of the FL related to this HASP:

- Conduct and document daily safety meetings or designate an alternate FL in his or her absence.
- Execute the Scope of Work and schedule.
- Conduct periodic field health and safety inspections to ensure compliance with this HASP.
- Oversee implementation of safety procedures.
- Implement site personnel protection levels.
- Enforce site control measures to help ensure that only authorized personnel are allowed on site.
- Notify, when necessary, local public emergency officials (all personnel on site may conduct this task as needed).
- Follow-up on incident reports to the PM.
- Periodically inspect protective clothing and equipment for adequacy and safety compliance.
- Ensure that protective clothing and equipment are properly stored and maintained.
- Perform or oversee air monitoring (if required) in accordance with this HASP.
- Maintain and oversee operation of monitoring equipment and interpretation of data from the monitoring equipment.
- Monitor site personnel for signs of stress, including heat stress, overexertion, cold exposure, and fatigue.
- Require participants to use the "buddy" system in performing tasks.
- Provide (via implementation of this HASP) emergency procedures, evacuation routes, and telephone numbers for the local hospital, poison control center, fire department, and police department.
- Communicate incidents promptly to the PM.
- Maintain communication with the SSHO regarding on-site activities.
- If applicable, ensure that decontamination and disposal procedures are followed.
- Maintain the availability of required safety equipment.
- Advise appropriate health services and medical personnel of potential exposures.
- Notify emergency response personnel in the event of an emergency and coordinate emergency medical care.

The FL will record health-and-safety-related details of the project in the field logbook. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all on-site personnel

- Level of PPE worn and any other specifics regarding PPE
- Weather conditions
- Type of field work being performed

The FL will have completed the required Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training and annual updates, the 8-hour Supervisor training, medical monitoring clearance, and current first aid and cardiopulmonary resuscitation (CPR) training. Other certifications or training may be stipulated based on client or site requirements.

4.3 Site Safety and Health Officer

The SSHO (or designee) will be responsible for managing on-site health and safety activities and will provide support to the PM and FL on health and safety-related issues. The following are specific duties of the SSHO:

- Provide technical input into the design and implementation of this HASP.
- Advise on the potential for occupational exposure to project hazards, along with appropriate methods and/or controls to eliminate site hazards.
- Ensure that a hazard assessment has been performed and that the adequacy of the PPE selected was evaluated as required by 29 CFR 1910.132(d), 29 CFR 1910.134, 29 CFR 1926.25, and 29 CFR 1926.55, and is duly noted by the signatures and date appearing on the Certification Page of this document.
- Consult with the FL on matters relating to suspending site activities in the event of an emergency.
- Verify that all on-site Anchor QEA personnel and subcontractors have read and signed the HASP Acknowledgement Form.
- Verify that corrective actions resulting from deficiencies identified by audit and observations are implemented and effective.

The SSHO or designee will have completed the required OSHA 40-hour HAZWOPER training and annual updates, as well as the 8-hour Supervisor training, and will have medical monitoring clearance. In addition, the SSHO or designee will have current training in first aid and CPR.

4.4 Project Field Team

All project field team members will attend a project-specific meeting conducted by the FL concerning safety issues and project work task review before beginning work on site. All field team members, including subcontractors, must be familiar with and comply with this HASP. The field team has the responsibility to immediately report any potentially unsafe or hazardous conditions to the FL, and all members of the field team have **STOP WORK AUTHORITY**—the authority to stop or suspend work if conditions arise that pose an unacceptable health and safety risk to the field team or environment, or if conditions arise that warrant modifications to this HASP. It is critical that all field team members proactively communicate with the FL to identify potential unsafe conditions. The field team reports to the FL for on-site activities and is responsible for the following:

- Reviewing and maintaining a working knowledge of this HASP
- Safe completion of on-site tasks required to fulfill the Scope of Work
- Compliance with the HASP
- Attendance and participation in daily safety meetings
- Notification to the FL of existing or potential safety conditions at the site
- Reporting all incidents to the FL
- Demonstrating safety and health-conscious conduct

Per OSHA 1910.120(e)(3)(i),[2] newly assigned HAZWOPER 40-hour trained field team members must have at least 3 days of field work supervised by an experienced FL with HAZWOPER Supervisor training. It is the responsibility of the PM to identify such "short service" personnel and ensure that their supervised field experience occurs (or has occurred) and is documented in the project field notes and on the Daily Safety Briefing form (Attachment A).

4.5 Director of Health and Safety

The Director of Health and Safety (or designee) will be responsible for managing on-site health and safety activities and will provide support to the PM and FL on health and safety-related issues. The following are specific duties of the Director of Health and Safety:

- Providing technical input into the design and implementation of this HASP
- Advising on the potential for occupational exposure to project hazards, along with appropriate methods and/or controls to eliminate site hazards
- Verifying that a hazard assessment has been performed and that the adequacy of the PPE selected was evaluated as required by 29 CFR 1910.132(d), 29 CFR 1910.134, 29 CFR 1926.25, and 29 CFR 1926.55, and is duly noted by the signatures and date appearing on the Certification Page of this document
- Consulting with the FL on matters relating to suspending site activities in the event of an emergency
- Verifying that all on-site Anchor QEA personnel and subcontractors have read and signed the HASP Acknowledgement Form

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[2] "General site workers (such as equipment operators, general laborers and supervisory personnel) engaged in hazardous substance removal or other activities which expose or potentially expose workers to hazardous substances and health hazards shall receive a minimum of 40 hours of instruction off the site, and a minimum of three days actual field experience under the direct supervision of a trained experienced supervisor."

- Verifying that corrective actions resulting from deficiencies identified by audit and observations are implemented and effective

The Director or designee will have completed the required OSHA 40-hour HAZWOPER training and annual updates as well as the 8-hour Supervisor training (or a minimum of 5 years of supervisory experience).

5 Project-Specific Requirements

This section provides activity-specific levels of protection and air monitoring requirements to be used on this site based on the Scope of Work and the chemicals of concern (COCs).

5.1 Activity-Specific Level of Protection Requirements

Refer to Section 10 for general requirements for PPE. Level D is the minimum acceptable level for most sites. An upgrade to Modified Level D occurs when there is a possibility that contaminated media can come in contact with the skin or work uniform. An upgrade to Level C occurs when there is a potential for exposure to airborne COCs (i.e., if the results of air monitoring reveal that action levels have been exceeded). Hearing protection must be worn when there are high noise levels. Site personnel must maintain proficiency in the use and care of PPE that is to be worn.

Table 5-1 describes the specific means of protection needed for each identified work activity.

5.2 Project Air Monitoring Requirements

Refer to Section 11 of this plan for general requirements for air monitoring at the project site, including information on air monitoring equipment. Upgrade from Level D and/or Modified Level D to Level C when the results of air monitoring reveals that action levels have been exceeded.

Table 5-2 describes the specific air monitoring required for each identified work activity.

Table 5-1
Project Job Tasks and Required PPE

Job Tasks		PPE Requirements
- Field activities on shore or on vessel with no anticipated direct contact with soils, sediments, sheens, or decontamination chemicals, including deploying instrumentation	☒	Standard work uniform/coveralls
	☒	Work boots with safety toe conforming to ASTM International (ASTM) F2412-2413 (above ankle height with outsoles designed to prevent or resist punctures, slips, and falls; defined heels; and composite or steel toes)
	☒	Traffic safety vest conforming to American National Standards Institute (ANSI) 107 (e.g., Class I or II) for onshore work.
	☐	Chemical-resistant clothing <u>check appropriate garments</u>: ☐ One-piece coverall ☐ Disposable chemical coveralls ☐ Bib-style overalls and jacket with hood ☐ Hooded one- or two-piece chemical splash suit ☐ Chemical-resistant hood and apron **Fabric Type**: Tyvek NOTE: Thick rain pants and coveralls may be substituted for coated Tyvek if sediments are not obviously contaminated with polycyclic aromatic hydrocarbons (PAHs) or related petroleum products. Rain slickers cannot be effectively decontaminated of tar/petroleum contamination.
	☐	Disposable inner gloves (latex or equivalent "surgical")
	☐	Disposable chemical-resistant outer gloves **Material Type**: Nitrile
	☐	Chemical-resistant boots with safety toe conforming to ASTM F2412-05/ASTM F2413-05 or disposable boot covers for safety toe/work boots **Material Type**: Rubber or leather
	☐	Puncture-resistant shanks in safety shoes conforming to ASTM F2412-05/ASTM F2413-05
	☐	Metatarsal guards conforming to ASTM F2412-05/ASTM F2413-05
	☐	Sleeves to be duct-taped over gloves and pants to be duct-taped over boots
	☐	Splash-proof safety goggles
	☒	Safety glasses conforming to ANSI/International Safety Equipment Association (ISEA) Z87.1 with permanently installed side shields
	☒	Hard hat (if overhead hazards exist) conforming to ANSI Z89
	☐	Hard hat with face shield
	☒	Hearing protectors (**REQUIRED** if site noise levels are greater than 85 decibels [dB] based on an 8-hour time-weighted average [TWA]). **Type**: Foam
	☐	Two-way radio communication (intrinsically safe, if explosive atmosphere is a potential)

Job Tasks		PPE Requirements
	☒	High-visibility, U.S. Coast Guard (USCG)-approved personal flotation device (PFD) (if working on any water vessel or without fall protection within 10 feet of water)
	☒	USCG-approved float coat and bib-overalls (e.g., full two-piece “Mustang” survival suit or similar) or one-piece survival suit if combined air and water temperature is below 90°F
	☐	Half-face air-purifying respirator (OSHA/National Institute for Occupational Safety and Health [NIOSH]-approved)
	☐	Full-face air-purifying respirator (OSHA/NIOSH-approved)
	☐	**Type of Cartridges to be Used**: ☐ **OV or** ☐ **OV/high-efficiency particulate air (HEPA) (if samples are dry)**
• Sampling or investigation activities on land or on vessel (i.e., drilling/coring) with reasonably anticipated contact with soils, sediments, or sheens containing COCs or with decontamination chemicals	☒	Standard work uniform/coveralls
	☒	Work boots with safety toe conforming to ASTM F2412-2413 (above ankle height with outsoles designed to prevent or resist punctures, slips, and falls; defined heels; and composite or steel toes)
	☒	Traffic safety vest conforming to ANSI 107 (e.g., Class I or II) for onshore work.
	☒	Chemical-resistant clothing <u>check appropriate garments</u>: ☐ One-piece coverall ☒ Disposable chemical coveralls ☐ Bib-style overalls and jacket with hood ☐ Hooded one- or two-piece chemical splash suit ☐ Chemical-resistant hood and apron **Fabric Type**: Tyvek NOTE: Thick rain pants and coveralls may be substituted for coated Tyvek if sediments are not obviously contaminated with PAHs or related petroleum products. Rain slickers cannot be effectively decontaminated of tar/petroleum contamination.
	☒	Disposable inner gloves (latex or equivalent “surgical”)
	☒	Disposable chemical-resistant outer gloves **Material Type**: Nitrile
	☐	Chemical-resistant boots with safety toe and steel shank conforming to ASTM F2412-05/ASTM F2413-05 or disposable boot covers for safety toe/work boots **Material Type**: Rubber or leather
	☐	Puncture-resistant shanks in safety shoes conforming to ASTM F2412-05/ASTM F2413-05
	☐	Metatarsal guards conforming to ASTM F2412-05/ASTM F2413-05
	☐	Sleeves to be duct-taped over gloves and pants to be duct-taped over boots

Job Tasks		PPE Requirements
	☐	Splash-proof safety goggles
	☒	Safety glasses conforming to ANSI/ISEA Z87.1 with permanently installed side shields
	☒	Hard hat (if overhead hazards exist) conforming to ANSI Z89
	☐	Hard hat with face shield
	☒	Hearing protectors (**REQUIRED** if site noise levels are greater than 85 dB based on an 8-hour TWA). **Type:** Foam
	☐	Two-way radio communication (intrinsically safe, if explosive atmosphere is a potential)
	☒	High-visibility, USCG-approved PFD (if working on any water vessel or without fall protection within 10 feet of water)
	☒	USCG-approved float coat and bib-overalls (e.g., full two-piece “Mustang” survival suit or similar) or one-piece survival suit if combined air and water temperature is below 90°F
	☐	Half-face air-purifying respirator (OSHA/NIOSH-approved)
	☐	Full-face air-purifying respirator (OSHA/NIOSH-approved)
	☐	**Type of Cartridges to be Used:** ☐ **OV or** ☐ **OV/HEPA (if samples are dry)**

Table 5-2
Project Air Monitoring Requirements

Instrument*	Job Tasks/Functions	Measurement	Monitoring Schedule[3]	Actions[1]
PID (10.6*eV lamp) – Measures Total OVs	Conduct air monitoring for VOCs during activities where contaminated media are present and/or when potentially contaminated media is disturbed. Make sure that a background reading is taken before the start of activities and periodically thereafter.	0 to 1 ppm sustained above background in breathing zone	Periodically (every 15-30 minutes)	Acceptable; continue work.
		>1 to 10 ppm sustained above background	Periodically (every 15 minutes)	Stop work if sustained readings for longer than 2 minutes.[2] Institute engineering controls. If concentrations decrease to below 1 ppm above background, continue work. If concentrations above 1 ppm persist, upgrade to Level C protection.[4] Monitor for benzene and vinyl chloride using colorimetric detector tubes. Continue working with respiratory protection if colorimetric detector tubes indicate less than 1 ppm for benzene and/or vinyl chloride. Leave the work area if colorimetric tubes indicate > 1 ppm in the employee's breathing zone; contact PM for further guidance.
		>10 ppm sustained above background in breathing zone		Stop work required.[2] Leave work area and contact PM and Director of Health and Safety for guidance.

Instrument*	Job Tasks/Functions	Measurement	Monitoring Schedule[3]	Actions[1]
Dust Monitor (respirable fraction)	Conduct monitoring when dusty conditions are encountered in areas that contain dry, potentially contaminated media and/or when dry, potentially contaminated media is disturbed. Monitor in employee breathing zones and general areas. Determine if potentially contaminated materials are migrating off site. Monitor in the workers' breathing zone. Dust concentration action levels are based on downwind minus upwind measurements.	< 0.1 mg/m^3 sustained above background in breathing zone	Initially and every 15 minutes while conditions persist	Acceptable; continue work.
		≥0.1 mg/m^3, < 1.0 mg/m^{3}sustained above background in breathing zone	Continuously	Initiate wetting work area to control dusts.
		≥ 1.0 mg/m^3, ≤ 5.0 mg/m^3 sustained above background in breathing zone	Continuously	Upgrade to Level C.[4]
		≥ 5mg/m^3 sustained above background in breathing zone	Continuous for one minute	Stop work required.[4] Leave work area and contact PM and Director of Health and Safety for guidance.
Hydrogen Cyanide Monitor	Conduct air monitoring for hydrogen cyanide during activities where contaminated media are present and/or when potentially contaminated media is disturbed. Monitor in the workers' breathing zone.	0 to 4 ppm sustained hydrogen cyanide	Periodically (every 15 minutes)	Acceptable; continue work.
		> 4 ppm sustained hydrogen cyanide	Continuously	Stop work required.[2] Leave work area and contact PM and Director of Health and Safety for guidance.
H_2S	Conduct air monitoring for H_2S during activities where H_2S could be present.	<5ppm	Continuous monitoring while in the work area	Acceptable, continue operations.
		>5ppm		Stop work and leave the area immediately; this atmosphere is extremely flammable. Notify PM or Director of Health and Safety for guidance.

Notes:

* Instruments must be calibrated according to manufacturer's recommendations.

1. For VOCs, a sustained reading for greater than 2 minutes in excess of the action level will trigger a protective measure.
2. Contact with the SSHO and PM must be made prior to continuance of work. A hazard review must be conducted before proceeding with work. Corrective actions may include temporary work stoppage to allow vapors to dissipate, and then returning to work if air monitoring data permits.
3. Monitoring frequency is from the beginning of each task and at specified intervals thereafter, or when detectable contamination is encountered (as indicated by strong, sustained odor, visual evidence of product, or petroleum-discolored soils).
4. Contact the PM for quantitative respiratory protection fit testing and air purifying cartridge change-out requirements.

6 Risk Analysis and Control

The following sections discuss the potential health and safety hazards associated with the field tasks described in the Scope of Work. Controls of these hazards are addressed through the mechanical and physical control measures, use of PPE, monitoring, training, decontamination, emergency response, and safety procedures.

Significant changes in the Scope of Work covered by this HASP must be communicated to the PM and SSHO, and a modification to this HASP must be created as needed (see Section 1.1). Any task conducted beyond those identified in the Scope of Work and this HASP must be evaluated using the Job Safety Analysis (JSA) process prior to conducting the work.

6.1 Job Safety Analysis

Anchor QEA work tasks have been evaluated for their hazards, and JSA documents have been developed that detail the chemical, physical, and biological hazards associated with these tasks, along with the control measures (e.g., engineering controls, administrative controls, and/or PPE) that will be used to ensure that these tasks are conducted in a safe manner.

The PM and FL are responsible for identifying work tasks and project site conditions that are beyond the previously developed JSA documents and for communicating such information to the SSHO. The SSHO will provide support, as needed, to the PM and/or the FL, who will have primary responsibility to develop project-specific JSAs.

The contents of the JSA documents shall be communicated to project personnel during the site orientation meeting and during daily safety meetings when conducting work where the specific JSAs are applicable.

JSA documents applicable to this project are located in Attachment B and include the following field tasks:

- Field activities (AQJSA001)
- Sediment sampling (AQJSA002)
- Drilling (AQJSA005)
- Boating activities (AQJSA003)
- Decontamination activities (AQJSA004)
- Motor vehicle operation (AQJSA006)
- Sample and laboratory glassware handling (AQJSA009)
- Investigation-derived waste management (AQJSA010)

6.1.1 Augmented Job Safety Analysis Process

If significant work tasks are identified during the course of the project that were not previously addressed in the JSA documentation supplied in Attachment B, then a task-specific JSA document must be developed at the project site prior to conducting the work. The PM and/or FL shall develop this document(s) with input from the SSHO, as needed, and this HASP will be modified to include the JSA document (see Section 1.1 for HASP modification procedures). Project personnel shall be trained on the contents of the developed task-specific JSA prior to its implementation. A copy of the task-specific JSA form used in this process is supplied in Attachment B of this HASP.

6.2 Exposure Routes

Possible routes of exposure to the chemicals potentially encountered on this project include inhalation, dermal contact, and ingestion of dust, mist, gas, vapor, or liquid. Exposure will be minimized by using safe work practices and by wearing the appropriate PPE. A further discussion of PPE requirements is presented in Section 10.

6.2.1 Inhalation

Inhalation of particulates, dust, mist, gas, or vapor during field activities is possible. Whenever possible, work activities will be oriented so that personnel are upwind of the sampling location. An organic vapor monitor (OVM) may be used to monitor ambient air and the breathing zone within the work area for organic compounds. Section 5.2 describes potential OVM action levels and response procedures.

6.2.2 Dermal Contact

Dermal contact with potentially contaminated soil, sediment, or water during field activities is possible. Direct contact will be minimized by using appropriate PPE and decontamination procedures.

6.2.3 Ingestion

Direct ingestion of contaminants can occur by inhaling airborne dust, mist, or vapors, or by swallowing contaminants trapped in the upper respiratory tract. Indirect ingestion can occur by introducing the contaminants into the mouth by way of food, tobacco, fingers, or other carriers. Although ingestion of contaminants can occur, proper hygiene, decontamination, and contamination reduction procedures should reduce the probability of this route of exposure.

6.3 Chemicals of Concern Profile

Table 6-1 provides a summary profile for the COCs for this project. As available, this profile is based on recent site history and site characterization information. For more detailed and specific information, always refer to the Safety Data Sheet (SDS) or equivalent information for the chemical (see Attachment C).

Table 6-1
Chemicals of Concern Profile

Chemical	Exposure Routes	Symptoms	Target Organs	Occupational Exposure Limits	Odor Threshold (ppm)	LEL (%)	Ionization Potential (eV)
Coal tar pitch volatiles (as benzo(a)pyrene) CAS# 65996-93-2	Inhalation, skin and/or eye contact	Dermatitis, bronchitis; potential occupational carcinogen	Respiratory system, skin, bladder, kidneys	NIOSH REL 0.1 mg/m^3	Various	Various	Various
VOCs (as benzene) CAS# 71-43-2	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; potential occupational carcinogen	Eyes, skin, respiratory system, blood, central nervous system, bone marrow	NIOSH REL 0.1 ppm; Short Term 1 ppm	8.65	1.2	9.24
Metals (as lead) CAS# 7439-92-1	Inhalation, ingestion, skin and/or eye contact	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension	Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival tissue	OSHA PEL 0.05 mg/m^3	N/A	N/A	N/A
Cyanide (as hydrogen cyanide) CAS# 74-90-8	Inhalation, skin absorption, ingestion, skin and/or eye contact	Asphyxia; lassitude (weakness, exhaustion), headache, confusion; nausea, vomiting; increased rate and depth of respiration or respiration slow and gasping; thyroid, blood changes	Central nervous system, cardiovascular system, thyroid, blood	ACGIH TLV-Ceiling 4.7 ppm	0.603	5.6	13.60
Hydrogen sulfide CAS# 7783-06-4	Inhalation, skin and/or eye contact	Irritation eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite	Eyes, respiratory system, central nervous system	1 ppm TWA ACGIH TLV; 5 ppm STEL ACGIH TLV; 10 ppm Ceiling Limit (NIOSH)	0.01 to 1.5	4.0	10.46

Note:
Sources: https://www.cdc.gov/niosh/npg/default.html https://multimedia.3m.com/mws/media/639110O/3m-respirator-selection-guide.pdf and https://www.osha.gov/SLTC/hydrogensulfide/hazards.html

7 Site Control and Communications

The primary purposes for site controls are to establish the hazardous area perimeter, reduce migration of contaminants into clean areas, and prevent unauthorized access or exposure to hazardous materials by site personnel and the public. Site control is especially important in emergency situations.

7.1 General Site Control Safety Procedures

The following standard safe work practices apply to all Anchor QEA site personnel and subcontractors and shall be discussed in the safety briefing prior to initiating work on the site:

- Eating, drinking, chewing gum or tobacco, and smoking are prohibited on site except in designated areas.
- Hands and faces must be washed upon leaving the work area and before eating, drinking, chewing gum or tobacco, and smoking.
- A buddy system will be used. Radio, cell phone, or hand signals will be established to maintain communication.
- During site operations, each worker will consider himself/herself as a safety backup to his/her partner.
- Visual contact will be maintained between buddies on site when performing potentially hazardous duties.
- No personnel will be admitted to the site without the proper safety equipment, training, and (if required) medical surveillance certification.
- All personnel must comply with established safety procedures. Any staff member who does not comply with safety policy as established in this HASP may be subject to corrective action, potentially including but not limited to, being reprimanded or immediate dismissal.
- Proper decontamination procedures must be followed before leaving a contaminated work area.

7.2 Work Area Access Control

If work is performed in public areas, the following precautions shall be taken to protect both the site personnel and the public. Access control to the work area will be accomplished using a combination of the following devices and/or methods:

- Fences and/or barricades
- Traffic control devices and/or use of flaggers
- Caution tape
- Other methods to keep the site secure and provide a visual barrier to help keep unauthorized personnel from entering the site and active work areas

7.3 Hazardous Waste Site Work Control Procedures

To prevent contamination from migrating from personnel and equipment, work areas will be clearly specified as an Exclusion Zone/Hot Zone (EZ), Contamination Reduction Zone (CRZ), or Support Zone/Clean Zone (SZ) prior to beginning operations. Each work area will be clearly identified using signs or physical barriers. At the end of each workday, the site should be secured and/or guarded to prevent unauthorized entry.

Site work zones will include:

- **Exclusion Zone/Hot Zone (EZ).** The EZ will be the "hot zone" or contaminated area inside the site perimeter (or sample collection area of boat). The EZ is the defined area where potential respiratory and/or health hazards exist. All personnel entering the EZ must use the required PPE, as set forth in this HASP, and meet the appropriate training and medical clearance. Entry to and exit from this zone will be made through a designated point. Appropriate warning signs to identify the EZ should be posted (e.g., DANGER, AUTHORIZED PERSONNEL ONLY, PROTECTIVE EQUIPMENT REQUIRED BEYOND THIS POINT). Personnel and equipment decontamination must be performed upon exiting the EZ.
- **Contamination Reduction Zone (CRZ).** The CRZ, also known as the "warm zone," is a transitional zone between the EZ and the SZ (also known as the "cold zone" or "clean zone"). The CRZ provides a location for removal and decontamination of PPE and tools leaving the EZ. A separate decontamination area will be established for heavy equipment. All personnel and equipment must exit via the CRZ. If the CRZ is compromised at any time, a new CRZ will be established.
- **Support Zone/Clean Zone (SZ).** This uncontaminated zone will be the area outside the EZ and CRZ and within the geographic perimeters of the site (including boat and processing areas). The SZ is used for support personnel; staging materials; parking vehicles; office, laboratory, and sanitation facilities; and receiving deliveries. Personnel entering this zone may include delivery personnel, visitors, security guards, and others who will not necessarily be permitted in the EZ or CRZ.

A log of all personnel visiting, entering, or working on the site shall be maintained by the FL. No visitor will be allowed in the EZ without showing proof of training and medical certification, per 29 CFR 1910.120(e),(f) (and 29 CFR 1926.1101(k)(9),(m) if appropriate). Visitors will attend a site orientation given by the FL and sign the HASP.

7.4 Site-Specific Work Zone Requirements

This section contains guidelines for maintaining safe conditions when working from a boat or at an excavation site.

7.4.1 Sediment Sampling Work Zones

This subsection contains guidelines concerning health and safety aboard marine sampling vessels. The vessel captain, onshore coring operator, and the FL will delineate the boundaries of the work zones aboard the vessel and will inform the field team of the arrangement. The purpose of the zones is to limit the migration of sample material out of the zones and to restrict access to active work areas.

Two work zones will be observed aboard the vessel. One will encompass the "moonhole" of the vessel where the samplers will be deployed and recovered. Only the coring team may enter this zone unless assistance is required by other personnel. The second work zone will be a sample processing area on the vessel. The contractor team will deliver sediment core tubes to this zone and open them. Anchor QEA personnel will log and process the sediment cores either on the boat or on shore.

Both the collection and processing areas on the vessel and onshore will have a SZ outside the CRZ to stage clean equipment, don PPE, take rest breaks, or perform any other site activities that do not involve potentially contaminated materials.

7.4.1.1 Vessel Decontamination Area

A station will be set up for decontaminating sample processing equipment and personnel gear such as boots or PPE. The station will have the buckets, brushes, soapy water, rinse water, or wipes necessary to perform decontamination operations. Plastic bags will be provided for expendable and disposable materials. Decontamination fluids will be stored in labeled, sealable containers and will be properly disposed of.

7.4.1.2 Access Control

Security and control of access to the sampling vessel and onshore area will be the responsibility of the captain and FL. Additional security measures may be placed into effect by the client, or as required by national security threat levels determined by the federal government. Access to the vessel and onshore areas will only be granted to necessary project personnel and authorized visitors. Any security or access control problems will be reported to the client or appropriate authorities.

7.4.1.3 Safety Equipment

In addition to PPE that will be worn by shipboard personnel, basic emergency and first aid equipment will also be provided. Equipment will include:

- U.S. Coast Guard (USCG)-approved personal flotation devices (PFDs)
- First aid kit adequate for the number of personnel
- Emergency eyewash

Anchor QEA and/or subconsultants will provide this equipment, which must be at the location(s) where field activities are being performed. Equipment will be checked daily to ensure its readiness for use.

7.5 Field Communications

Communications between all Anchor QEA employees and subcontractors at the work site can be verbal and/or non-verbal. Verbal communication can be affected by the on-site background noise and various PPE. See Table 7-1 for a list of the types of communication methods and equipment to use, depending on site conditions. Communication equipment must be checked daily to ensure proper operation. All project personnel must be initially briefed on the communication methods prior to starting work; communication methods should be reviewed in daily safety meetings.

Table 7-1
Field Communication Methods

Type of Communication	Communication Device	Signal
Emergency notification	On-site telephone or cellular telephone	Initiate phone call using applicable emergency numbers
Emergency notification among site personnel	Two-way radio or cellular telephone	Initiate radio communication with Code Red message
Hailing site personnel for non-emergency	Compressed air horn	One long blast, one short blast
Hailing site personnel for emergency evacuation	Compressed air horn	Three long, continuous blasts
Hailing site personnel for distress, need help	Visual	Arms waved in circle over head
Hailing site personnel for emergency evacuation	Visual	Arms waved in criss-cross over head
Contaminated air/strong odor	Visual	Hands clutching throat
Break, lunch, end of day	Visual	Two hands together, break apart

8 Decontamination Procedures and Practices

8.1 Minimization of Contamination

The following measures will be observed to prevent or minimize exposure to potentially contaminated materials:

Personnel

- Do not walk through spilled materials.
- Do not handle, touch, or smell sample media directly.
- Make sure PPE has no cuts or tears prior to use.
- Protect and cover any skin injuries.
- Stay upwind of airborne dusts and vapors.
- Do not eat, drink, chew tobacco, or smoke in the work zones.

Sampling Equipment and Vehicles/Vessels

- Use care to avoid getting sampled media on the outside of sample containers.
- If necessary, bag sample containers before filling with sampled media.
- Place clean equipment on a plastic sheet to avoid direct contact with contaminated media.
- Keep contaminated equipment and tools separate from clean equipment and tools.
- Fill sample containers over a plastic tub to contain spillage.
- Clean up spilled material immediately to avoid tracking around the vehicle/vessel.

8.2 Decontamination Equipment

All vehicles, vessels, and equipment that have entered potentially contaminated areas will be visually inspected and, if necessary, decontaminated prior to leaving the area. If the level of vehicle contamination is low, decontamination may be limited to rinsing tires and wheel wells with an appropriate detergent and water. If the vehicle is significantly contaminated, steam cleaning or pressure washing may be required. Tools will be cleaned in the same manner. Rinsate from all decontamination activities will be collected for proper disposal. Decontamination of equipment and tools will take place within the CRZ.

The following supplies will be available to perform decontamination activities:

- Wash and rinse buckets
- Tap water and phosphate-free detergent
- Scrub brushes
- Distilled/deionized water
- Deck pump with pressurized freshwater hose (aboard the vessel)
- Pressure washer/steam cleaner, if appropriate

- Paper towels and plastic garbage bags

8.3 Personnel Decontamination

The FL will ensure that all site personnel are familiar with personnel decontamination procedures as listed below. All personnel wearing PPE in a work area (EZ) must undergo decontamination prior to entering the SZ. Personnel will perform the following decontamination procedures:

- Wash and rinse outer gloves and boots in portable buckets to remove gross contamination.
- If suit is heavily soiled, rinse it off.
- Remove outer gloves; inspect and discard if damaged. Leave inner gloves on. Personnel will remove their outer garment and gloves, dispose of them, and properly label container or drum. Personnel will then decontaminate their hard hats and boots with an aqueous solution of detergent or other appropriate cleaning solution. These items then will be hand-carried to the next station. Remove inner gloves.
- Thoroughly wash hands and face before leaving CRZ.
- Sanitize respirators and place in a clean plastic bag.

8.4 Sampling and Processing Equipment Decontamination

To prevent sample cross-contamination, sampling and processing equipment in contact with soil, sediment, or water samples will undergo the following decontamination procedures when work is completed in the CRZ and prior to additional use:

1. Rinse with potable water and wash with scrub brush.
2. Wash with phosphate-free detergent (Alconox®).
3. Visually inspect the sampler and repeat the scrub and rinse step, if necessary. If scrubbing and rinsing with Alconox® is insufficient to remove visually observable tar-related contamination on equipment, the equipment will be scrubbed and rinsed using hexane (or similar type solution) until all visual signs of contamination are absent.
4. Rinse external sampling equipment with potable water three times prior to use. Rinse homogenizing equipment once with potable water and three times with distilled water prior to and between sample processing.

8.5 Handling of Investigation-Derived Waste

All remaining soil or sediment, fluids used for decontamination of sampling equipment, and sample collection disposable wastes (e.g., gloves, paper towels, foil, or others) will be placed into appropriate labeled containers and staged on site for disposal.

8.5.1 Disposable PPE

Disposable PPE may include Tyvek suits, inner latex gloves, and respirator cartridges. Dispose of PPE according to the requirements of the client and state and federal agencies.

8.5.2 Non-Disposable PPE

Non-disposable PPE may include respirators and boots and gloves. When decontaminating respirators, observe the following practices and procedures:

- Wipe out the respirator with a disinfecting pad prior to donning.
- Decontaminate the respirator on site at the close of each day with an approved sanitizing solution.

When decontaminating boots and gloves, observe the following practices and procedures:

- Decontaminate the boots or gloves outside with a solution of detergent and water; rinse with water prior to leaving the site.
- Protect the boots or gloves from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.

8.6 Sanitizing of PPE

Respirators, reusable protective clothing, and other personal articles must not only be decontaminated before being reused, but also sanitized. The insides of masks and clothing become soiled due to exhalation, body oils, and perspiration. Manufacturer's instructions should be used to sanitize respirator masks. If practical, reusable protective clothing should be machine-washed after a thorough decontamination; otherwise, it must be cleaned by hand. Follow the requirements in the Coronavirus Disease 2019 Management Plan (Attachment E) regarding sharing PPE and requirements for disinfection using EPA-registered cleaners for COVID-19.

8.7 Emergency Personnel Decontamination

Personnel with medical problems or injuries may also require decontamination. There is the possibility that the decontamination may aggravate or cause more serious health effects. If prompt lifesaving, first aid, and medical treatment are required, decontamination procedures will be omitted. In either case, a member of the site management team will accompany contaminated personnel to the medical facility to advise on matters involving decontamination.

8.8 Containment of Decontamination Fluids

As necessary, spill control measures will be used to contain contaminated runoff that may enter into clean areas. Use plastic sheeting, hay bales, or install a spill control system to prevent spills and contain contaminated water.

8.9 Pressure Washing

The following procedure is required when using high-pressure washing equipment for decontamination purposes:

- Wear modified Level D protection, including a face shield and safety goggles.
- Verify that other personnel are out of the area prior to decontamination.
- Secure the area around the decontamination pad with cones, caution tape, or barricades.
- Verify that safe work practices and precautions are taken to minimize the potential for physical injury from high-pressure water spray. Follow the manufacturer's operating instructions.
- The pressure washer wand must be equipped with a safety release handle.
- Verify that the area is clean after equipment is decontaminated. Barricades, cones, or caution tape must be left in place and secured at all times.

9 Health and Safety Training and Informational Programs

This section describes the health and safety training and informational programs with which Anchor QEA project site personnel must comply. All certifications required in this section will be kept on internal file.

9.1 Initial Project Site Orientation

Work on all Anchor QEA project sites requires participation in an initial health and safety orientation presented by the PM or FL that will consist of, at a minimum, the following topics:

- A review of the contents of this HASP, including the Scope of Work and associated site hazards and control methods and procedures.
- Provisions of this plan are mandatory for all Anchor QEA personnel assigned to the project.
- Anchor QEA subcontractors are also expected to follow the provisions of this plan unless they have their own HASP that covers their specific activities related to this project and includes the minimum requirements of this HASP.
- All visitors to the work site will also be required to abide by the requirements of this plan.
- Personnel assigned to perform work at the project site, working under the provisions of this HASP, will be required to read the plan and must sign the Health and Safety Plan Acknowledgement Form to confirm that they understand and agree to abide by the provisions of this plan. Personnel not directly affiliated with the project (i.e., visitors) may also be required to sign the Liability Waiver.

9.2 Daily Safety Meetings

Daily safety meetings (“tailgate meetings”) make accident prevention a top priority for everyone and reinforce awareness of important accident-prevention techniques. The following daily safety meeting procedures and practices are required:

- Daily safety meetings will be held each morning prior to conducting site activities.
- The Daily Safety Briefing form in Attachment A will be used to document each meeting.
- Copies of the completed Daily Safety Briefing forms will be maintained on site during the course of the project.

9.3 End-of-Day Wellness Checks

Similar to the daily safety meetings, field staff will gather at the end of the day to verify group health and wellness and discuss any near misses that occurred that day. The wellness checks will be recorded on that day’s Daily Safety Briefing form.

9.4 Hazardous Waste Operations Training

Personnel working on project sites that present a potential exposure to hazardous wastes or other hazardous substances shall be trained in accordance with the requirements of the 29 CFR 1910.120 (HAZWOPER) regulation. Training requirements will consist of the following:

- Field personnel must complete a minimum of 40 hours of hazardous waste activity instruction.
- Field personnel must complete a minimum of 3 days of supervised field instruction.
- Field personnel assigned to the site will also have received 8 hours of refresher training if the time lapse since their previous training has exceeded 1 year.
- On-site managers and supervisors directly responsible for employees engaged in hazardous waste operations will receive an additional 8 hours of supervisory training.
- Field personnel shall be current in first aid/CPR training offered by the American Red Cross or equivalent.
- Other training may be required depending on the task to be performed (e.g., confined space, excavation/trenching, underground storage tank removal, fall protection, respiratory protection, and hazard communication).
- As part of annual Anchor QEA HAZWOPER refresher training staff will receive training on Hazard Communications.
- For this project staff will review all SDSs associated with this project as part of the review and acknowledgement of this HASP. Additionally, all project specific SDSs (including COCs) will be overviewed with staff during the initial daily safety briefing.
- HAZWOPER, first aid/CPR, and other applicable certificates for field personnel are included in Attachment D.

9.5 Transportation Worker Identification Credential

All Anchor QEA field personnel will maintain current Transportation Worker Identification Credential status, pursuant to the Maritime Transportation Security Act of 2002, unless this requirement is waived specifically in writing by relevant property owners.

9.6 Hazard Communication Program

The purpose of hazard communication (Employee Right-to-Know) is to ensure that the hazards of all chemicals located at the field project site are communicated to all Anchor QEA personnel and subcontractors according to 29 CFR 1926.59. Refer to the Anchor QEA Hazard Communication Program document for additional information.

Every container of hazardous materials must be labeled by the manufacturer, who must also provide an SDS upon initial order of the product and upon request thereafter. The actual format may differ from company to company (e.g., National Fire Protection Association, Hazardous Material

Information System, or other), but the labels must contain similar types of information. Maintain manufacturer labels if possible. The label may use words or symbols to communicate the following:

- Introduction
- Hazard(s) identification
- Composition/information on ingredients
- First-aid measures
- Fire-fighting measures
- Accidental release response measures
- Handling and storage
- Exposure controls/personal protection
- Physical and chemical properties
- Stability and reactivity properties
- Toxicological properties
- Ecological properties
- Disposal considerations
- Transport considerations
- Regulatory information
- Other information, including at a minimum, label preparation or last revision date

SDSs for all chemicals brought onto the site or anticipated to be used on site shall be provided in Attachment C of this HASP. These SDSs shall be readily available for reference by site personnel and emergency response personnel.

Hazardous materials received without proper labels shall be set aside and not distributed for use until properly labeled.

If a hazardous chemical is transferred into a portable container (approved safety can), even if for immediate use only, the contents (e.g., acetone or gasoline) of the portable container must be identified.

9.7 Respiratory Protection Training

Anchor QEA employees who use respiratory protection must be trained in accordance with Anchor QEA's RPP, as required by 29 CFR 1910.134. This training includes the following:

- Medical evaluations of employees required to use respirators
- Fit testing procedures for tight-fitting respirators
- Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations

- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators
- Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations
- Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance

See Section 10.2 for additional information.

10 General PPE Requirements

The minimum level of PPE should be selected according to the hazards that may be encountered during site activities in accordance with established U.S. Environmental Protection Agency (EPA) levels of protection (D and C). Only PPE that meets American National Standards Institute (ANSI) standards shall be worn. Site personnel must maintain proficiency in the use and care of PPE. Damaged or defective PPE must be replaced and may not be used. Anchor QEA will provide all necessary PPE for its employees as described in this HASP.

Refer to Section 5 for site-specific job task and level-of-protection requirements.

10.1 Minimum Requirements – Level D Protection

The minimum level of protection on project sites will be Level D protection, which consists of the following equipment:

- Standard work uniform/coveralls
- Work boots with safety toe conforming to ASTM International (ASTM) F2412-05/ASTM F2413-05
- Approved safety glasses or goggles (meets ANSI Z87.1 – 2010 requirements for eye protection)
- Hard hat (meets ANSI Z89.1 – 1986 requirements for head protection)
- Traffic safety vest
- Hearing protection when there are high noise levels

Level D protection will be used only when:

- The atmosphere contains no known hazards
- Work functions preclude splashes, immersions, or the potential for unexpected inhalation of, or contact with, hazardous concentrations of chemicals
- Atmospheric concentrations of contaminants are less than the Permissible Exposure Limit (PEL) and/or Threshold Limit Value (TLV)

10.1.1 Modified Level D Protection Requirements

Depending on the Scope of Work and the potential hazards to be encountered, Level D protection shall be modified to include additional protective equipment such as USCG-approved PFDs, face shields/goggles, chemical-resistant clothing, and disposable gloves of varying materials depending on the chemical substances involved. An upgrade to Modified Level D occurs when there is a possibility that contaminated media can contact the skin or work uniform, or if unique, site-specific hazards exist.

10.2 Respiratory Protection Requirements

Respiratory protection is not anticipated to be required for the Scope of Work. This section is provided for reference. If work conditions change, work will be stopped, and the Director of Health and Safety will be consulted prior to proceeding with work.

10.2.1 Level B and A Protection Requirements

An upgrade to Level B protection occurs when the results of air monitoring reveal that action levels have been exceeded (site personnel must meet training requirements). Prior to upgrading to Level B, stop work and contact the PM and/or FL and SSHO if air monitoring results exceed the Level C protection levels.

10.2.2 Respirator Fit Testing

All Anchor QEA personnel who may be required to wear an air-supplied or negative-pressure air-purifying respirator in the performance of their work duties shall be fit-tested on an annual basis. Employees who wear a respirator for more than 30 days per year shall be enrolled in a medical surveillance program as detailed in Section 13 of this HASP.

Employees shall have the opportunity to handle the respirators and wear them in normal air for a familiarity period prior to fit-testing. On each occasion that employees don a respirator for work purposes, they shall test the piece-to-face seal by use of the following positive and negative pressure tests:

- ***Positive Pressure Test:*** With the exhaust port(s) blocked, the positive pressure of slight exhalation should remain consistent for several seconds.
- ***Negative Pressure Test:*** With the intake ports blocked, the negative pressure of slight inhalation should remain constant for several seconds.

Air-purifying respirators shall not be worn when conditions prevent a seal of the respirator to the wearer. Such conditions may be the growth of a beard, sideburns, a skull cap that projects under the face piece, or temple pieces on glasses. No employee may wear a beard if it interferes with the fit of the respirator. Also, the absence of one or both dentures can seriously affect the fit of a face-piece and should be worn at all times that respirators are being used.

11 General Air Monitoring Requirements

11.1 General Requirements

In general, air monitoring shall be conducted when the possibility of hazardous atmospheres, chemical volatilization, or contaminated airborne dust exists (e.g., from intrusive activities involving contaminated soils or groundwater, developing new monitoring wells, working with wells containing known COCs, confined space entry, or others).

Air movers or other engineering controls shall be used to exhaust or dilute solvent vapors emanating from monitoring wells or hazardous atmospheres in confined spaces prior to the use of respiratory protection devices.

Site-specific air monitoring action levels are provided in Section 5.2.

Of particular note, recent land-based drilling activities encountered a subsurface vapor/gas pocket of unknown but presumably inert chemistry. If at any time vapor or gas venting is noted during drilling from a boring (e.g., hissing noise, liquid spray), work will stop immediately, the drill rig will be shut down, all staff will vacate the area, and the SSHO will be contacted before work may resume.

11.2 Real-Time Air Monitoring Equipment

As applicable, OV concentrations shall be monitored in the field with either a photoionization detector (PID) or flame ionization detector (FID). Flammable vapors and/or gasses are monitored with an oxygen/Lower Explosive Limit (O_2/LEL) real-time instrument. OV measurements are usually taken in the breathing zone of the worker while O_2/LEL measurements are taken at the point of operation (e.g., monitoring well head or auger point).

As applicable, airborne dust/particulate concentrations shall be measured using a real-time aerosol monitor (using a scattered light photometric sensing cell) when there are visible signs of potentially contaminated airborne dust. Both area and personal air monitoring readings are to be taken to characterize site activities.

As applicable, colorimetric detector tubes shall be used to monitor specific COCs such as benzene or vinyl chloride if there is a possibility that they may be present in elevated concentrations based upon the background of the project site, the Scope of Work, and conditions discovered at the site.

As applicable, other real-time air monitoring equipment, such as hydrogen cyanide meters, may be utilized depending upon the Scope of Work and COCs.

Air monitoring results shall be documented on the Daily Air Monitoring Record form (see Attachment A) or in the field logbook.

11.3 Time-Integrated Air Monitoring Equipment

Some Anchor QEA projects may require the use of time-integrated air monitoring equipment to determine employee exposures to COCs. Time-integrated air monitoring would be required if there is the possibility that employees would be exposed to concentrations of a COC that approach or exceed an established exposure limit.

Typical time-integrated sampling methods will usually involve the use of personal sampling pumps and associated filter and/or charcoal sampling media, or the use of diffusion-based sampling media. Exposed sampling media is normally sent to an accredited laboratory for analysis.

Contact the SSHO for consultation and assistance with the performance of time-integrated air monitoring activities.

11.4 Equipment Calibration and Maintenance

Calibration and maintenance of air monitoring equipment shall follow manufacturer specifications and must be documented. Recalibration and adjustment of air monitoring equipment shall be completed as site conditions and equipment operation warrant. Record all air monitoring equipment calibration and adjustment information on the Daily Air Monitoring Record form (see Attachment A) and in the field logbook.

11.5 Air Monitoring Action Levels

Air monitoring action levels have been developed that stipulate the chemical concentrations in the breathing zone that require an upgrade in level of PPE.

Air monitoring action levels are typically set at one-half of the OSHA PEL, NIOSH Recommended Exposure Limit, or the American Conference of Governmental Industrial Hygienists TLVs. The rationale for establishing action levels is based on the available data that characterize COCs in site media.

Air monitoring measurements shall generally be taken in the breathing zone of the worker most likely to have the highest exposure. Transient peaks will not automatically trigger action. Action will be taken when levels are consistently exceeded in a 5-minute period. Similarly, if chemical odors are detected that are a nuisance, bothersome, or irritating, an upgrade in respiratory protection can provide an extra level of comfort or protection when conducting site activities.

11.6 Air Monitoring Frequency Guidelines

In general, conduct periodic air monitoring when:

- It is possible that an immediately dangerous to life or health condition or a flammable atmosphere has developed (e.g., confined space entry or intrusive activities)

- There is an indication that exposures may have risen over established action levels, PELs, or published exposure levels since the last monitoring. Look for a possible rise in exposures associated with the following situations:
  - **Change in site area:** Work begins on a different section of the site.
  - **Change in on-site activity:** One operation ends and another begins.
  - **Change in contaminants:** Handling contaminants other than those first identified.
  - Visible signs of particulate exposure from intrusive activities such as drilling, boring, or excavation.
  - Perceptible chemical odors or symptoms of exposure.
  - Handling leaking drums or containers.
  - Working with obvious liquid contamination (e.g., a spill or lagoon).
  - Conduct air monitoring when the possibility of volatilization exists (such as with a new monitoring well or a well containing known COCs).

12 Health and Safety Procedures and Practices

In addition to the task-specific JSAs listed in Section 6.1 and presented in Attachment B, this section lists the health and safety procedures and practices applicable to this project. For additional information, consult with the PM.

12.1 Physical Hazards and Controls

12.1.1 General Site Activities

Observe the following general procedures and practices to prevent physical hazards:

- Legible and understandable precautionary labels shall be affixed prominently to containers of potentially contaminated soil, sediment, water, and clothing.
- No food or beverages shall be present or consumed in areas that have the potential to contain COCs and/or contaminated materials or equipment.
- No tobacco products or cosmetics shall be present or used in areas that have the potential to contain COCs and/or contaminated materials or equipment.
- An emergency eyewash unit shall be located immediately adjacent to employees who handle hazardous or corrosive materials, including decontamination fluids. All operations involving the potential for eye injury or splash must have approved eyewash units locally available capable of delivering at least 0.4 gallons per minute for at least 15 minutes.
- Personnel working within 10 feet of bodies of water shall wear USCG-approved PFDs.
- Certain project sites may have newly finished work (e.g., concrete, paving, framing, habitat reconstruction, or sediment caps) that may be damaged by unnecessary contact, or that could cause dangerous conditions for personnel (e.g., slipping, sinking, or tripping). Personnel working in or around these areas shall communicate with the PM, FL, and property owner as needed to prevent damaging new work or entering dangerous conditions.
- Generally, all on-site activities will be conducted during daylight hours. If work after dusk is planned or becomes necessary due to an emergency, adequate lighting must be provided.
- Hazardous work, such as handling hazardous materials and heavy loads and operating equipment, should not be conducted during severe storms.
- All temporary electrical power must have a ground-fault circuit interrupter (GFCI) as part of its circuit if the circuit is not part of permanent wiring. All equipment must be suitable and approved for the class of hazard present.

12.1.2 Slips, Trips, and Falls

Observe the following procedures and practices to prevent slips, trips, and falls:

- Inspect each work area for slip, trip, and fall potential prior to each work task.

- Slip, trip, and fall hazards identified must be communicated to all personnel. Hazards identified shall be corrected or labeled with warning signs to be avoided.
- All personnel must be aware of their surroundings and maintain constant communication with each other at all times.

12.1.3 Ergonomic Considerations

Certain field tasks may involve workers in fixed positions (e.g., observing subcontractor work) or performing repetitive motions over a period of time (e.g., sediment sample processing). It is important that workers self-monitor for ergonomic fatigue (e.g., soreness, tightness, stiffness, or pain in muscles) and make adjustments to work tasks, body positions, or work areas so that ergonomic stressors are minimized. Suggestions for decreasing the likelihood of ergonomic stress include the following:

- Limit fixed positions. Periodically vary standing and sitting positions, take frequent short walks, and modify observation locations when possible.
- Minimize extreme postures. Conduct work tasks using comfortable postures (particularly if the tasks are repetitive), and use tools or structures to minimize the need to hold or work with materials or access the work area.
- Limit contact stress. Be aware of soft tissue resting on hard surfaces, and limit these occurrences (e.g., use comfortable footwear, and use tools to hold materials).
- Contact the Field Mobilization Team in advance for prolonged field efforts that involve a field trailer. This group can set up field staff with a monitor, mouse, and keyboard so they are not working solely on laptops.
- Take breaks from work tasks, particularly repetitive ones.
- Consider performing stretching exercises before and during work activities, if those tasks are anticipated to be long in duration and/or strenuous.

12.1.4 Corrosive Material Handling Procedures

Corrosive materials include acids and bases. They are extremely corrosive materials with a variety of uses. Acids include hydrochloric, nitric, and sulfuric acids. Bases include sodium hydroxide. Observe the following procedures when working with corrosive materials:

- Wear gloves and eye-splash protection while using acid dispensed from a small dropper bottle during water sampling.
- Wear a full-face, air-purifying respirator equipped with combination cartridges (OV/acid gas) as well as Tyvek coveralls and nitrile gloves for large volume applications.
- Have an eyewash bottle and/or portable eyewash station on site.
- Do not add anything into a virgin chemical drum, including unused product.

- Avoid mixing strong acids and bases. Consult the SSHO for task-specific evaluation. If mixing is absolutely necessary, do it slowly. Avoid vapors or fumes that are generated.
- When diluting acids and bases, add the acid or base to water in small quantities and mix cautiously.

12.1.5 Sediment Core Sampling

Sediment and porewater samples may be collected using vibracore or other drilling equipment operated from an on-water vessel. Please see Sections 12.1.17.1 and 12.1.17.2 for additional safety information regarding working on or near water.

All operations involving the use of powered sediment coring rigs will follow generally accepted drilling/coring practices. One person will be assigned the responsibility of Lead Driller/Corer. Additional personnel will assist with equipment as needed. The Lead Driller/Corer will be responsible for operating the drilling/coring rig and ensuring safety.

General rules associated with drilling/coring rig operations will be as follows:

- While drilling, all non-essential personnel shall remain at a distance that is past the radius of any moving parts.
- All operators and team members will be familiar with the rig operations and will have received practical training.
- All personnel will be instructed in the use of the emergency kill switch/shutdown on the drill rig.
- No loose-fitting clothing, jewelry, or free long hair is permitted near the drilling rig or moving machinery parts.
- A first aid kit and fire extinguisher will be available at all times.
- No drilling will occur during impending electrical storms or tornadoes, or when rain, ice, snow, or wind conditions create undue potential hazards.
- Never allow “horsing around” within the vicinity of the drill rig and tool and supply storage areas, even when the drill rig is shut down.

12.1.6 Dry Ice (Solid Carbon Dioxide) Use

Dry ice (solid form of carbon dioxide) presents the following three types of hazards:

- Explosion: Due to pressurized gas produced during sublimation, dry ice can explode if stored in an airtight container.
- Suffocation: Carbon dioxide gas may create an oxygen-deficient atmosphere by displacing breathable air.
- Direct contact: Dry ice is very cold (-109°F/-78°C) and can cause severe frostbite to unprotected skin.

When using dry ice, the following precautions must be taken:

- Always handle dry ice with thermal gloves, never with bare hands.
- Avoid contact with unprotected skin at all times (e.g., hands, forearms).
- Dry ice must be stored and handled in only well-ventilated areas to prohibit creation of an oxygen-deficient atmosphere.
- Do not store dry ice in airtight containers.
- Packaging, marking, labeling, loading, and shipping/transporting samples with dry ice may be carried out only by staff who have received specific training required by the U.S. Department of Transportation (DOT). Contact Health and Safety for assistance with ensuring applicable staff are appropriately trained in accordance with DOT regulations.
- Shipping samples with dry ice must comply fully with courier requirements and those shipping must have received training.
- Dry ice is not to be transported by staff in vehicles until training is completed and the Director of Health and Safety is consulted.

12.1.7 Underground/Overhead Utility Line Contact Prevention

Observe the following underground/overhead utility line contact prevention procedures and practices:

- Prior to conducting work, the PM or FL shall ensure that all existing underground or overhead utilities in the work area are located per the state or local mark-out methods. Documentation of utility mark-out shall be completed using the Utility Contact Prevention Checklist form (see Attachment A). No excavation work is to be performed until all utility mark-outs are verified.
- The PM or FL shall conduct a site survey to search for signs of other buried or overhead utilities. The results of such surveys shall be documented on the Utility Mark-out documentation form.
- The property owner or facility operator shall be consulted on the issue of underground utilities. As-built drawings shall be reviewed, when available, to verify that underground utility locations are consistent with the utility location mark-outs. All knowledge of past and present utilities must be evaluated prior to conducting work.
- If on-site subsurface utility locations are in question, a private locating service shall be contacted to verify locations. If the investigation calls for boreholes in an area not covered by the municipal One-Call system, then a private utility locate firm shall be contacted to determine the location of other underground utilities.
- The PM shall have documented verbal contact and an agreement with the fiber optic company for all work within 50 feet of any fiber optic cables.
- **Only non-destructive excavation, such as hand digging or hydro excavation, is permitted within 3 feet of underground high voltage, product, or gas lines.** Once the line

is exposed, heavy equipment can be used, but must remain at least 3 feet from the exposed line.

- Elevated superstructures (e.g., drill rig, backhoe, scaffolding, ladders, and cranes) shall remain a distance of 10 feet away from utility lines and 20 feet away from power lines. Distance from utility lines may be adjusted by the FL depending on actual voltage of the lines.
- Overhead utility locations shall be marked with warning tape or flags where equipment has the potential for contacting overhead utilities.

Table 12-1 shows the minimum clearances required for energized overhead electrical lines.

Table 12-1
Overhead Utility Clearance Requirements

Minimum Clearance from Energized Overhead Electric Lines	
Nominal System Voltage	**Minimum Required Clearance**
0 to 50 kV	10 feet
51 to 100 kV	12 feet
101 to 200 kV	15 feet
201 to 300 kV	20 feet
301 to 500 kV	25 feet
501 to 750 kV	35 feet
751 to 1,000 kV	45 feet

Note:
Whenever equipment operations must be performed closer than 20 feet from overhead power lines, the FL must be notified. When clearance to proceed is received from the FL, the electric utility company must be contacted to turn the power off or physically insulate (protect) the lines if the operation must be performed closer to the power line than is allowed in this table. For voltages not listed on this table, add 0.4 inches per kV to obtain the safe distance between equipment and power lines.

12.1.8 Electric Safety

Observe the following procedures and practices to prevent electric shock:

- General
  - Use only appropriately trained and certified electricians to perform tasks related to electrical equipment. A good rule of thumb is to defer any task that would not normally and reasonably be completed by the average public consumer.
  - Each circuit encountered will be considered live until proven otherwise.
  - Only proper tools will be used to test circuits.
  - No wire will be touched until the circuit is determined to be de-energized.
- Extension Cords
  - All extension cords used on any project will be three-pronged.
  - All extension cords will be in good working order.

  - Each extension cord ground will be tested for continuity on at least a quarterly basis and marked to indicate when the inspection occurred.
  - Each extension cord will be visually inspected before each use.
  - If any extension cord is found in disrepair or fails the continuity test, it will be taken out of service.
  - Any extension cord that does not have the grounding pin will be taken out of service and not used.
  - Extension cords will not be used in place of fixed wiring.
  - Extension cords will not be run through holes in walls, ceilings, or floors.
  - Extension cords will not be attached to the surface of any building.
  - No extension cord will be of the "flat wire" type. Every extension cord will have each individual wire insulated and further protected by an outside cover.
  - Be sure to locate extension cords out of traffic areas or, if this is unavoidable, flag cords and protect workers from tripping over them (i.e., use barricades and tape the cord down).
  - Do not stage extension cords or powered equipment in wet areas, to the degree possible. Elevate cords, connections, and equipment out of puddles.
- Power Tools/Plug and Cord Sets
  - Any cord that is cut in a way that exposes insulation will be removed from service.
  - All tools and plug and cord sets will be tested for continuity.
  - If grounding pins are missing, the plug and cord will be removed from service.
  - Any tool or plug and cord set failing the continuity test will be removed from service.
  - All power tools will have three-pronged plugs unless double insulated.
- Ground-Fault Circuit Interrupters
  - Each 120-volt electrical wall receptacle providing power to the job site will be protected by a portable GFCI.
  - Each GFCI will be tested quarterly and marked to indicate when the inspection occurred.
  - Each 120-volt, single-phase, 15- and 20-ampere receptacle outlet, including those on generators, will have an approved GFCI.
  - GFCIs will be located in line as close to the piece of equipment as possible.
- Specific
  - If unsure if a task requires specific electrical training, err on the side of caution and contact the PM and FL prior to proceeding.
  - If subsurface work is to be performed, follow the guidelines in Section 12.1.6 and conduct utility locating prior to work and in accordance with local ordinances.
  - If lock out/tag out (LO/TO) procedures are required (i.e., de-energizing machinery or equipment so work may be performed), the equipment owner must provide LO/TO procedures and training. By default, the equipment owner should perform any LO/TO. If

  it becomes necessary for Anchor QEA personnel to perform LO/TO tasks, contact the PM and FL prior to doing so.
  - Maintain appropriate distance from overhead utilities (see Table 12-1).
  - If unexpected electrical equipment is encountered (i.e., buried wire) assume it is live, stop work, and contact the PM and FL immediately.
  - If working in enclosed or restricted areas where electrical hazards may be present, contact a licensed electrician or other suitably trained party to provide barriers, shields, or insulating materials to prevent electric shock.
  - If working in areas where electrical hazards are present, ensure that conductive clothing and jewelry is replaced with non-conductive clothing or removed.

12.1.9 General Falls and Ladder Usage

Observe the following general falls/ladders procedures and practices:

- Assess work areas for fall hazards. A fall protection system that meets OSHA and ANSI Z3591 standards must be used if work is conducted 4 feet or more above the surface.
- Use ANSI Type 1A rated ladders.
- Ensure that ladders are placed so their rungs, cleats, and steps are parallel, level, and uniformly spaced prior to use.
- Make sure ladder rungs are sturdy and free of cracks.
- Use ladders with secure safety feet.
- Pitch ladders at a 1 horizontal to 4 vertical (1H:4V) ratio.
- Secure ladders at the top or have another person at the bottom to help stabilize it.
- Ladders used to access an upper landing surface shall extend at least 3 feet above the upper landing surface.
- Use non-conductive ladders near electrical wires.
- The top rung of a ladder should not be used as a step.
- Do not carry any object or load that could cause a loss of balance or a fall.
- If a ladder is defective, damaged, or in disrepair (i.e., broken or missing rungs, cleats, or steps; broken or split rails; corroded components; or other faulty or defective components), tag the ladder "Do Not Use" and remove it from service until repaired.

12.1.10 Heavy Equipment Operations

Observe the following heavy equipment operations procedures and practices:

- Wear leather gloves while attaching support members to protect against pinching injuries.
- While working from elevated levels greater than 4 feet, ensure that all employees have fall protection that meets OSHA and ANSI Z3591 standards.
- Do not stand under loads that are being raised or lowered with cranes or aerial lifts.

- The subcontractor or Anchor QEA equipment operator must conduct pre-operational inspections of all equipment. In addition, daily inspections will be conducted on the equipment prior to site activities.
- Maintain the appropriate distance from overhead utilities (see Table 12-1):
- Always stay out of the swing radius of all heavy equipment. Always use a spotter during movement of equipment. The spotter and others, as appropriate, shall maintain constant communication with the operator.
- All operators must have adequate training and be qualified to operate the particular heavy equipment unit.
- Conduct a site evaluation to determine proper positioning for the unit. Make sure the surface is level. Cordon off holes, drop-offs, bumps, or weak ground surfaces.
- When using a crane, do not use hands when the load is being lifted or lowered. Use non-conductive tag line to help direct and position the load.
- Never climb a raised platform or stand on the mid-rail or top-rail.
- Tools should always be hung or put into a belt whenever possible

12.1.11 Drilling with Direct Push Technology

General rules associated with direct push technology (DPT) intrusive activities are as follows:

- Maintain all equipment in a safe condition.
- Keep all guards in place during use.
- Before DPT sampling is started, ensure that everyone who operates the rig has had adequate training and is thoroughly familiar with the DPT rig, its controls, capabilities, and operating manual.
- Set-up on stable and level terrain.
- Outriggers shall be extended per the manufacturer’s specifications.
- Do not place outriggers on underground structures such as vaults, manholes, stormwater inlets, catch basins, or well boxes.
- Use proper dunnage, cribbage, plates, or wooden blocks between outriggers and supporting surfaces.
- The Driller and helper must be present during all active operations and TEST THE TWO KILL SWITCHES DURING EACH STARTUP.
- The DPT rig helper and other site personnel must know the location of the two emergency shutoff switches.
- The area around the drilling operation must be cordoned off/barricaded.
- When hazardous conditions are deemed present, the operation must be shut down.
- Team members shall not wear loose clothing, free long hair, jewelry, or equipment that might become caught in moving machinery. Secure PPE close to the body to avoid getting caught in moving parts.

- Unauthorized personnel must be kept clear of the DPT rig.
- Shut down, lock, and tag out the DPT rig to make repairs or adjustments or to lubricate fittings. Release all pressure on the hydraulic systems, the drilling fluid system, and the air pressure systems of the drill rig prior to performing maintenance.
- Identify and understand parts of the equipment that may cause crushing, pinching, rotating, or similar injuries.
- Neatly stack pipe, rods, or similar on racks or sills to prevent spreading, rolling, or sliding.
- Wear proper work gloves when the possibility of pinching or other injury may be caused by moving or handling large or heavy objects.
- Establish a system of responsibility for the operator and helpers to follow during the series of various activities, such as connecting and disconnecting sections and inserting and removing the sections.
- Never reach behind or around rotating equipment for any reason.
- Clean equipment only when the DPT rig is in neutral and the equipment has stopped.
- Don’t place hands, feet, and/or limbs into or through openings of equipment frames or structures that were not intended to be used in such a fashion.

12.1.12 Drilling with a Hollow Stem Auger or Rotary/Sonic Drill Rig

All operations involving the use of powered drilling rigs will follow generally accepted drilling practices. One person will be assigned the responsibility of Lead Driller. Additional personnel will assist with equipment as needed. The Lead Driller will be responsible for operating the drilling rig and ensuring safety.

General rules associated with drilling rig operations will be as follows:

- An Exclusion Zone will be established around the drilling rig using barricade tape as a physical barrier.
- While drilling, all non-essential personnel shall remain at a distance that is past 1.5 times the radius of the boom, whenever possible. Workers (e.g., drillers, hydrogeologists, etc.) remaining around the drill rig will be kept to a minimum.
- All vehicles and heavy equipment must be parked at least 50 feet from the drill rig when lowering the mast.
- All operators and team members will be familiar with the rig operations and will have received practical training.
- All personnel will be instructed in the use of the emergency kill switch/shutdown on the drill rig.
- Hard-hats, steel-toed boots conforming to ASTM F2412-05/ASTM F2413-05, goggles or safety glasses with side shields, hearing protection, and gloves for hand protection are required.

- As project conditions dictate (i.e., the presence of puncture or crushing risks to the feet), protective shanks and/or metatarsal guards conforming to ASTM F2412-05/ ASTM F2413-05 must be worn.
- No loose-fitting clothing, jewelry, or free long hair is permitted near the drilling rig or moving machinery parts.
- Before leaving the controls, the Lead Driller will shift the transmission controlling the rotary drive into neutral and place the feed level in neutral. Before leaving the vicinity of the drill, the Lead Driller will shut down the drill engine.
- Drilling must cease immediately if combustible gas concentrations greater than 20% of the LEL are detected in the work area.
- A first aid kit and fire extinguisher will be available at all times.
- If lubrication fittings are not accessible with guards in place, machinery must be stopped for oil and greasing.
- The work area around the borehole shall be kept free of obstructions and undue accumulations of oil, water, ice, or circulating fluids.
- No drilling will occur during impending electrical storms or tornadoes, or when rain, ice, snow, or wind conditions create undue potential hazards.
- During freezing weather, do not touch any metal parts of the drill rig with exposed flesh. Freezing of moist skin to metal can occur almost instantaneously.
- The driller will not attempt to reach a well or borehole location in a manner that compromises the safety of the rig or team.
- All well or borehole locations will be inspected by the drill team to ensure that a stable surface exists.
- Before raising the drill mast, the Lead Driller will check for overhead obstructions.
- Before the mast of a drill rig is raised, the drill rig must first be leveled and stabilized with leveling jacks and/or cribbing. Re-level the drill rig if it settles after initial setup. Lower the mast only when the leveling jacks are down, and do not raise the leveling jack pads until the mast is lowered completely.
- The drill rig shall be driven or moved only after the mast has been lowered.
- The leveling jacks shall not be raised until the derrick is lowered.
- Adequately cover or protect all unattended boreholes to prevent drill rig personnel or site visitors from stepping or falling into the borehole.
- Maintain professional behavior at all times in the work area, even when the rig is shut down.

Rotary Drill Rig Operations:

- Drillers must never engage the rotary clutch without watching the rotary table and ensuring that it is clear of personnel and equipment.

- Unless the drill rig is equipped with an automatic feed control, the brake must not be left unattended without first being tied down.
- Drillers will not add or remove pipe from the drill stem without assistance from the driller’s helper.
- Drill pipe must not be hoisted until the driller is sure that the pipe is latched and the drilling assistant has signaled that he/she may safely hoist the load.
- During instances of unusual loading of the derrick or mast, such as when making an unusually hard pull, only the driller will be on the rig floor and no one will be on the rig or derrick.
- The brakes of every drilling rig must be tested at the beginning of each shift to determine whether they are in good order.
- A hoisting line with a load imposed will not be permitted to be in direct contact with any derrick member or stationary equipment unless it has been specifically designed for line contact.
- Hoisting control stations must be kept clean and controls shall be labeled as to their functions.
- Under no circumstances will personnel be permitted to ride the traveling block or elevators, nor will the cat line be used as a personnel carrier.

12.1.13 Hand and Power Tools

Observe the following procedures and practices when working with hand and power tools:

- Keep hand tools sharp, clean, oiled, dressed, and not abused.
- Worn tools are dangerous. For example, the “teeth” in a pipe wrench can slip if worn smooth, an adjustable wrench will slip if the jaws are sprung, and hammerheads can fly off loose handles.
- Tools subject to impact (e.g., chisels, star drills, and caulking irons) tend to “mushroom.” Keep them dressed to avoid flying spalls, and use tool holders.
- Do not force tools beyond their capacity.
- Flying objects can result from operating almost any power tool, so always warn people in the vicinity and use proper eye protection.
- Each power tool should be examined before use for damaged parts, loose fittings, and frayed or cut electric cords. Tag and return defective tools for repairs. Ensure that there is adequate lighting, inspect tools for proper lubrication, and relocate tools or material that could “vibrate into trouble.”
- Compressed air must be shut off or the electric cord unplugged before making tool adjustments. Air must be “bled down” before replacement or disconnection.
- Proper guards or shields must be installed on all power tools before issue. Do not use improper tools or tools without guards in place.
- Replace all guards before startup. Remove cranks, keys, or wrenches used in service work.

12.1.14 Motor Vehicle Operation

All drivers are required to have a valid driver's license, and all vehicles must have appropriate state vehicle registration and inspection stickers. **Anchor QEA prohibits the use of hand-held wireless devices while driving any vehicle for business use at any time, for personal use during business hours, and as defined by law**. Additionally, site-specific motor vehicle requirements must be followed, if any.

When driving to, from, and within the job site, be aware of potential hazards including:

- Vehicle accidents
- Distractions
- Fatigue
- Weather and road conditions

To mitigate these hazards, observe the following procedures and practices regarding motor vehicle operation:

- Before leaving, inspect fuel and fluid levels and air pressure in tires, and adjust mirrors and seat positions appropriately.
- Wear a seat belt at all times and make sure that clothing will not interfere with driving.
- Plan your travel route and check maps for directions or discuss with colleagues.
- Clean windows and mirrors as needed throughout the trip.
- Wear sunglasses as needed.
- Fill up when the fuel level is low (not near empty).
- Follow a vehicle maintenance schedule to reduce the possibility of a breakdown while driving.
- Stop driving the vehicle, regardless of the speed (e.g., even 5 miles per hour) or location (e.g., a private road), when the potential of being distracted by conversation exists.
- Using hand-held communication devices (e.g., cell phones) while operating any motor vehicle is prohibited.
- Get adequate rest prior to driving.
- Periodically change your seat position, stretch, open the window, or turn on the radio to stay alert.
- Pull over and rest if you are experiencing drowsiness.
- Check road and weather conditions prior to driving.
- Be prepared to adjust your driving plans if conditions change.
- Travel in daylight hours, if possible.
- Give yourself plenty of time to allow for slowdowns due to construction, accidents, or other unforeseen circumstances.
- Use lights at night and lights and wipers during inclement weather.

12.1.15 Vehicular Traffic

Observe the following procedures and practices regarding vehicular traffic:

- Wear a traffic safety vest when vehicle hazards exist.
- Use cones, flags, barricades, and caution tape to define the work area.
- Use a vehicle to block the work area (if conditions allow).
- Engage a police detail for high-traffic situations.
- Always use a spotter in tight or congested areas for material deliveries.
- As necessary, develop traffic control plans and train personnel as flaggers in accordance with the DOT Manual of Uniform Traffic Control Devices and/or local requirements.

See Section 7.4 for additional information regarding work in roadways.

12.1.16 Boating Operations

The following precautions shall be followed when conducting boating trailer and launch activities:

- Follow the trailer and boat manufacturers' instructions for securing the boat to the trailer.
- Follow the trailer manufacturer's instructions for securing the trailer to the towing vehicle.
- Prohibit site personnel from moving into trailer/vehicle pinch points without advising the vehicle operator.
- Use experienced operators when backing trailers on boat ramps.
- Wear proper work gloves when the possibility of pinching or other injury may be caused by moving or handling large or heavy objects.
- Maintain all equipment in a safe condition.
- Launch boats one at a time to avoid collisions.
- Use a spotter for vehicles backing boats to the launch area.
- Understand and review hand signals.
- Wear boots with non-slip soles when launching boats.
- Wear USCG-approved PFDs when working within 10 feet of the water.
- Keep ropes and lines coiled and stowed to eliminate trip hazards.
- Maintain three-point contact on dock/pier or boat ladders.
- Ensure that drain plugs are in place, as present.

The following precautions shall be followed when conducting boating operations:

- Maintain a current boater's license(s) as required.
- Wear USCG-approved PFDs for work activities within 10 feet of the water.
- Obtain and review information regarding dams that may be present in work areas, particularly with regard to "no boating" zones and safety buoys, cables, and warning signage.

- Maintain boat anchorage devices commensurate with anticipate currents, distance to shore, and water depths.
- Provide a floating ring buoy in the immediate boat launch/landing areas with at least 60 feet (18.3 meters) of line for a vessel less than 65 feet (19.8 meters) in length, or 90 feet (27.4 meters) of line for a vessel 65 feet (19.8 meters) or greater in length (see http://www.uscg.mil/d13/cfvs/CheckLists/Regs/28.115.pdf for more information).
- Step into the center of the boat.
- Keep your weight low when moving on the boat.
- Move slowly and deliberately.
- Steer directly across other boat wakes at a 90-degree angle to avoid capsizing.
- Steer the boat facing forward.
- Watch for floating objects in the water.
- Right-of-way is yielded to vessels on your boat's right, or starboard, and vessels with limited ability to maneuver such as any wind-propelled vessel.

The following precautions shall be followed when working on a boat:

- Observe proper lifting techniques.
- Obey lifting limits (see Section 12.1.19).
- Use mechanical lifting equipment (i.e., pulleys or winches) to move large or awkward loads.
- Wear USCG-approved PFDs for work activities within 10 feet of the water.

The safety-related items listed in Table 12-2 shall be available when conducting boating operations.

Table 12-2
Safety Equipment Specific to In-Water Work

Additional Safety Equipment for Sampling Vessel per USCG Requirements:

- Proper vessel registration, numbering, and documentation (registered with state, certificate of vessel registration number displayed, and carrying a valid certificate of number)
- USCG-approved personal flotation devices (PFDs; or life jackets) for every person on the sampling vessel (Type II PFD required; Type I PFD preferred as it will turn most unconscious wearers face up in the water)
- Appropriate, non-expired, visual distress devices for day and night use from the following:
  - Three hand-held red flares (day and night), or
  - One hand-held red flare and two parachute flares (day and night), or
  - One hand-held orange smoke signal, two floating orange smoke signals (day), and one electric distress light (night only)
- Alternate means of propulsion (oars or paddles)
- Dewatering device (pump or bailer)
- Properly maintained and inspected USCG-approved fire extinguishers (no fixed system = (2) B-1 or (1) B-2 type extinguishers; fixed system = (1) B-1 type extinguisher)
- Proper ventilation of gasoline-powered vessels
- Sound-producing device (whistle, bell, or horn)
- VHF 2-way radio
- Proper navigational light display
- Throwable life ring with attached line (any vessel larger than 16 feet is required to carry one Type IV [throwable] PFD)

Additional USCG Recommended Equipment Includes:

- Extra visual distress signals
- Primary and spare anchor
- Heaving line
- Fenders
- First aid kit
- Flashlight
- Mirror
- Searchlight
- Sunburn lotion
- Tool kit
- Spare fuel
- Boat hook
- Spare propeller
- Mooring line
- Food and water
- Binoculars
- Spare batteries
- Sunglasses
- Marine hardware
- Extra clothing
- Spare parts
- Pertinent navigational chart(s) and compass

12.1.17 Working Over or Near Water

12.1.17.1 Personal Flotation Devices

PFDs are not required where employees are continuously protected from the hazard of drowning by railings, nets, safety belts, or other applicable provisions.

Type III, Type V, or better USCG-approved, high-visibility PFD shall be provided and properly worn by all personnel in the following circumstances:

- On or within 10 feet of water
- On floating pipelines, pontoons, rafts, or stages
- On structures extending over or next to the water, except where guard rails or safety nets are provided for employees
- Working alone at night where there are drowning hazards, regardless of other safeguards provided
- In skiffs, small boats, or launches, unless in an enclosed cabin or cockpit
- Whenever there is a drowning hazard

The following precautions shall be followed when using PFDs:

- Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects that would alter their strength or buoyancy. Defective devices or devices with less than 13 pounds buoyancy shall be removed from service.
- All PFDs shall be equipped with reflective tape as specified in 46 CFR 25.25-15.
- Thirty-inch USCG-approved ring buoys with at least 150 feet of 600-pound capacity line shall be provided and readily available for emergency rescue operations. The distance between ring buoys shall not exceed 200 feet.
- PFD lights conforming to 46 CFR 161.012 shall be required whenever there is a potential need for life rings to be used after dark. Onshore installations, at least one life ring, and every third one thereafter, shall have a PFD light attached. PFD lights on life rings are required only in locations where adequate general lighting (e.g., floodlights or light stanchions) is not provided.

12.1.17.2 Cold Water Work

When the combined air and water temperature is below 90°F, field personnel working on or near water shall wear either a float coat and bib overalls (e.g., a full two-piece "Mustang" survival suit or similar) or a one-piece survival suit. Suits or float coats shall be USCG approved. If extremely cold or severe weather conditions are forecast, work activities should be postponed. Work activities will be continually reviewed and adjustments made if wearing a survival suit during work activities potentially poses a hazard due to warm air temperatures, or limited mobility or agility. In addition, proximity of water work to shore and scope/duration/timing of work activities will be considered when stipulating the above requirement. Overall, if watercraft will be used during work, or work will be conducted near water, it is imperative that site-specific conditions are considered and evaluated so that proper safeguards and procedures are in place prior to beginning work.

In addition to considering the use of apparel appropriate for anticipated air, weather, and water conditions, field teams shall identify any procedures necessary for cold-water “man-overboard” scenarios. These procedures should be identified in the site-specific HASP, described in the JSA used for boating activities and, if prudent, practiced before work.

12.1.18 Noise

Excessive noise is hazardous not only because of its potential to damage hearing, but also because of its potential to disrupt communications and instructions. The following procedures and practices shall be followed to prevent noise-related hazards:

- All employees will have access to ear protection with a Noise Reduction Rating of not less than 30.
- Ear protection must be worn in any environment where site personnel must raise their voices to be heard while standing at a distance of 3 feet or less.
- Ear protection must be worn by any personnel observing or operating concrete cutting or sawing equipment, pile driving, or other loud noise-generating activities.

Hearing protection is required for site personnel operating or working near noisy equipment or operations, where the noise level is greater than 85 A-weighted decibels (dBA) (time-weighted average [TWA]), as well as personnel working around heavy equipment. The FL will determine the need and appropriate testing procedures, (i.e., sound level meter and/or dosimeter) for noise measurement.

When needed, a sound level meter will be used to measure noise levels at selected locations in the work area and on the site perimeter. When used, noise monitoring equipment must be calibrated before and after each shift.

If continuous noise levels are found to exceed 85 dBA at any location within the work area, warning signs will be posted. Site personnel and visitors will be notified that hearing protection is required. Appropriate hearing protection (i.e., ear plugs or earmuffs) will be worn whenever personnel or visitors are working in that location. A supply of ear plugs will be maintained on site.

Action levels in Table 12-3 will trigger the use of appropriate hearing protection (plugs or muffs). Hearing protection must be able to attenuate noise below 90 dBA (8-hour TWA). Each hearing protection or device has a Noise Reduction Rating (NRR) assigned by EPA. The calculation for a hearing protection device’s effectiveness is:

Equation 1

$$\text{Noise reading } dbA - (NNR - 7db) < 90dbA$$

where:

dbA = A-weighted decibel

NRR = Noise Reduction Rating

Table 12-3
Noise Exposure Action Levels

Instrument	Measurement	Action
Type I or Type II Sound Level Meter or Dosimeter	> 80 dBA to 85 dBA	Hearing protection recommended. Limit work duration to 8-hour shifts.
	> 85 dBA to 90 dBA	Hearing protection required. Limit work duration to 8-hour shifts.
	> 90 dBA to 115 dBA	Hearing protection required. Investigate use of engineering controls. Limit work duration to 8-hour shifts.
	> 115 dBA	Stop work. Consult SSHO.

12.1.19 Lifting and Material Handling

Observe the following procedures and practices for lifting and material handling:

- Use leather gloves when handling metal, wire rope, sharp debris, or transporting materials (e.g., wood, piping, or drums).
- The size, shape, and weight of the object to be lifted must first be considered. No individual employee is permitted to lift any object that weighs more than 60 pounds. Multiple employees or mechanical lifting devices are required for objects heavier than the 60-pound limit.
- Plan a lift before doing it. Bend at the knees and lift with the legs; maintain the natural curves of the back; do not use back muscles.
- Check the planned route for clearance.
- Use the buddy system when lifting heavy or awkward objects.
- Do not twist your body while lifting.
- Know the capacity of any handling device (e.g., crane, forklift, chain fall, or come-along) that you intend to use.
- Use tag lines to control loads.
- Ensure that your body, material, tools, and equipment are safe from such unexpected movement as falling, slipping, rolling, tripping, bowing, or any other uncontrolled motion.
- Trucks (i.e., flat beds) hauling equipment or materials must not be moved once rigging has been released.

- Chock all material and equipment (such as pipe, drums, tanks, reels, trailers, and wagons) as necessary to prevent rolling.
- Tie down all light, large-surface-area material that might be moved by the wind.
- When working at heights, secure tools, equipment, and wrenches against falling.
- Do not store materials or tools on ducts, lighting fixtures, beam flanges, hung ceilings, or similar elevated locations.
- Fuel-powered tools used inside buildings or enclosures shall be vented and checked for excessive noise.

12.1.20 Fire Control

Observe the following fire control procedures and practices:

- Smoke only in designated areas.
- Keep flammable liquids in closed containers.
- Keep the work site clean; avoid accumulating combustible debris such as paper.
- Obtain and follow property owner hot work safety procedures when welding or performing other activities requiring an open flame.
- Isolate flammable and combustible materials from ignition sources.
- Ensure fire safety integrity of equipment installations according to National Electrical Code specifications.

12.1.21 Static Electricity and Transfer of Flammable Liquids

Observe the following procedures and practices regarding static electricity when transferring flammable liquids:

- Electrically bond and ground pumps, transfer vessels, tanks, drums, bailers, and probes when moving flammable liquids.
- Electrically bond and ground vacuum trucks and the tanks they are emptying.
- Do not splash fill containers with flammable liquids.
- Pour flammable liquids slowly and carefully.
- Two fire extinguishers (2A20:BC) must be available, charged, inspected, and readily accessible.

12.1.22 Cleaning Equipment

Observe the following procedures and practices when cleaning equipment:

- Wear appropriate PPE to avoid skin and eye contact with isopropyl alcohol, Alconox®, or other cleaning materials.
- Stand upwind to minimize any potential inhalation exposure.
- Dispose of spent cleaning solutions and rinses accordingly.

12.2 Environmental Hazards and Controls

12.2.1 Fatigue Management

Because Anchor QEA personnel may be working during both daytime and nighttime hours several days per week, depending on the activity, it is important that all personnel are aware of the hazards related to fatigue. Fatigue can be defined as an increasing difficulty in performing physical or mental activities. Signs of fatigue may include tiredness, changes in behavior, loss of energy, and reduced ability to concentrate. Fatigued site personnel may have a reduced ability to recognize or avoid risks on the work site, which may lead to an increase in the number and severity of injuries and other incidents. Fatigue can occur at any time when working and may cause safety concerns due to decreased manual dexterity, reaction time, and alertness.

Fatigue results from insufficient rest and sleep between activities. Contributing factors to fatigue may include the following:

- The time of day that work takes place
- The length of time spent at work and in work-related duties
- The type and duration of a work task and the environment (e.g., weather conditions and ambient noise) in which it is performed
- The quantity and quality of rest obtained prior to, during, and after a work period
- Non-work activities
- Individual factors such as sleeping disorders, medications, or emotional state

Personnel suffering from fatigue may exhibit both physical and mental effects, such as the following:

- Slower movements
- Poor coordination
- Slower response time to interaction
- Bloodshot eyes
- Slumped or weary appearance
- Nodding off
- Distractedness or poor concentration
- Inability to complete tasks
- Fixed gaze
- Appearing depressed, irritable, frustrated, or disinterested

Employees are strongly encouraged to get sufficient pre-work rest, maintain sufficient nutritional intake during work (i.e., eat and drink at regular intervals), and communicate with team members and leaders if their level of fatigue elevates.

Use the following procedures to help detect and address fatigue-related issues:

- Periodically observe and query coworkers for signs or symptoms of fatigue.
- Site personnel that express concern over their level of fatigue, or that are observed to be fatigued such that elevated worker risk is evident, will be relieved or their work tasks adjusted so that they may rest sufficiently.
- Work schedules will consider fatigue factors and optimize continuous periods available for uninterrupted sleep. The employee is responsible for reporting to work properly rested and fit for duty. In case of an emergency or operational difficulties (e.g., limited access due to water levels or boat repairs), work hours may require adjustment.
- Maintain a routine exercise program and regular sleep schedule as much as possible over the course of the work.
- Avoid heavy meals or caffeine and minimize or eliminate the consumption of alcohol and nicotine before sleeping.

12.2.2 Heat Stress

Observe the following general procedures and practices regarding heat stress:

- Increase the number of rest breaks and/or rotate site personnel in shorter work shifts.
- Watch for signs and symptoms of heat stress and fatigue (see Section 12.2.2.1).
- During hot months, plan work for early morning or evening.
- Use ice vests when necessary.
- Rest in cool, dry areas.
- Ensure that employees have access to potable drinking water and shade.
- During conditions exceeding 95°F, ensure that the following additional procedures are adhered to:
  - Establish effective communication by voice, observation, or electronic means.
  - Observe employees for alertness and signs or symptoms of heat illness.
  - Designate one or more employees on each work site as authorized to call for emergency medical services.
  - Remind employees to drink water throughout the shift.
  - Conduct pre-shift meetings before beginning work to review the high heat procedures, encourage drinking water, and remind employees of their right to take a cool-down rest when necessary.

12.2.2.1 Signs, Symptoms, and Treatment

The FL will be trained in heat stress prevention, including the following, prior to supervising employees:

- Procedures to prevent heat illness.

- Procedures to follow when an employee exhibits symptoms consistent with possible heat illness, including emergency response procedures.

The information provided below addresses these training requirements.

Adverse climatic conditions are important considerations in planning and conducting site operations. High ambient temperature can result in health effects ranging from transient heat fatigue, physical discomfort, reduced efficiency, personal illness, and increased accident probability to serious illness or death. Heat stress is of particular concern when chemical protective garments are worn because they prevent evaporative body cooling. Wearing PPE places employees at considerable risk of developing heat stress.

Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is probably one of the most common (and potentially serious) illnesses, regular monitoring and other preventive precautions are vital.

Heat Rash. Heat rash can be caused by continuous exposure to hot and humid air and skin abrasion from sweat-soaked clothing, rubber boots, or impermeable waders. The condition is characterized by a localized red skin rash and reduced sweating. Heat rash reduces the ability to tolerate heat. To treat, keep skin hygienically clean and allow it to dry thoroughly after using chemical protective clothing. Take measures to prevent heat rash by changing clothes often to maximize use of dry garments or by taking frequent breaks to allow doffing of equipment and drying of skin.

Heat Cramps. Heat cramps are caused by profuse perspiration with inadequate electrolytic fluid replacement. This often robs the larger muscle groups (stomach and quadriceps) of blood, which can cause painful muscle spasms and pain in the extremities and abdomen. To treat, move the employee to a cool place and give sips of water or an electrolytic drink. Watch for signs of heat exhaustion or heat stroke.

Heat Exhaustion. Heat exhaustion is a mild form of shock caused by increased stress on various organs to meet increased demand to cool the body. Onset is gradual and symptoms should subside within 1 hour. Symptoms include a weak pulse; shallow breathing; pale, cool, moist skin; profuse sweating; dizziness; and fatigue. To treat, move the employee to a cool place and remove as much clothing as possible. Give sips of water or electrolytic solution and fan the person continuously to remove heat by convection. Do not allow the affected person to become chilled. Treat for shock if necessary.

Heat Stroke. Heat stroke is the most severe form of heat stress; the body must be cooled immediately to prevent severe injury and/or death. ***This is a medical emergency!*** Symptoms include red, hot, dry skin; a body temperature of 105°F or higher; no perspiration; nausea; dizziness and confusion; and a strong, rapid pulse. Because heat stroke is a true medical emergency, transport the patient to a medical facility immediately. Prior to transport, remove as much clothing as possible and wrap the patient in a sheet soaked with water. Fan the patient vigorously while transporting to help reduce body temperature. If available, apply cold packs under the arms, around the neck, or any other place where they can cool large surface blood vessels. If transportation to a medical facility is delayed, reduce body temperature by immersing the patient in a cool-water bath (however, be careful not to over-chill the patient once body temperature is reduced below 102°F). If this is not possible, keep the patient wrapped in a sheet and continuously douse with water and fan.

12.2.2.2 Prevention

The implementation of preventative measures is the most effective way to limit the effects of heat-related illnesses. During periods of high heat, adequate liquids must be provided to replace lost body fluids. Replacement fluids can be a 0.1% saltwater solution, a commercial mix such as Gatorade, or a combination of these with fresh water. The replacement fluid temperature should be kept cool, 50°F to 60°F, and should be placed close to the work area. Employees must be encouraged to drink more than the amount required to satisfy thirst. Employees should also be encouraged to salt their foods more heavily during hot times of the year.

Cooling devices such as vortex tubes or cooling vests can be worn beneath impermeable clothing. If cooling devices are worn, only physiological monitoring will be used to determine work activity.

All site personnel are to rest when any symptoms of heat stress are noticed. Rest breaks are to be taken in a cool, shaded rest area. Employees shall remove chemical protective garments during rest periods and will not be assigned other tasks.

All employees shall be informed of the importance of adequate rest and proper diet, including the harmful effects of excessive alcohol and caffeine consumption.

12.2.2.3 Monitoring

Heat stress monitoring should be performed when employees are working in environments exceeding 90°F ambient air temperature. If employees are wearing impermeable clothing, this monitoring should begin at 77°F. There are two general types of monitoring that the health and safety representative can designate to be used: wet bulb globe temperature (WBGT), and physiological. The Heat Stress Monitoring Record form (see Attachment A) will be used to record the results of heat stress monitoring.

Note that some states such as Washington and California have specific regulatory standards for protection of employees from heat stress-related injuries.

Wet Bulb Globe Temperature (WBGT). The WBGT index is the simplest and most suitable technique to measure the environmental factors that most nearly correlate with core body temperature and other physiological responses to heat. When WBGT exceeds 25°C (77°F), the work regiment in Table 12-4 should be followed.

Table 12-4
Permissible Heat Exposure Threshold Limit Values

Work/Rest Regimen	Workload Light	 Moderate	 Heavy
Continuous work	86°F (30.0°C)	80°F (26.7°C)	77°F (25.0°C)
75% work, 25% rest each hour	87°F (30.6°C)	82°F (28.0°C)	78°F (25.9°C)
50% work, 50% rest, each hour	89°F (31.4°C)	85°F (29.4°C)	82°F (27.9°C)
25% work, 75% rest, each hour	90°F (32.2°C)	88°F (31.1°C)	86°F (30.0°C)
These TLVs assume that nearly all acclimated, fully-clothed site personnel with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 100.4°F (38°C).			

Note:
Source: OSHA Technical Manual, Section III: Chapter 4 – Heat Stress

The TLVs denoted in Table 12-4 apply to physically fit and acclimatized individuals wearing light, summer clothing. If heavier clothing that impedes sweat or has a higher insulation value is required, the permissible heat exposure TLVs should be adjusted based on the WBGT Correction Factors in Table 12-5.

Table 12-5
Wet Bulb Globe Temperature Correction Factors

Clothing Type	WBGT Correction
Summer lightweight working clothing	0°F (0°C)
Cotton coveralls	-3.6°F (-2°C)
Winter work clothing	-7.2°F (-4C)
Water barrier, permeable	-10.8°F (-6°C)
Fully encapsulating	-14.4°F (-10°C)

Physiological. Physiological monitoring can be used in lieu of, or in addition to, WBGT. This monitoring can be self-performed once the health and safety representative demonstrates appropriate techniques to affected employees. Because individuals vary in their susceptibility to heat, this type of monitoring has its advantages. The following two parameters are to be monitored at the beginning of each rest period:

- **Heart Rate:** The maximum heart rate (MHR) is the amount of work (beats) per minute a healthy person's heart can be expected to safely deliver. Each individual will count his/her radial (wrist) pulse for 1 minute as early as possible during each rest period. If the heart rate of any individual exceeds 75% of his/her calculated MHR (MHR = 200 - age) at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same. An individual is not permitted to return to work until his/her sustained heart rate is below 75% of his/her calculated MHR.
- **Temperature:** Each individual will measure his/her temperature with a thermometer for 1 minute as early as possible in the first rest period. If the temperature exceeds 99.6°F at the beginning of the rest period, then the work cycle will be decreased by one-third. The rest period will remain the same. An individual is not permitted to return to work if his/her temperature exceeds 100.4°F.

12.2.2.4 Training

Employees potentially exposed to heat stress conditions will be instructed on the contents of this procedure. This training can be conducted during daily tailgate safety meetings.

12.2.3 Cold Stress

Observe the following procedures and practices regarding cold stress:

- Take breaks in heated shelters when working in extremely cold temperatures.
- Upon entering the shelter, remove the outer layer of clothing and loosen other layers to promote evaporation of perspiration.
- Drink warm liquids to reduce the susceptibility to cold stress.
- Be aware of cold stress symptoms, including shivering, numbness in the extremities, and sluggishness.
- Provide adequate insulating dry clothing to maintain warmth if work is performed in air temperature below 40°F. Wind chill cooling rates and the cooling power of air are critical factors. The higher the wind speed and the lower the temperature in the work area, the greater the insulation value of the protective clothing required.
- If the air temperature is 32°F or less, hands should be protected.
- If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing in use should be impermeable to water. With more severe work under such conditions, the outer layer should be water repellent, and the outer wear should be changed as it becomes wetted. The outer garments should include provisions for easy ventilation in order to prevent wetting of the inner layer by sweat.

- If available clothing does not give adequate protection to prevent cold injury, work should be modified or suspended until adequate clothing is made available, or until weather conditions improve.
- Implement a buddy system in which site personnel are responsible for observing fellow workers for early signs and symptoms of cold stress.

12.2.3.1 Signs, Symptoms, and Treatment

Cold stress can range from frostbite to hypothermia. The signs and symptoms of cold stress are listed below. The appropriate guidelines should be followed if any personnel exhibit these symptoms:

Frostbite. Frostbite is characterized by pain in the extremities and loss of manual dexterity. "Frostnip," or reddening of the tissue, is accompanied by a tingling or loss of sensation in the extremities and continuous shivering.

Hypothermia. Hypothermia is characterized by pain in the extremities and loss of manual dexterity, with severe, uncontrollable shivering, and an inability to maintain the level of activity. Symptoms include excessive fatigue, drowsiness, irritability, or euphoria. Severe hypothermia includes clouded consciousness, low blood pressure, pupil dilation, cessation of shivering, unconsciousness, and possible death.

Move the patient to a warm, dry place. If the patient's clothing is wet, remove it and replace it with dry clothing. Keep the patient warm. Re-warming of the patient should be gradual to avoid stroke symptoms. Dehydration, or the loss of body fluids, may result in a cold injury due to a significant change in blood flow to the extremities. If the patient is conscious and alert, warm sweet liquids should be provided. Coffee and other caffeinated liquids should be avoided because of diuretic and circulatory effects. Extremities affected by frostbite should be gradually warmed up and returned to normal temperature. Moist compresses should be applied; begin with lukewarm compresses and slowly increase the temperature as changes in skin temperature are detected. Keep the patient warm and calm and move them to a medical facility as soon as possible.

12.2.4 Sunlight and Ultraviolet Exposure

Observe the following procedures and practices regarding ultraviolet (UV) exposure:

- Protect against extended exposure to sunlight with shade, long clothing, sunscreen, and high-SPF, broad-spectrum sunscreen applied frequently.
- Plan work to avoid unnecessary UV exposure (see Section 12.2.2.2).
- During peak daylight months, plan work for early morning or evening.
- Many factors affect the hazards associated with UV exposure, including the following:
  - **Time of day:** UV rays are strongest between 10:00 a.m. and 4:00 p.m.

  - **Season of the year:** UV rays are stronger during spring and summer months. This is less of a factor near the equator.
  - **Distance from the equator (latitude):** UV exposure goes down as you get farther from the equator.
  - **Altitude:** More UV rays reach the ground at higher elevations.
  - **Cloud cover:** The effect of clouds can vary. Sometimes cloud cover blocks some UV from the sun and lowers UV exposure, while some types of clouds can reflect UV and increase UV exposure. What is important to know is that UV rays can get through, even on a cloudy day.
  - **Reflection off surfaces:** UV rays can bounce off surfaces like water, sand, snow, pavement, or grass, leading to an increase in UV exposure.
- Cloud cover does not necessarily protect from UV exposure. Consider monitoring the UV index for your work area: http://www2.epa.gov/sunwise/uv-index.
- Evaluate site-specific factors affecting UV exposure and address work practices, as appropriate.

12.2.4.1 Signs, Symptoms, and Treatment

The best way to treat sunburn is to prevent it using the guidelines listed in the bullets in the prior subsection and in Section 12.2.2.2. Signs of sunburn include the following:

- Pinkness or redness
- Skin that feels warm or hot to the touch
- Pain, tenderness, or itching
- Swelling
- Small, fluid-filled blisters, which may break
- Headache, fever, chills, and fatigue if the sunburn is severe

If signs of sunburn are noticed, avoid further exposure and immediately implement treatment. If the sunburn is blistering *and* covers 15% or more of the body, seek medical attention.

12.2.4.2 Prevention

UV exposure hazards and their impacts on each worksite should be evaluated to determine the best practices for risk mitigation. The most effective way to prevent skin damage from UV exposure is to protect bare skin from the exposure. This can be accomplished with shade, clothing (e.g., pants, long sleeves, or hats), sunscreen, and sunglasses. Plan work to either create shade or take advantage of natural shade, and avoid peak UV times during the day when possible.

12.2.5 Inclement Weather

Observe the following procedures and practices regarding inclement weather:

- Evaluate the worksite for hazards that may be amplified during inclement weather, such as traction issues, ingress and egress, slope stability, or wind-driven hazards (e.g., dust, debris, or falling trees).
- Stop outdoor work during electrical storms (lightning strikes), hailstorms, high winds, and other extreme weather conditions such as extreme heat or cold.
- Take cover indoors or in a vehicle that will provide adequate protection. In some cases, this may require exiting the worksite, such as during windstorms in areas with overhead hazards (e.g., trees or power lines).
- Listen to local forecasts for warnings about specific weather hazards such as tornadoes, hurricanes, and flash floods.
- Verify that on-site equipment and resources are adequately protected from inclement weather.
- If working in an unfamiliar geographic location, consult with local resources for unique weather hazards.

12.2.6 Insects/Spiders

Observe the following general procedures and practices regarding insects/spiders:

- Tuck pants into socks.
- Wear long sleeves.
- Use insect repellent.
- Avoid contact by always looking ahead to where you will be walking, standing, sitting, leaning, grabbing, lifting, or reaching.
- Check for signs of insect/spider bites, such as redness, swelling, and flu-like symptoms.

The most dangerous spiders to humans in North America are black widows and brown spiders (also known as brown recluse or fiddleback spiders). A guide to identifying these spiders is presented in Table 12-6.

Table 12-6
North American Hazardous Spider Identification Guide

Hazardous Spider Identification Guide	
Black Widow Spider - Abdomen usually shows hourglass marking - Female is 3 to 4 centimeters in diameter - Have been found in well casings and flush-mount covers - Not aggressive, but more likely to bite if guarding eggs - Light, local swelling and reddening are early signs of a bite, followed by intense muscular pain, rigidity of the abdomen and legs, difficulty breathing, and nausea - If bitten, see a physician as soon as possible	
Brown Spiders (aka Brown Recluse or Fiddleback) - Found in the central and southern United States, although in some other areas, as well - 1/4-to-1/2-inch-long body, and size of a silver dollar - Hide in baseboards, ceiling cracks, and undisturbed piles of material - Bite may either go unnoticed or may be followed by a severe localized reaction, including scabbing, necrosis of the affected tissue, and very slow healing - If bitten, see a physician as soon as possible	

12.2.7 Bees and Wasps

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

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

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

12.2.8 Ticks

Ticks in North America can be carriers of several diseases, including Lyme’s Disease, Rocky Mountain Spotted Fever, and ehrlichiosis.

Limiting exposure to ticks reduces the likelihood of infection when exposed to tick-infested habitats. Measures to prevent tick exposure include the following:

- Remove leaf litter and brush in areas where you will be working prior to tick season.
- Wear light-colored clothing so that ticks are visible.
- Tuck your pant legs into your socks.
- Apply repellents to discourage tick attachment.
- Promptly inspect your body and remove crawling or attached ticks when you leave a tick-infested area.
- Conduct tick checks on buddies upon exiting any suspect area (may be needed multiple times per work day).
- Be aware of seasonal activity; ticks are often most active in the spring.

Observe the following procedures and practices if you are bitten by a tick:

- Use fine-tipped tweezers or shield your fingers with tissue, paper towel, or rubber gloves.
- Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause mouthparts to break off and remain in the skin.
- Do not squeeze, crush, or puncture the body of the tick because its fluids may contain infectious organisms.
- Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin.
- After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.
- You may wish to save the tick for identification in case you become ill within 2 to 3 weeks. Place the tick in a sealed plastic bag in the freezer, and mark the bag with the date of the bite.

12.2.9 Mosquitoes

Mosquitoes in the United States have been known to carry West Nile virus, Zika virus, St. Louis encephalitis, and Dengue fever. Avoid mosquito bites by doing the following:

- Apply insect repellent containing DEET (N,N-diethyl-meta-toluamide) when outdoors. DEET is very effective, but could potentially contaminate samples.
- Read and follow the product directions whenever you use insect repellent.

- Wear long-sleeved clothes and long pants treated with repellent to further reduce your risk, or stay indoors during peak mosquito feeding hours (dusk until dawn).
- Limit the number of places available for mosquitoes to lay their eggs by eliminating standing water sources from around the work area.
- If you need to destroy a nest, consult with the PM and project FL first.
- Check to see if there is an organized mosquito control program near the project site. If no program exists, work with the local government officials to establish a program.

12.2.10 Bird Droppings

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

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

- Wear a respirator that can filter particles as small as 0.3 microns, such as a HEPA filter.
- Wear disposable protective gloves, hat, coveralls, and boots if you will be in close contact.
- Wash or shower at the work site after cleanup, if possible.
- If allowable, modify the structure or use methods to prevent birds from re-establishing the roost.

12.2.11 The Public at Large

The community residents around worksites may pose their own specific hazards. These conditions may include the following:

- Unintentional disruption of work
- Benign or malicious trespass
- Criminal intent

Scenarios may include the following:

- Pedestrians, cyclists, or motorists disregarding site boundaries due to distraction or willful disobedience.
- Public use of private site facilities for shelter, relief, and other reasons with no ill-intention.
- Public use of private site facilities for mischievous or criminal activity, such as loitering, vandalism, or theft.
- Encounters with community members who are disgruntled with the project activity.
- Encounters with criminal activities on or near a project site.

If any of the above are anticipated to be likely, take the following precautions as appropriate:

- Verify that the site is adequately marked and barricaded to limit unintentional disruptions of the work by the public.
- Review the site for attractive nuisances (e.g., hazards or conditions that are likely to attract children), and mitigate those.
- Secure all equipment and site facilities to prevent unauthorized access or use.
- Remove valuable items from the site or adequately secure them on site to limit the temptation for potential criminals.
- Have contact information for the client's or owner's public relations office while on site, and direct disgruntled community members to that office. If necessary, vacate the site to relieve the situation and notify the PM or FL.
- Work in pairs when uncertain of the public safety situation at a site. In questionable situations, postpone work as necessary until a plan of action can be developed to verify a safe working environment.

12.2.12 Personal Health and Safety

In addition to hazards associated with chemicals of concern, equipment, operations or site conditions discussed above, there may be additional personal safety issues to consider at a site, including those related to one or multiple protected classes, such as race, gender, religion, ability, sexual orientation, or gender identity. These conditions may involve the following, perpetrated by the public or those associated with the work:

- Malicious disruption of work
- Harassment, including unwanted comments, gestures, or actions
- Threats of violence, either implied (using derogatory language) or explicit
- Assault

<u>It is critical that the work environment be discussed within the project team to evaluate risks, ways to avoid those risks, and communication protocols. Anchor QEA requires that work be performed in teams.</u>

Specifically, if any of the above are anticipated, take the following precautions as appropriate:

- Alert the PM, FL, SSHO, and/or Human Resources Department of potential issue(s).
- Formulate a plan of action to verify and maintain a safe working environment prior to field work, which may include the following:
    - Working in pairs and/or within a certain physical distance of other work groups.
    - Coordinated check-ins (calls to or from the office or visual check-ins with other field members).

- Whenever possible, schedule work only within daylight hours (which fluctuate seasonally) or on weekends when questionable scenarios may be more minimal.
  - If night work is required, maintain a minimum of two field personnel at all times, and potentially increase the total number of personnel.
  - If working in high-risk areas, discuss the possibility of hiring security if work needs to be performed at night, in low light, or near potentially dangerous areas (e.g., abandoned buildings, public displays of hostility, discrimination, or gang-related activity).
- Maintain a field phone with active GPS and non-locking 911 capability at all times while out in the field.
- If a need arises for a change in field work (e.g., additional sampling or moving to an area that was not planned) or travel plans (e.g., dead battery or flat tire), immediately alert the FL and PM as to the event.

In addition, practice active awareness of your environment. Discuss personal health and safety concerns at the daily tailgate meeting. If you feel unsafe based on the potential behavior of others, immediately bring it up to field team coworkers. If the issue is not resolved to your satisfaction, alert the PM, FL, SSHO, and/or Human Resources Department to assist in resolving any potential issue(s).

13 Medical Surveillance Program

This section describes the medical surveillance program that Anchor QEA field personnel must comply with when working on sites where there is a potential for exposure to hazardous wastes or other hazardous substances.

13.1 General Requirements

Anchor QEA employees shall be enrolled in a medical surveillance program in compliance with OSHA standards (29 CFR 1910.120(f)) under the following circumstances.

If they are involved with any of the following operations:

- *Cleanup operations* required by a governmental body, whether federal, state, local, or other involving hazardous substances that are conducted at uncontrolled hazardous waste sites (including, but not limited to, the EPA's National Priority List [NPL] sites, state priority list sites, sites recommended for the EPA NPL, and initial investigation of government-identified sites that are conducted before the presence or absence of hazardous substances has been ascertained)
- *Corrective actions* involving cleanup operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 United States Code 6901 et seq)
- *Voluntary cleanup operations* at sites recognized by federal, state, local, or other governmental bodies as uncontrolled hazardous waste sites
- *Operations involving hazardous wastes* that are conducted at treatment, storage, and disposal facilities regulated by 40 CFR 264 and 40 CFR 265 pursuant to RCRA or by agencies under agreement with the EPA to implement RCRA regulations
- *Emergency response operations* for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard

And, if they meet the following criteria:

- Are or may be exposed to hazardous substances or health hazards at or above the established PEL, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more per year

In addition, employees are required to be enrolled in the medical surveillance program if they meet any of the following conditions:

- Wear a respirator for 30 days or more per year
- Are injured, become ill, or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operations

- Are members of a Hazardous Materials (HAZMAT) team

Anchor QEA employees required to be enrolled in a medical surveillance program under 29 CFR 1910.120(f) shall have medical examinations and consultations made available to them by Anchor QEA on the following schedule:

- Prior to assignment
- At least once every 12 months unless the attending physician believes a longer interval (not greater than biennially) is appropriate
- At termination of employment or reassignment to an area where the employee would not be covered if the employee has not had an examination within the last 6 months
- As soon as possible upon notification that the employee has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards, or that the employee has been injured or exposed above the PEL or published exposure levels in an emergency situation
- At more frequent times, if the examining physician determines that an increased frequency of examination is medically necessary

The content of medical examinations or consultations made available to employees shall be determined by the attending physician but shall include, at a minimum, a medical and work history with special emphasis on symptoms related to the handling of hazardous substances and health hazards, and to fitness for duty including the ability to wear any required PPE under conditions (i.e., temperature extremes) that may be expected at the work site.

The attending physician shall provide Anchor QEA with a written opinion for each examined employee that contains the following information:

- Whether the employee has any detected medical conditions that would place the employee at an increased risk of impairment of the employee’s health from hazardous waste operations work, emergency response, or respirator use
- Any recommended limitations on the employee’s assigned work
- A statement that the employee has been informed of the results of the medical examination and any medical conditions that require further examination or treatment

The written opinion obtained by Anchor QEA shall not reveal specific findings or diagnoses unrelated to occupational exposures. Medical surveillance and other employee-related medical records shall be retained for at least the duration of employment plus 30 years.

13.2 Team Self-Monitoring

All personnel will be instructed to look for and inform each other of any deleterious changes in their physical or mental condition during the performance of all field activities. Examples of such changes are as follows:

- Headaches
- Dizziness
- Nausea
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Skin chafing from damp or wet clothing
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern
- Symptoms of heat stress or heat exhaustion
- Symptoms of hypothermia

If any of these conditions develop, the affected person will be moved from the immediate work location and evaluated. If further assistance is needed, personnel at the local hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious. If the condition is the result of sample collection or processing activities, procedures and/or PPE will be modified to address the problem.

Attachment A

Health and Safety Logs and Forms

Daily Air Monitoring Record

Project Name: ______________________ **Date:** ______________________

Project Number: ______________________ **Location:** ______________________

Temperature: ______________________

Conditions: ______________________

COC	Instrument	S/N	Calibration Date	Calibration Gas/Method	Calibration by
Organic vapors					
Particulates					
O_2					
Other:					
Other:					
Other:					

Time	Location/Description	Organic Vapor (ppm)	O2%	CG %LEL	Other	Other

Notes:

Completed by:

Printed Name ______________________ Signature ______________________ Date ______________________

Daily Safety Briefing Form

Date: ______________________

Project No: ______________________

Project Name: ______________________

Person Conducting Meeting: ______________ **Health & Safety Officer:** ______________ **Project Manager:** ______________

TOPICS COVERED:

- ☐ Emergency Procedures and Evacuation Route
- ☐ Directions to Hospital
- ☐ HASP Review and Location
- ☐ Safety Equipment Location
- ☐ Proper Safety Equipment Use
- ☐ Employee Right-to-Know/ SDS Location
- ☐ Fire Extinguisher Location
- ☐ Eye Wash Station Location
- ☐ Buddy System
- ☐ Self and Coworker Monitoring
- ☐ Lines of Authority
- ☐ Communication
- ☐ Site Security
- ☐ Vessel Safety Protocols
- ☐ Work Zones
- ☐ Vehicle Safety and Driving/ Road Conditions
- ☐ Equipment Safety and Operation
- ☐ Proper Use of PPE
- ☐ Decontamination Procedures
- ☐ Near Miss Reporting Procedures
- ☐ Lifting Techniques
- ☐ Slips, Trips, and Falls
- ☐ Hazard Exposure Routes
- ☐ Heat and Cold Stress
- ☐ Overhead and Underfoot Hazards
- ☐ Chemical Hazards
- ☐ Flammable Hazards
- ☐ Biological Hazards
- ☐ Eating/Drinking/Smoking
- ☐ Reviewed Prior Lessons Learned
- ☐ Field Team Medical Conditions for Emergency Purposes (Confidential): ______________________
- ☐ Other: ______________________

Weather Conditions: ______________________

Daily Work Scope: ______________________

Site-specific Hazards: ______________________

Safety Comments: ______________________

Attendees

Printed Name	Signature

End of Day Wellness Check

PLAYING IT SAFE

ANCHOR QEA

Modification to Health and Safety Plan

Date:

Project No:

Project Name:

Modification:

Reason for Modification:

Site Personnel Briefed

Name: **Date:**
Name: **Date:**
Name: **Date:**
Name: **Date:**
Name: **Date:**
Name: **Date:**
Name: **Date:**
Name: **Date:**
Name: **Date:**
Name: **Date:**
Name: **Date:**

Approvals

Field Lead:
Printed Name Signature Date

Project Manager:
Printed Name Signature Date

Heat Stress Monitoring Record

Date: ______________________

Project No: ______________________

Project Name: ______________________

Location: ______________________

	Monitoring Results												
	Initial Reading Time:	First Work Period Time:		Second Work Period Time:		Third Work Period Time:		Fourth Work Period Time:		Fifth Work Period Time:		Sixth Work Period Time:	
	WBGT (°F):	WBGT (°F):		WBGT (°F):		WBGT (°F):		WBGT (°F):		WBGT (°F):		WBGT (°F):	
Employee Name	Air Temp (°F):	Air Temp (°F):		Air Temp (°F):		Air Temp (°F):		Air Temp (°F):		Air Temp (°F):		Air Temp (°F):	
	Initial Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:	Initial Temp:	Final Temp:
	Initial H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:	Initial H.R.:	Final H.R.:
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Notes:

Completed by:

Printed Name

Signature

Date

ANCHOR QEA

Utility Contact Prevention Checklist

NOTE: Utility mark-out requirements vary from state to state;
consult state authorities before beginning work.

Purpose: This form is intended to help the Field Lead confirm that underground or overhead utilities are identified to the extent practicable and consistent with applicable regulations **PRIOR** to site work.

INVESTIGATIONS MUST NOT OCCUR UNTIL MULTIPLE LINES OF EVIDENCE INDICATE THAT SUBSURFACE OR OVERHEAD UTILITIES ARE NOT PRESENT IN THE WORK AREA

Project Name/No: ____________________ **Date:** ____________________

Field Lead: ____________________ **Project Address:** ____________________

Project Manager: ____________________ **Health & Safety Officer:** ____________________

Emergency Contact Information for One Call: ______________________________

Duration/Summary of Work to be Performed: ______________________________

____

____

Consideration	Check		Explanation	Initial
Has the state One Call been contacted?	☐ Yes	☐ No		
Has the property owner or client been contacted for local knowledge of utilities, as applicable?	☐ Yes	☐ No		
Does the property owner or client have specific utility contact prevention procedures and, if so, have they been completed?	☐ Yes	☐ No		
Are any as-built drawings available? If so, do they show any utilities?	☐ Yes	☐ No		
Has a visual inspection of the work area(s) been completed?	☐ Yes	☐ No		
Has the potential presence of in-water utilities been assessed (shore markers, streets dead-ending at water's edge, etc.)	☐ Yes	☐ No		
Is evidence of electrical utilities present? (electric meters on structures, conduits, overhead lines, light poles, etc.)	☐ Yes	☐ No		
Is evidence of water/sewer utilities present? (water meter, hydrants, restrooms, grates in ground, etc.)	☐ Yes	☐ No		
Is evidence of telecommunications utilities present? (fiber optic warning signs, conduits from utility poles, wall-mounted boxes, etc.)	☐ Yes	☐ No		
Is other evidence of utilities present? (unknown ground markings, manholes or valve covers, "Call Before You Dig" signs, linear asphalt or concrete repair characteristics, liner subsidence of ground surface, pin flags or stakes, etc.)	☐ Yes	☐ No		

PLAYING IT SAFE

ANCHOR QEA

Utility Contact Prevention Checklist

NOTE: Utility mark-out requirements vary from state to state;
consult state authorities before beginning work.

Consideration	Check		Explanation	Initial
Has a private locating service been contacted?	☐ Yes	☐ No		
Were any utilities identified and marked out through a private locating service? If so, duplicate mark-outs on site drawings.	☐ Yes	☐ No		
Are there any fiber optic cables, fuel lines, or high-pressure lines within 50 feet of work locations?	☐ Yes	☐ No		
If fiber optic cables, fuel lines, or high-pressure lines are within 50 feet, has an agreement with the utility owner been established?	☐ Yes	☐ No		
Can a test borehole be advanced by hand digging, probing, post-hole digging, and/or air knifing to 5 feet below ground surface (bgs)?	☐ Yes	☐ No		
If hand digging, probing, post-hole digging, and/or air knifing to 5 feet bgs is not possible, can a non-invasive geophysical investigation be conducted? If not, why?	☐ Yes	☐ No		
Other considerations:				

NOTE: Please fill in second page and attach additional reports, drawings, or other information, as necessary.

Confirmation Number:

Contact Name: **Organization:**

Contact Date: **Contact Time:**

Response:

Completed by:

Printed Name Signature Date

Contractor:

Printed Name Signature Date

Attachment B

Job Safety Analysis Documents

Job Safety Analysis

Field Activities

Project Name: Bench Scale Treatability Study Sampling	**Project Number:** 000029-02.85	**JSA Number:** 001	**Issue Date:**
Location: Portland, Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Billie-Jo Gauley	**Analysis Date:** February 14, 2023
Work Operation: Field activities	**Superintendent/Competent Person:** Nik Bacher	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Tim Shaner **Approved by:** Ryan Barth	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating		• Follow the JSA for boating activities.	
Outdoor, physical activity	Slips, trips, and falls	• Be aware of potentially slippery surfaces and tripping hazards. • Use handrails where available. • Wear footwear that has sufficient traction. • Maintain good housekeeping practices. • Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Keep all areas clean and free of debris to prevent any trips and falls. • Be aware of and limit loose clothing or untied shoelaces that may contribute to slips, trip, and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.

Job Safety Analysis

Field Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity (continued)	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.
	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • Use appropriate cold-weather gear, up to and including Mustang-type bib coveralls or jacket/bib combinations. • Consider additional precautions if working near water in cold weather. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain/snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.
	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are available.
	Lightning	• Do not begin or continue work until lightning subsides for at least 30 minutes. Disconnect and do not use or touch electronic equipment. • Immediately head for shore if on the water and lightning is observed. If not able to get to shore, disconnect and do not use or touch the major electronic equipment, including the radio, throughout the duration of the storm.	• Obtain weather forecast and updates as needed.

Job Safety Analysis

Field Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity (continued)	High winds	• Wear goggles or safety glasses if dust or debris are visible.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are available.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellant. • Wear hand and arm protection when clearing plants or debris from the work area. • Be aware of potential wildlife and defensive behavior (e.g., nesting birds, or animals with young).	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state boater safety courses.
- All personnel working on this project must have received Hazard Communications training, part of annual refresher, in addition to the field lead providing an overview of all SDSs for this project.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Sediment Sampling

Project Name: Bench Scale Treatability Study Sampling	**Project Number:** 000029-02.85	**JSA Number:** 002	**Issue Date:**
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Billie-Jo Gauley	**Analysis Date:** February 14, 2023
Work Operation: Sediment sampling	**Superintendent/Competent Person:** Nik Bacher	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Tim Shaner	**Reviewed Date:**
		Approved by: Ryan Barth	**Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating		• Follow the JSA for boating activities.	
If using glassware		• Follow the JSA for handling glassware.	
Sediment sample retrieval and processing	Injury from hand and power tool operation (e.g., spatula or drill)	• Be aware of sharp edges on hand tools (e.g., spatulas, knives, drill bits, and saw blades). • Be aware of electrical connections and water hazards when working with electric- or battery-operated tools. • Ensure that all tools are working properly; repair or replace defective tools. Repair when unplugged and off. • Keep guards on power tools when not in use.	• Inspect tools to ensure that they are in good working order. • Inspect electrical connections (if applicable). • Inspect tools periodically to ensure dry and clean operation.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.

Job Safety Analysis

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Sediment sample retrieval and processing (continued)	Slips, trips, and falls	• Be aware of potentially slippery surfaces, including boat decks, riprap, muddy or algae-covered rocks, shoreline plants/seaweed, thick mud, and tripping hazards. • Use handrails where available. • Wear footwear that has sufficient traction. • Maintain good housekeeping practices. • Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Be cautious when entering or exiting the vessel, and load/unload items onto/off of the pier or shore once boarded. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.
	Ingestion of contaminants, skin/eye contact with contaminants	• Wear appropriate PPE (uniform/coveralls, work boots, safety glasses, dust mask, and/or gloves) to prevent or reduce exposure. • Contact 911, as necessary; perform CPR if breathing stops. • Move exposed person away from source of contamination, and rinse mouth. • If exposure to skin occurs, promptly wash contaminated skin using soap or mild detergent and water. • Rinse eyes with large amounts of water. • Follow decontamination procedures as outlined in the Health and Safety Plan (HASP).	• Ensure that decontamination procedures are on hand and are reviewed. • Ensure that PPE and rinsing water are available.
	Inhalation of contaminants	• Follow air monitoring requirements and action levels contained in HASP.	• Review air monitoring requirements in the HASP
	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects. • If boating, avoid carrying objects directly onto or off the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.
	Pinch points	• If boating, secure any unsecured objects on deck; they may shift on deck quickly in wave, current, or engine acceleration conditions. • Maintain a safe distance from closing mechanisms and moving parts on sampling gear. • Avoid placing hands or self between boat and dock/piles.	

Job Safety Analysis

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Sediment sample retrieval and processing (continued)	Wading	• Be aware of potentially slippery surfaces and tripping hazards such as fallen brush, logs, rocks, and other debris. Wear footwear that has sufficient traction. • Be aware of water depth and potential drop-offs. • Be aware of existing and projected river flows. • Wear hip or chest waders as appropriate for traction and to protect against cold water. • Keep an extra set of dry clothes on hand, including socks. • Use a wading staff for balance and to check for obstructions in murky water. • Always wear a PFD equipped with a whistle, even if water looks shallow or slow; drop-offs occur and water is often moving faster than it looks. • Avoid entering the water when depths are greater than waist height. • Avoid entering the water in areas of high flow or when large floating debris is present. • Waders should fit the person and not be overly baggy • A wading belt should always be worn (some waders come equipped with one) • Felt and/or studded wading boots • When water is deeper than knee deep, walk sideways, at an angle, or shuffle your feet when walking and never cross your feet • Bottom conditions, water conditions and flow can change and must be considered when determining safe allowable wading depth. Higher flow conditions will reduce the safe allowable wading depth. • Water should be entered from the bank and only from a boat that is anchored or on the bank. • If a boat is being used, all applicable boating H&S procedures should be followed (e.g., throwable safety buoy/line (throw bag)) • When entering the water, depth at entry point should be one foot or less and the bottom visible. • Wading should not be conducted if there is overhanging vegetation, logs or other obstructions that would prevent standing upright while wading. • If the current makes it difficult to hold your position, stop and cease wading • Deepest water depth acceptable for wading is to an individual's waist. If water depth increases beyond that point, do not proceed into deeper water. Look for an area with shallower water. If shallower water cannot be found, work must be completed from a boat.	• Inspect work area for tripping hazards visible from streambank. • Inspect waders for leaks. • Check depths and flows before wading. • Ensure that change of dry clothes is available if wading in cold weather or cold water conditions.

Job Safety Analysis

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.
	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • Use appropriate cold-weather gear, up to and including Mustang-type bib coveralls or jacket/bib combinations. • Consider additional precautions if working near water in cold weather. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain/snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.
Working outdoors (continued)	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are available.
	Lightning	• Do not begin or continue work until lightning subsides for 30 minutes. Disconnect and do not use or touch electronic equipment. • Immediately head for shore if on the water and lightning is observed. If not able to get to shore, disconnect and do not use or touch the major electronic equipment, including the radio, throughout the duration of the storm.	• Obtain weather forecast and updates as needed.

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
	High winds	• Wear goggles or safety glasses if dust or debris are visible.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are available.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellant. • Wear hand and arm protection when clearing plants or debris from the work area.	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state boater safety courses.
- All personnel working on this project must have received Hazard Communications training, part of annual refresher, in addition to the field lead providing an overview of all SDSs for this project.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

General Boating Activities

Project Name: Bench Scale Treatability Study Sampling	**Project Number:** 000029-02.85	**JSA Number:** 003	**Issue Date:**
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Billie-Jo Gauley	**Analysis Date:** February 14, 2023
Work Operation: General boating activities	**Superintendent/Competent Person:** Nik Bacher	**Revised by:**	**Revised Date:**
Required PPE: • USCG-approved PFD; see cold stress section for cold-weather PFD information • USCG-approved float coat and bib-overalls (e.g., full two-piece “Mustang” survival suit or similar) or one-piece survival suit if combined air and water temperature is below 90°F • See Section 5 of HASP for PPE for activities on vessels other than transportation		**Reviewed by:** Tim Shaner	**Reviewed Date:**
		Approved by: Ryan Barth	**Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Walking on deck	Pinch points	• Secure any unsecured objects on deck; they may shift quickly in wave, current, or engine acceleration conditions. • Maintain a safe distance from closing mechanisms and moving parts, such as on sampling gear. • Avoid placing your hands or yourself between the boat and the dock or piles.	
	Slips, trips, and falls	• Be aware of potentially slippery surfaces, including boat decks, riprap, muddy or algae-covered rocks, shoreline plants or seaweed, thick mud, and tripping hazards. Use handrails where available. • Wear footwear that has sufficient traction. • Maintain good housekeeping practices. • Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Be cautious when entering or exiting the vessel, and load/unload items onto/off of the pier or shore once boarded. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions. • Keep rope lines neatly coiled and stowed. Avoid stepping on or over lines.	• Routinely inspect work area for unsafe conditions.

Job Safety Analysis

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Walking on deck (continued)	Exceeding boat capacity	• Keep the number of passengers and equipment as posted on boat placards within limits at all times. If conditions warrant, reduce capacity to maintain boat stability.	• Ensure that field team is aware of limits and adheres accordingly.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.
Working outdoors	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.
	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • If the combined air and water temperature is below 90 degrees Fahrenheit (˚F), wear a USCG-approved float coat, Mustang-type bib coveralls, or one-piece survival suit. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain/snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.
	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are onboard.
	Fog	• Wait for fog to lift for adequate visibility.	• Review weather forecast prior to field work.

Job Safety Analysis

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors (continued)	Lightning	• Do not begin or continue work until lightning subsides for at least 30 minutes. Disconnect and do not use or touch electronic equipment. • Immediately head for shore if on the water and lightning is observed. • If not able to get to shore, disconnect and do not use or touch the major electronic equipment, including the radio, throughout the duration of the storm.	• Obtain weather forecast and updates as needed.
	High river flows or high waves	• Be aware of waves and forecasts and recent rainfall in your watershed.	• Have forecast available.
	High winds	• Wear goggles or safety glasses if dust or debris are visible. • Stow or secure loads or equipment that could be moved by wind, particularly when underway.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are onboard.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellent.	• Ensure that insect repellent is onboard.
Vessel emergencies	Person overboard	If you witness someone fall overboard: • Yell, "Person overboard!" • Throw a flotation device immediately. • If the engine is running, take it out of gear and swing the stern clear to keep from hitting the person. • Call 911 or USCG as appropriate. • Assign a spotter to keep the person in sight at all times. • Contact nearby vessels for assistance. • Recover the person from the water. If you fall overboard: • Hold your mouth and nose closed and protect your head. • When you reach the surface, look for movement, listen for sounds, and call for help. Use the whistle attached to the PFD and activate the beacon light. • It is only sensible to swim if there is reason to believe you have a chance of reaching your destination. Too much movement in cold water causes hypothermia.	• Ensure that flotation devices are available. • Ensure that team wears PFDs.

Job Safety Analysis

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Vessel emergencies (continued)	Fire, abandon ship	• Be prepared to abandon ship in case of major fire (too large to control with a fire extinguisher), or other emergency. • Only the boat captain can order abandon ship. • Communicate intent to abandon ship to all personnel onboard. • Notify USCG and nearby vessels of intent to abandon ship. • Call 911. • Notify the Project Manager and Field Lead, if time permits. • Be aware of the propeller position before abandoning ship. • Identify a rally point for all personnel. • Know the dangers of hypothermia. • Use the buddy system to support injured personnel.	• Ensure that fire extinguisher is available, current, and in working order. • Review abandon ship procedures with field team prior to work.
Navigation	Boat traffic	• Maintain a safe operating distance from shoreline and other vessels.	• Be aware of on-water surroundings.
Motor vehicle operation and trailering	Boat not secured properly	• Ensure that latches, straps, antennas, and onboard gear are secure. Ensure that motor is up and lights are plugged in for driving. • Follow Job Safety Analysis (JSA) for motor vehicle operation.	• Inspect around entire boat before driving.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If professional captained vessel is not in use, boat operators must take appropriate state boater safety courses.
- All personnel working on this project must have received Hazard Communications training, part of annual refresher, in addition to the field lead providing an overview of all SDSs for this project.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Decontamination Activities

Project Name: Bench Scale Treatability Study Sampling	**Project Number:** 000029-02.85	**JSA Number:** 004	**Issue Date:**
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Billie-Jo Gauley	**Analysis Date:** February 14, 2023
Work Operation: Decontamination activities	**Superintendent/Competent Person:** Nik Bacher	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Tim Shaner **Approved by:** Ryan Barth	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating		• Follow the JSA for boating activities.	
Decontamination area set up	Vehicle, heavy equipment traffic, or boat traffic in work area	• Wear high-visibility safety vest and hard hat PPE. • Be alert when working around heavy equipment and/or other boats, especially if wearing hearing protection.	• Ensure that safety vests are available for staff and visitors.
	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects. • If boating, avoid carrying objects directly onto or off of the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellent. • Wear hand and arm protection when clearing plants or debris from the work area.	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.

Job Safety Analysis

Decontamination Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Decontamination activities	Injury from hand and power tool operation (e.g., spatula or drill)	• Be aware of sharp edges on hand tools (e.g., spatulas, knives, drill bits, and saw blades). • Be aware of electrical connections and water hazards when working with electric- or battery-operated tools. • Ensure that all tools are working properly; repair or replace defective tools. Repair when unplugged and off. • Keep guards on power tools when not in use.	• Inspect tools to ensure that they are in good working order. • Inspect electrical connections (if applicable). • Inspect tools periodically to ensure dry and clean operation.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.
	Slips, trips, and falls	• Be aware of potentially slippery surfaces and tripping hazards. • Use handrails where available. • Wear footwear that has sufficient traction. • Maintain good housekeeping practices. • Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.
	Ingestion of contaminants, skin/eye contact with contaminants	• Wear appropriate PPE to prevent/reduce exposure. • Contact 911, as necessary; perform CPR if breathing stops. • Move exposed person away from source of contamination, and rinse mouth. • If exposure to skin occurs, promptly wash contaminated skin using soap or mild detergent and water. • Rinse eyes with large amounts of water. • Follow decontamination procedures as outlined in the Health and Safety Plan (HASP).	• Ensure that decontamination procedures are on hand and are reviewed. • Ensure that PPE and rinsing water are available.

Job Safety Analysis

Decontamination Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors	Inhalation of contaminants	• Follow air monitoring requirements and action levels contained in HASP.	• Review air monitoring requirements in the HASP
	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.
	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • Use appropriate cold-weather gear, up to and including Mustang-type bib coveralls or jacket/bib combinations. • Consider additional precautions if working near water in cold weather. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain/snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.
	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are available.
	Lightning	• Do not begin or continue work until lightning subsides for at least 30 minutes. Disconnect and do not use or touch electronic equipment.	• Obtain weather forecast and updates as needed.
	High winds	• Wear goggles or safety glasses if dust or debris are visible.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are available.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state boater safety courses.
- All personnel working on this project must have received Hazard Communications training, part of annual refresher, in addition to the field lead providing an overview of all SDSs for this project.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Drilling

Project Name: Bench Scale Treatability Study Sampling	**Project Number:** 000029-02.85	**JSA Number:** 005	**Issue Date:**
Location: Portland, Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Billie-Jo Gauley	**Analysis Date:** February 14, 2023
Work Operation: Drilling and Soil Sampling	**Superintendent/Competent Person:** Nik Bacher	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP): PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Tim Shaner	**Reviewed Date:**
		Approved by: Ryan Barth	**Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating		• Follow the JSA for boating activities.	
Borehole logging and soil sampling/ processing	Cuts or incisions from opening sample liner with cutting tools	• If possible, have drilling contractor open plastic sample liners, split-spoon samplers, etc. • Wear Cut resistant gloves when opening or handling sample liners. • Cut away from body while opening plastic liners. • Use specialized core cutting table if available. • Be aware of electrical connections and water hazards when working with electric- or battery-operated tools. • Ensure that all tools are working properly; repair or replace defective tools. Repair when unplugged and off. • Keep guards on power tools when not in use.	• Inspect tools to ensure that they are in good working order. • Inspect electrical connections (if applicable). • Inspect tools periodically to ensure dry and clean operation.

Drilling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Borehole logging and soil sampling/ processing (continued)	Muscle strain/injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects.	• Evaluate weight and center of gravity of heavier items prior to lifting/moving.
	Ingestion of contaminants, skin/eye contact with contaminants	• Wear appropriate PPE (uniform/coveralls, work boots, safety glasses, dust mask, and/or gloves) to prevent or reduce exposure. • Contact 911, as necessary; perform CPR if breathing stops. • Move exposed person away from source of contamination, and rinse mouth. • If exposure to skin occurs, promptly wash contaminated skin using soap or mild detergent and water. • Rinse eyes with large amounts of water. • Follow decontamination procedures as outlined in the Health and Safety Plan (HASP).	• Ensure that decontamination procedures are on hand and are reviewed. • Ensure that PPE and rinsing water are available.
	Inhalation of contaminants	• Follow air monitoring requirements and action levels contained in HASP.	• Review air monitoring requirements in the HASP
	Pinch points	• Maintain a safe distance from closing mechanisms and moving parts on sampling gear. • Avoid placing hands or self between pieces of equipment or objects.	
Drilling activities	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.
	Rotating and moving equipment	• Set up borehole logging station in area well clear of drill rig and drilling activities. • Set up borehole logging station in an upwind location, if possible. • Stay clear of drill rig while drill rig is in operation.	• Get visual contact with driller and ensure driller has shut down rig before approaching drilling work area • Confirm with driller that borehole logging station will not be in a potentially hazardous location.

Job Safety Analysis

Drilling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Drilling activities (continued)	Traffic	- Use methods such as cones, signs, lights, caution tape, etc., to divert and slow traffic near work site.	- Evaluate work site for traffic hazards before commencing work.
	Moving support vehicles or forklifts	- Set up borehole logging station in area well clear of moving vehicles and work zones.	- Confirm with driller that borehole logging station will not be in a potentially hazardous location.
	Slips, trips, and falls	- Be aware of potentially slippery surfaces, including riprap, muddy or algae-covered rocks, shoreline plants/seaweed, thick mud, and tripping hazards. - Wear footwear that has sufficient traction. - Maintain good housekeeping practices. - Clean up all spills immediately. - Be aware of weather effects on the work area, including wet and/or frozen ground. - Jumping, running, and horseplay are prohibited. - Keep all areas clean and free of debris to prevent any trips and falls. - Notify the field team members of any unsafe conditions.	- Routinely inspect work area for unsafe conditions.
Working outdoors	Heat stress	- Adjust work schedules, as necessary, to avoid the hottest part of the day. - Take rest breaks as warranted. - Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. - Maintain body fluids at normal levels. - Train workers to recognize the symptoms of heat-related illness.	- Review weather forecast prior to field work. - Monitor workers' physical conditions. - Monitor outside temperature versus worker activity.

Job Safety Analysis

Drilling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors (continued)	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • Use appropriate cold-weather gear. • Consider additional precautions if working near water in cold weather. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain/snow	• Wear appropriate PPE (rain gear). • Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • Routinely inspect work area for deteriorating conditions.
	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are available.
	Lightning	• Do not begin or continue work until lightning subsides for 30 minutes. Disconnect and do not use or touch electronic equipment. • Immediately take shelter if lightning is observed or thunder is heard.	• Obtain weather forecast and updates as needed.
	High winds	• Wear goggles or safety glasses if dust or debris are visible.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are available.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellant. • Wear hand and arm protection when clearing plants or debris from the work area.	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.

Job Safety Analysis

Drilling

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including, but not limited to initial 40-hour and annual 8-hour refresher training.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120 (f).
- All personnel working on this project must have received Hazard Communications training, part of annual refresher, in addition to the field lead providing an overview of all SDSs for this project.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity.

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Project Name: Bench Scale Treatability Study Sampling	**Project Number:** 000029-02.85	**JSA Number:** 006	**Issue Date:**
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Billie-Jo Gauley	**Analysis Date:** February 14, 2023
Work Operation: Anchor QEA motor vehicle operation	**Superintendent/Competent Person:** Vehicle Driver	**Revised by:**	**Revised Date:**
Required PPE: • Wear seat belt at all times. • Make sure that clothing will not interfere with driving.		**Reviewed by:** Tim Shaner	**Reviewed Date:**
		Approved by: Ryan Barth	**Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Anchor QEA motor vehicle operation	Unfamiliar with the vehicle	• Allow yourself some time to get familiar with an Anchor QEA vehicle, a rental vehicle, or one not used often. • Test the lights, windshield wipers, hazard lights, horn, parking brake, and other important functions. • Review the dashboard controls, steering radius, and overhead and side clearances. • Allow extra side, front, and back space around the vehicle while driving or parking an unfamiliar vehicle. • Adjust mirrors and the seat while the vehicle is in park. • Drive slowly in confined locations, as in a parking garage, parking lots, or industrial settings. Confirm adequate clearances by sight before turning or backing up in tight or unfamiliar locations. • Use a second person to be a spotter outside the vehicle if needed in tight spaces.	• Inspect fluid levels and air pressure in tires, adjust mirrors and seat positions appropriately, monitor the fuel level, and fill up when the fuel level is low
	Speed and Braking	• Fasten and properly adjust the seat belt. • Obey all posted and designated speed limits. • Radar detectors are prohibited in all company-owned, leased, or rented vehicles. • Reduce travel speed during hazardous conditions (e.g., rain, fog, or snow). • Identify whether your vehicle has Anti-Lock Brakes (ABS). If it does, DO NOT pump the brakes to stop when the vehicle has begun to skid. Apply steady pressure to the brakes. If the vehicle does not have ABS, pump the brakes to stop during slippery conditions.	• Seatbelt • Identify designated speed limits • Determine if vehicle has ABS

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Anchor QEA motor vehicle operation (continued)	Distance spacing	• Continually check your rear and side view mirrors. • Use the 3-second rule to keep a safe distance between vehicles. • Increase the 3-second rule as necessary during hazardous travel conditions. • Regularly scan the area you will be entering in the next 10 to 12 seconds. • Always leave yourself an "out" during travel. • When stopping, make sure that you leave enough distance between you and the car in front of you. You should be able to see the rear tires of the vehicle in front when stopped. • Obey the speed limit and traffic regulations. • When at a red light and it turns green, use the "delayed start" technique, by counting to three before you take your foot off the brake. • DO NOT TAILGATE. • Keep headlights (and running lights, if available) on for maximum visibility.	• Seatbelt
	Skids	• If the vehicle has begun to skid out of control, turn the steering wheel in the direction of the skid and re-adjust the wheel, as necessary. • Reduce speed during hazardous travel conditions. • Use 4-wheel drive, if available, when driving vehicles off-road, on steep inclines, or in muddy conditions. • Do not take vehicles off-road if they cannot be operated safely in such conditions.	• Seatbelt
	Blind spots	• Become familiar with any blind spots associated with your vehicle. • Adjust mirrors to give the maximum viewing area. • Use your directional devices to signal all turns and when changing lanes; check rear and side view mirror and glance over your shoulder to check that the lane is clear. • Avoid other driver's blind spots; slow down and let the other vehicle pass. • If parked for an extended period and staying in the vehicle, be sure to inspect the area for changed conditions (e.g., a car that moved in behind you) before leaving.	• Seatbelt • Mirrors
	Backing	• Back into parking spaces upon arrival whenever possible. • Perform a 360-degree walk around the vehicle before backing to identify any new conditions or obstructions. • Use a spotter when backing whenever possible. • Understand hand signals. • Sound the horn prior to backing. • Check the rear and side view mirrors prior to backing. • Back slowly in areas of obstructed vision. • Anticipate others who may be backing out into your pathway and adjust accordingly.	• Seatbelt • Mirrors

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Anchor QEA motor vehicle operation (continued)	Distractions (e.g., cell phones, reading maps or directions, eating)	• Do not engage in distracted driving—focus on operating the vehicle, and on your surroundings (e.g., road conditions and other drivers). • Obey state or local laws regarding cell phone use, at a minimum. • Certain clients prohibit cell phone use regardless of the state you are operating in—know your client's policy. • Use hands-free devices (not hand-held cellular phones) while driving. • Pull over to the side of the road when making a call or checking directions.	• Seatbelt • Hands-free devices connected and ready for use
	Accidents	• In the event of an accident, use the following procedures: – Stop, call for medical assistance, notify police, and complete an accident report and submit it to your supervisor. – Notify the Project Manager (PM) and Field Lead (FL). – Complete the appropriate incident investigation reports. – Contact Sara Weiskotten, Operations Liaison, at (857) 445-4987. – Contact Diana Reynolds, Insurance Liaison, at (302) 236-8403.	• Seatbelt
	Influenced by drugs or alcohol	• NEVER DRIVE UNDER THE INFLUENCE OF DRUGS OR ALCOHOL. • Keep in mind that the person in another vehicle may be under the influence of controlled substances, and be prepared for erratic or sudden driving changes on their part.	• Seatbelt
	Driver attitude	• Do not operate any vehicle when abnormally tired, temporarily disabled (i.e., injured), or under the influence of drugs or alcohol. • Keep an even temper when driving. Do not let the actions of others affect your attitude. • Do not allow yourself to become frustrated, rushed, distracted, or drowsy.	• Seatbelt
	Fatigue	• Stop and rest if fatigued. Exit the road and enter a safe area. Rest until fully refreshed. • Be aware that certain medications (such as cold or allergy medicines) may make you drowsy when driving a vehicle.	• Seatbelt
	Vehicle loading	• DO NOT OVERLOAD the vehicle. • Secure all equipment and supplies within the body of the vehicle using proper tie-downs. • Do not block side view mirrors with the load. • Do not transport U.S. Department of Transportation (DOT)-manifested hazardous materials. • Dispatch all equipment and personnel with proper forms and identification.	• Seatbelt

Anchor QEA Motor Vehicle Operation

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Anchor QEA motor vehicle operation (continued)	Equipment failure	• Perform daily inspections of your vehicle. • Maintain vehicle safety equipment (e.g., mirrors, alarms, horns, wipers, lights, and brakes). • Maintain the vehicle (e.g., tire pressure and fluid levels). • Any vehicle with mechanical defects that may endanger the safety of the driver, passengers, or the public shall not be used. • Ensure that appropriate safety equipment is in the vehicle. Safety equipment should include a spare tire, jack, first-aid kit, fire extinguisher, and flashlight. Flares and/or reflective triangles should be available in larger trucks. • Ensure that the proper documentation is in the vehicle. Documentation should include an operations manual for the vehicle, insurance card, vehicle registration, and accident forms.	• Inspect and maintain the vehicle

Training Requirements:

- All drivers are required to have a valid driver’s license, and all vehicles must have appropriate state vehicle registration and inspection stickers. The use of hand-held wireless devices is prohibited while driving any vehicle for business use at any time, for personal use during business hours, and as defined by law.
- **If operating a vehicle or vehicle and trailer with a capacity greater than 10,000 pounds, U.S. Department of Transportation regulations may apply. Contact the PM prior to any travel in this configuration.**
- All assigned employees are required to read, familiarize themselves with the contents of Job Safety Analysis, and sign the signature page before the operation of an Anchor QEA vehicle, and review it with their supervisor during their daily safety meeting. All assigned drivers are required to complete annual driver training.

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Vehicle Operation Job Safety Analysis Acknowledgement Form

The Anchor QEA Motor Vehicle Operation Job Safety Analysis must be read, understood, and signed before the operation of any Anchor QEA vehicle. My signature below certifies that I have read and understand the procedures presented in the Anchor QEA Motor Vehicle Operation Job Safety Analysis and have completed annual driver training.

Date	Name (print)	Signature

Anchor QEA Motor Vehicle Operation

Date	Name (print)	Signature

Job Safety Analysis

Sample and Laboratory Glassware Handling

Project Name: Bench Scale Treatability Study Sampling	**Project Number:** 000029-02.85	**JSA Number:** 009	**Issue Date:**
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Billie-Jo Gauley	**Analysis Date:** February 14, 2023
Work Operation: Sample and laboratory glassware handling	**Superintendent/Competent Person:** Nik Bacher	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP):, PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Tim Shaner **Approved by:** Ryan Barth	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Transporting and using glassware	Breakage of containers during field activities	• Use appropriately sized tubs or bottle carriers with dividers to prevent bottle-to-bottle contact during transport. • Consider using coated glassware, if practicable. • Carry oversize bottles in tubs or bottle carriers using both hands during transfer to the sampling vessel and whenever the vessel is underway. • Comply with cooler weight limits if provided by laboratory.	• Ensure dividers are sufficient and will remain in place during transport.
	Faulty glassware	• Do not use and replace any glassware that is chipped, nicked, or cracked.	• Inspect glassware before use.
	Impact with equipment and other objects	• Use care when loading and unloading sampling equipment. • Minimize the handling of individual containers to the extent possible.	
Transporting and using glassware (continued)	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects. • If boating, avoid carrying objects directly onto or off the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.

Job Safety Analysis

Sample and Laboratory Glassware Handling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Filling sample containers	Over-tightening of bottle lids causing breakage	• Avoid use of excessive force to tighten bottle caps (i.e., finger tight). • Secure lids with clear tape to prevent opening during transport.	
	Breakage during sample collection	• Place containers in plastic tubs between aliquots to limit contact with hard surfaces. • Place containers on a stable and non-slip surface during collection. • Use the buddy system as needed to hold bottles during filling.	
	Contact with sample preservatives (generally HCL or H_2SO_4 to lower pH to less than 2)	• Wear nitrile gloves and protective eyewear to prevent skin and eye contact. • Do not open preserved bottles until necessary.	
Packing samples for shipment	Breakage during packing and shipment	• Use bottle wraps, foam sleeves, or bubble wrap to prevent bottle contact in the cooler. • Pack coolers snugly, but do not over pack.	• Ensure glass bottles do not touch to minimize potential breakage during transport.
	Dry ice use and handling	• Always handle dry ice with thermal gloves, never with bare hands • Avoid contact with unprotected skin at all times (hands, forearms, etc.) • Dry ice must be stored and handled in only well-ventilated areas, to prohibit creation of an oxygen-deficient atmosphere • Do not store dry ice in airtight containers. • Packaging, marking, labeling, loading, and shipping/transporting samples with dry ice may be carried out only by staff who have received specific training required by DOT. Contact Health and Safety for assistance with ensuring applicable staff are appropriately trained in accordance with DOT regulations. • Shipping samples with dry ice must comply fully with courier requirements and only after receiving training. • No staff may transport dry ice in a vehicle prior to receiving training and discussing with the Director of Health and Safety.	

Job Safety Analysis

Sample and Laboratory Glassware Handling

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including, but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- Dry ice training as appropriate.
- All personnel working on this project must have received Hazard Communications training, part of annual refresher, in addition to the field lead providing an overview of all SDSs for this project.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Investigation-Derived Waste Management

Project Name: Bench Scale Treatability Study Sampling	**Project Number:** 000029-02.85	**JSA Number:** 010	**Issue Date:**
Location: Portland Oregon	**Contractor:** Anchor QEA, LLC	**Analysis by:** Billie-Jo Gauley	**Analysis Date:** February 14, 2023
Work Operation: Investigation-derived waste (IDW) management	**Superintendent/Competent Person:** Nik Bacher	**Revised by:**	**Revised Date:**
Required PPE: • Modified Level D—Standard work uniform/coveralls, work boots conforming to ASTM F2412-05, traffic safety vest conforming to ANSI 107, safety glasses conforming to ANSI Z87.1 with permanently installed side shields, hard hat conforming to ANSI Z89, hearing protection • Depending on activity, the following PPE may also be required (see Section 5 of HASP):, PFD, cold water clothing, disposable chemical coveralls, inner and outer gloves		**Reviewed by:** Tim Shaner **Approved by:** Ryan Barth	**Reviewed Date:** **Approved Date:**

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Containerizing IDW at the source	Lifting	• Use care when lifting to redistribute IDW from one container (e.g., drums and buckets) to another at the source. • Seek assistance if loads are too heavy, or if you are experiencing fatigue. • Fill containers only to the degree that will be manageable in the future (e.g., half full) and to limit weight.	• Inspect containers for competency (i.e., no cracks, and handles in good repair).
	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects. • If boating, avoid carrying objects directly onto or off the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.
	Pinch points	• Wear hand protection when closing containers. • Use the buddy system when affixing drum rings.	• Inspect drums for rust or sharp edges prior to opening or closing.

Job Safety Analysis

Investigation-Derived Waste Management

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Relocating or staging IDW containers	Lifting	• Use task-specific tools whenever possible to move full containers (i.e., hoists, drum caddies or dollies, and vehicles). • When task-specific tools are not available, use the buddy system to move containers that are reasonable to lift. • Never roll drums or containers holding IDW. • Stage containers in areas protected from heavy traffic and weather, if possible.	• Ensure tools are in good repair. • Assess IDW container weight prior to moving.
	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects. • If boating, avoid carrying objects directly onto or off the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.
Relocating or staging IDW containers (continued)	Pinch points or crushing	• Use tools to achieve the final arrangement when staging containers—do not place hands on the edges of containers while moving them into place. • Stand well clear of containers being moved in case they become dislodged from their handling tool during transport. • Do not stack IDW containers, as this poses a risk for container toppling and damage. • Place containers on a wooden pallet for easy transfer using a pallet jack, if possible.	• Inspect drums for evidence of cracks or rust.
IDW management – general	Splash	• Wear the required PPE at all times. • Use care to minimize splashing or smearing of IDW during handling and containerization.	• Inspect PPE upon donning and periodically during tasks.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 CFR 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- All personnel working on this project must have received Hazard Communications training, part of annual refresher, in addition to the field lead providing an overview of all SDSs for this project.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Attachment C

Safety Data Sheets

SAFETY DATA SHEET

Version 6.3
Revision Date 08/02/2021
Print Date 09/16/2021

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name : **Acetone**

Product Number : 00585
Brand : Fluka
Index-No. : 606-001-00-8
CAS-No. : 67-64-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Inc.
3050 SPRUCE ST
ST. LOUIS MO 63103
UNITED STATES

Telephone : +1 314 771-5765
Fax : +1 800 325-5052

1.4 Emergency telephone

Emergency Phone # : 800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Flammable liquids (Category 2), H225
Eye irritation (Category 2A), H319
Specific target organ toxicity - single exposure (Category 3), Central nervous system, H336

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H225	Highly flammable liquid and vapor.
H319	Causes serious eye irritation.
H336	May cause drowsiness or dizziness.

Precautionary statement(s)

P210	Keep away from heat/ sparks/ open flames/ hot surfaces. No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P261	Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ eye protection/ face protection.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor if you feel unwell.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337 + P313	If eye irritation persists: Get medical advice/ attention.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

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SECTION 3: Composition/information on ingredients

3.1 Substances

Formula : C_3H_6O

Molecular weight : 58.08 g/mol

CAS-No. : 67-64-1

EC-No. : 200-662-2

Index-No. : 606-001-00-8

Component	Classification	Concentration
acetone		
	Flam. Liq. 2; Eye Irrit. 2A; STOT SE 3; H225, H319, H336 Concentration limits: >= 20 %: STOT SE 3, H336;	<= 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

SECTION 4: First aid measures

4.1 Description of first-aid measures

General advice
Consult a physician. Show this material safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

Carbon oxides

5.3 Advice for firefighters

Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information

Use water spray to cool unopened containers.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapors accumulating to form explosive concentrations. Vapors can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up

Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Advice on safe handling

Avoid contact with skin and eyes. Avoid inhalation of vapor or mist.

Advice on protection against fire and explosion

Use explosion-proof equipment.**Advice on protection against fire and explosion**
Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.

Hygiene measures

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Storage conditions

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Storage class (TRGS 510): 3: Flammable liquids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

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SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Ingredients with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
acetone	67-64-1	TWA	250 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Not classifiable as a human carcinogen		
		STEL	500 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Not classifiable as a human carcinogen		

		TWA	250 ppm 590 mg/m3	USA. NIOSH Recommended Exposure Limits
		TWA	1,000 ppm 2,400 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		STEL	1,000 ppm 2,400 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	750 ppm 1,800 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		C	3,000 ppm	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		PEL	500 ppm 1,200 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		STEL	750 ppm 1,780 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
acetone	67-64-1	Acetone	25 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift (As soon as possible after exposure ceases)			

Predicted No Effect Concentration (PNEC)

Compartment	Value
Soil	33.3 mg/kg
Sea water	1.06 mg/l
Fresh water	10.6 mg/l
Sea sediment	3.04 mg/kg
Fresh water sediment	30.4 mg/kg
Onsite sewage treatment plant	100 mg/l

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested:Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested:Butoject® (KCL 897 / Aldrich Z677647, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the EC approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Impervious clothing, Flame retardant antistatic protective clothing., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid, clear Color: colorless
b)	Odor	No data available
c)	Odor Threshold	No data available
d)	pH	No data available
e)	Melting point/freezing point	Melting point/range: -94 °C (-137 °F) - lit.
f)	Initial boiling point and boiling range	56 °C 133 °F at 1,013 hPa - lit.

g)	Flash point	-17.0 °C (1.4 °F) - closed cup
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 13 %(V) Lower explosion limit: 2 %(V)
k)	Vapor pressure	533.3 hPa at 39.5 °C (103.1 °F) 245.3 hPa at 20.0 °C(68.0 °F)
l)	Vapor density	No data available
m)	Density	0.79 g/cm3 at 20 °C (68 °F)
	Relative density	No data available
n)	Water solubility	completely miscible
o)	Partition coefficient: n-octanol/water	log Pow: -0.24
p)	Autoignition temperature	465.0 °C (869.0 °F)
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information

Surface tension	23.2 mN/m at 20.0 °C (68.0 °F)

SECTION 10: Stability and reactivity

10.1 Reactivity

No data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

Vapors may form explosive mixture with air.

10.4 Conditions to avoid

Heat, flames and sparks.

10.5 Incompatible materials

Bases, Oxidizing agents, Reducing agents, Acetone reacts violently with phosphorous oxychloride.

10.6 Hazardous decomposition products

In the event of fire: see section 5

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - Rat - female - 5,800 mg/kg
Remarks: (ECHA)
LC50 Inhalation - Rat - 4 h - 76 mg/l
Remarks: Unconsciousness
Drowsiness
Dizziness
(External MSDS)
LD50 Dermal - Rabbit - 20,000 mg/kg
Remarks: (IUCLID)
No data available

Skin corrosion/irritation
Skin - Rabbit
Result: Mild skin irritation - 24 h
(Draize Test)
Remarks: (RTECS)

Serious eye damage/eye irritation
Eyes - Rabbit
Result: Eye irritation - 24 h
(Draize Test)
Remarks: (RTECS)

Respiratory or skin sensitization
Maximization Test - Guinea pig
Result: Not a skin sensitizer.
Remarks: (ECHA)
Chronic exposure may cause dermatitis.

Germ cell mutagenicity
Test Type: Mutagenicity (mammal cell test): chromosome aberration.
Test system: Chinese hamster ovary cells
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 473
Result: negative
Test Type: Ames test
Test system: Salmonella typhimurium
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 471
Result: negative
Test Type: In vitro mammalian cell gene mutation test
Test system: Mouse lymphoma test
Metabolic activation: without metabolic activation
Method: OECD Test Guideline 476
Result: negative

Carcinogenicity

IARC: No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

NTP: No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is on OSHA’s list of regulated carcinogens.

Reproductive toxicity
No data available

Specific target organ toxicity - single exposure
Inhalation - May cause drowsiness or dizziness. - Narcotic effects

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

11.2 Additional Information

RTECS: AL3150000
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

After absorption:

Headache
Salivation
Nausea
Vomiting
Dizziness
narcosis
Coma

Other dangerous properties can not be excluded.

Handle in accordance with good industrial hygiene and safety practice.

Kidney - Irregularities - Based on Human Evidence

Skin - Dermatitis - Based on Human Evidence

Kidney - Irregularities - Based on Human Evidence

Skin - Dermatitis - Based on Human Evidence

SECTION 12: Ecological information

12.1 Toxicity

Toxicity to fish	flow-through test LC50 - Pimephales promelas (fathead minnow) - 6,210 mg/l - 96 h (OECD Test Guideline 203)
Toxicity to daphnia and other aquatic invertebrates	static test LC50 - Daphnia pulex (Water flea) - 8,800 mg/l - 48 h Remarks: (ECHA)

Toxicity to algae	static test NOEC - M.aeruginosa - 530 mg/l - 8 d (DIN 38412) Remarks: (maximum permissible toxic concentration) (IUCLID)
Toxicity to bacteria	static test EC50 - activated sludge - 61.15 mg/l - 30 min (OECD Test Guideline 209)

12.2 Persistence and degradability

Biodegradability	aerobic - Exposure time 28 d Result: 91 % - Readily biodegradable. (OECD Test Guideline 301B)
Biochemical Oxygen Demand (BOD)	1,850 mg/g Remarks: (IUCLID)
Chemical Oxygen Demand (COD)	2,070 mg/g Remarks: (IUCLID)
Theoretical oxygen demand	2,200 mg/g Remarks: (Lit.)

12.3 Bioaccumulative potential

Does not bioaccumulate.

12.4 Mobility in soil

No data available

12.5 Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product

Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging

Dispose of as unused product.

SECTION 14: Transport information

DOT (US)

UN number: 1090 Class: 3 Packing group: II
Proper shipping name: Acetone
Reportable Quantity (RQ): 5000 lbs
Poison Inhalation Hazard: No

IMDG

UN number: 1090 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: ACETONE

IATA
UN number: 1090 Class: 3 Packing group: II
Proper shipping name: Acetone

SECTION 15: Regulatory information

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Fire Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
acetone	67-64-1	1993-02-16

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
acetone	67-64-1	1993-02-16

New Jersey Right To Know Components

	CAS-No.	Revision Date
acetone	67-64-1	1993-02-16

California Prop. 65 Components
This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

SECTION 16: Other information

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Version: 6.3 Revision Date: 08/02/2021 Print Date: 09/16/2021

Aquabiotics Industrial Pty. Ltd
SAFETY DATA SHEET

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1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: BoreSaver Ultra C

Other names:	Oxalic acid (stabilized), Ethanedioic acid; Dicarboxylic acid.
Supplier:	**Aquabiotics Industrial Pty Ltd**
ABN:	90119750186
Address:	14 Goongarrie Street, Bayswater, Western Australia 6053
Tel:	(All Hours)+61 (0)8 9379 2911 Fax: +61 (0)8 676856.
E-mail:	sales@boresaver.com.au

Additional European Addresses:
Italy: Millars Products s.r.l.
Segrate (Milano), Italy
Tel: 0039 02 2134267 Fax: 0039 02 2132456

LAVAL UNDERGROUND SURVEYS. LLC
2476 N. BUNDY AVE
FRESNO CALIFORNIA 937727 U.S.A.
TELEPHONE: (559)251-1396

United Kingdom: geoquip project services limited
Unit 7 Sovereign Centre, Farthing Road Industrial Estate
Ipswich, Suffolk, England, IP1 5AP
Tel: 0044 (0)1473 463546 Fax: 0044 (0)1473 462146

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2. HAZARDS IDENTIFICATION

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; **NON-DANGEROUS GOODS**.

This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:

Acute Oral Toxicity -	Category 4
Acute Dermal Toxicity -	Category 4
Eye Damage -	Category 1

SIGNAL WORD: DANGER

Hazard Statement(s):
H302+H312 Harmful if swallowed or in contact with skin.
H318 Causes serious eye damage.
Precautionary Statement(s):
Prevention:
P264 Wash hands thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

Response:
P301+P312 IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
P330 Rinse mouth.
P302+P352 IF ON SKIN: Wash with plenty of soap and water.
P312 Call a POISON CENTER or doctor/physician if you feel unwell.
P363 Wash contaminated clothing before re-use.
P322 Specific measures (see First Aid Measures on Safety Data Sheet).
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes.
Remove contact lenses, if present and easy to do. Continue rinsing.
P310 immediately call a POISON CENTER or doctor/physician.

Disposal:
P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

Poisons Schedule (SUSMP): S6 Poison.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Proportion	Hazard Codes
Oxalic acid (processed)	144-62-7	>90%	H312 H302
Stabilizers N.O.S.	**NA**	**To 100%**	**NA**

4. FIRST AID MEASURES

Inhalation:
Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. Seek medical advice if effects persist.
Skin Contact:
If skin or hair contact occurs, immediately remove any contaminated clothing and wash skin and hair thoroughly with running water. If swelling, redness, blistering or irritation occurs seek medical assistance.
Eye Contact:
Immediately wash in and around the eye area with large amounts of water for at least 15 minutes. Eyelids to be held apart. Remove clothing if contaminated and wash skin. Urgently seek medical assistance. Transport to hospital or medical centre.
Ingestion:
Rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.
Indication of immediate medical attention and special treatment needed:
Treat symptomatically. Can cause corneal burns.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, corrosive and toxic gases may be generated by thermal decomposition.
Hazardous Combustion Products: This material will not burn.
Fire / Explosion Hazards: May react violently with: strong bases strong oxidizers
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Extinguishing Media NOT To Be Used: Not applicable
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear. Containers can build up pressure if exposed to high levels of heat.

6. ACCIDENTAL RELEASE MEASURES

Emergency procedures/Environmental precautions:
Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

Personal precautions/Protective equipment/Methods and materials for containment and cleaning up:
Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contact and breathing in dust. Sweep up, but avoid generating dust. Collect and seal in properly labeled containers or drums for disposal.

7. HANDLING AND STORAGE

This material is a Scheduled Poison S6 and must be stored, maintained and used in accordance with the relevant regulations.

Precautions for safe handling:
Avoid skin and eye contact and breathing in dust. Avoid handling which leads to dust formation.

Conditions for safe storage, including any incompatibilities:
Store in a cool, dry, well-ventilated place and out of direct sunlight. Store away from foodstuffs. Store away from incompatible materials described in Section 10. Keep containers closed when not in use - check regularly for spills.

Use of the substance/preparation: A cleaning agent to remove iron oxide from water bores, pumps, reticulation systems and other industrial water systems.

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Oxalic acid: 8hr TWA = 1 mg/m3, 15 min STEL = 2 mg/m3

As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.
TWA - The time-weighted average airborne concentration of a particular substance when calculated over an eight-hour working day, for a five-day working week.

STEL (Short Term Exposure Limit) - the airborne concentration of a particular substance calculated as a time-weighted average over 15 minutes, which should not be exceeded at any time during a normal eight hour work day. According to current knowledge this concentration should neither impair the health of, nor cause undue discomfort to, nearly all workers.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

Appropriate engineering controls:
Ensure ventilation is adequate to maintain air concentrations below Workplace Exposure Standards. If inhalation risk exists: Use with local exhaust ventilation or while wearing dust mask. Keep containers closed when not in use.

Individual protection measures, such as Personal Protective Equipment (PPE):
The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.
Orica Personal Protection Guide No. 1, 1998: F - OVERALLS, SAFETY SHOES, CHEMICAL GOGGLES, GLOVES, DUST MASK.




Wear overalls, chemical goggles and impervious gloves. Avoid generating and inhaling dusts. If dust exists, wear dust mask/respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use. **NOTE: BoreSaver Ultra C is manufactured to present no dust hazard to users.**

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: white unconsolidated crystalline solid mixture. Non-flammable, non-volatile.
Physical state: Granules or Crystals
Colour: White to Clear
Odour: Odourless
Solubility: Soluble in water , glycerol and alcohol. Partially soluble in ether. Insoluble in chloroform, petroleum ether and benzene .
Specific Gravity: 1.65 @20°C
Relative Vapour Density (air=1): Not available
Vapour Pressure (20 °C): <0.14 Pa
Flash Point (°C): Not applicable
Flammability Limits (%): Not available
Autoignition Temperature (°C): Not available
Melting Point/Range (°C): 101.5
Decomposition Point (°C): Not available
pH: 1.3 (0.1M when in solution) ***Supplied product is NOT in solution.***
Metal Corrosivity:
Steel: Not determined
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Heat
Reactivity / Incompatibility: Incompatible with: oxidizers alkalies. Dry oxalic acid is not corrosive to metals.
Hazardous Decomposition: Heating to decomposition releases toxic fumes of carbon monoxide and carbon dioxide.
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label.

Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

Ingestion:	Swallowing can result in a severe burning pain of the mouth, throat and stomach followed by profuse vomiting (sometimes bloody). Small doses of oxalate in the body can cause headache, pain and twitching in muscles, and cramps. Larger doses can cause weak and irregular heartbeat, drop in blood pressure and signs of heart failure. Large doses rapidly cause a shock-like state, convulsions, coma and possibly death.
Eye contact:	A severe eye irritant. Contamination of eyes can result in permanent injury.
Skin contact:	Contact with skin may result in irritation. Solutions of 5% to 10% oxalic acid are irritating to the skin after prolonged exposure and can cause corrosive injury.
Inhalation:	Breathing in dust may result in respiratory irritation. Inhaled oxalic acid is readily absorbed into the body and may cause headaches and nausea. Boresaver Ultra C is manufactured such that there is no dust hazard.

Acute toxicity:
Oral LD50 (rat): 475 mg/kg
Dermal LD50 (rabbit): 2000 mg/kg

Chronic effects: Long term exposure can result in kidney stones and stone formation in the urinary tract.

Exposure to this compound can result in systemic effects including kidney damage, muscle twitching, cramps and nervous system complaints.

This product does NOT contain any IARC listed chemicals.

12. ECOLOGICAL INFORMATION

Ecotoxicity: Avoid contaminating waterways in raw or concentrated state.

13. DISPOSAL CONSIDERATIONS

Disposal methods:
Refer to Waste Management Authority. Dispose of contents/container in accordance with local/regional/national/international regulations.

14. TRANSPORT INFORMATION

Road and Rail Transport
Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.

Marine Transport
Not classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; NON-DANGEROUS GOODS.

Air Transport
Not classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; NON-DANGEROUS GOODS.

UN number: NA

UN proper shipping name: OXALIC ACID DIHYDRATE (STABALISED)

15. REGULATORY INFORMATION

Classification:
This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

Classification of the substance or mixture:
Acute Oral Toxicity - Category 4
Acute Dermal Toxicity - Category 4
Eye Damage - Category 1

Hazard Statement(s):
H302+H312 Harmful if swallowed or in contact with skin.
H318 Causes serious eye damage.

Poisons Schedule (SUSMP): S6 Poison.

This material is listed on the Australian Inventory of Chemical Substances (AICS).

National Inventories:

REACH Registration Number: A registration number is not available for this substance as the substance or its use is exempted from registration according to Article 2 REACH regulation (EC) No 1907/2006, the annual tonnage doesn't not require registration or the registration is envisaged for a later registration deadline.

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16. OTHER INFORMATION

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. CCINFO RTECS. Canadian Centre for Occupational Health and Safety. Hamilton, Ontario Canada: 30 June 1993. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. Vendor Information. The Merck Index, 11th Ed. Rahway, New Jersey: Merck and Co., Inc., 1989. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. Technical Judgment.

Use of the substance/preparation: A cleaning agent to remove iron oxide from water bores, pumps, reticulation systems and other industrial water systems.

Supplier Safety Data Sheet; 03/ 2013.
This safety data sheet is based on one prepared by Orica Toxicology & SDS Services. Only section:1 contact information has been modified.

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Orica Limited cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

Legend:
NA - Not Applicable w/w - weight/weight
ND - Not Determined w/v - weight/volume
NV - Not Available v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

SAFETY DATA SHEET

Revision Date: 25-September-2018 Revision 1

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Product Identifier

Product Name	Conductivity / TSD Standard Solutions 23 µS/cm Conductivity Solution 84 µS/cm Conductivity Solution 447 µS/cm Conductivity Solution 1413 µS/cm Conductivity Solution 1,500 µS/cm Conductivity Solution 2,070 µS/cm Conductivity Solution 2,764 µS/cm Conductivity Solution 8,974 µS/cm Conductivity Solution 12,880 µS/cm Conductivity Solution 15,000 µS/cm Conductivity Solution 80,000 µS/cm Conductivity Solution 111,900 µS/cm Conductivity Solution
Product Number(s)	00606-10, 00653-15, 00653-16, 00653-23, 00653-18, 00653-20, 00653-27, 00653-47, 00653-89, 00653-50, 00653-32, 00653-35, 00653-36, 00653-37, 00653-38, 35653-08, 35653-09, 35653-10, 35653-11, 35653-13, 35653-14 This SDS applies to conductivity solutions with Lot # starting with CC.
Pure Substance/mixture	Mixture

Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Use as laboratory reagent
Uses advised against	No information available
Manufacture/Supplier	Cole-Parmer™ North America 625 East Bunker Court Vernon Hills, IL 60061 USA Tel: 1-800-323-4340
E-mail address	info@coleparmer.com
Made In	USA
Product Information	888-358-4717 8:00 am – 6:00 pm CST

2. HAZARDS IDENTIFICATION

Classification

Classification – Mixture

OSHA Regulatory Status
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Classification according to Regulation (EC) No. 1272/2008 [CLP]
This mixture is classified as not hazardous according to regulation (EC) 1272/2008 [GHS]

Symbol(s)
Not dangerous goods.

Label Elements

Emergency Overview

The product contains no substances which at their given concentration, are considered hazardous to health.

Appearance Clear **Physical State** Liquid **Odor** None

EUH210 - Safety data sheet available upon request.

Precautionary Statements
P202 - Do not handle until all safety information has been read and understood.

Hazards not otherwise classified (HNOC)
No information available

Other Information
No information available

3. COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous ingredients

Component	Chemical Formula	EC-No.	CAS-No	Classification according Regulation (EC) No. 1272 [CLP]	Weight %	Trade Secret
Water	-	-	7732-18-5	-	>92 %	*
Potassium chloride	KCL	231-211-8	7447-40-7	-	0-6 %	*
N-Proponal	-	-	71-23-8	-	1-2 %	*

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. FIRST AID MEASURES

First Aid Measures

General Advice	Use first aid treatment according to the nature of the injury. For further assistance, contact your local Poison Control Center. Show this safety data sheet to the doctor in attendance.
Eye Contact	In case of eye contact, remove contact lens and rinse thoroughly with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.
Skin Contact	Wash off immediately with soap and plenty of water while removing all contaminated clothing and shoes. If skin reactions occur, contact a physician.
Inhalation	Move to fresh air. If breathing is difficult, give oxygen. If symptoms persist, obtain medical attention.

Ingestion	Clean mouth with water and drink afterwards plenty of water. Do not include vomiting. Call a physician or Poison Control Center immediately.
Production of First-Aiders	Use personal protective equipment. See Section 8 for more detail. Do not use mouth to mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical devices.

Most important symptoms and effects, both acute and delayed

Most important symptoms/effects	No information available

Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable Extinguishing Media
No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures

Personal Precautions	Use personal protective equipment. Refer to Section 8. Evacuate personnel to safe areas.
Environmental Precautions	Avoid discharge into drains, water courses or onto the ground.

Method and Material for Containment and Cleaning Up

Methods for Containment	Prevent further leakage or spillage if safe to do so.
Methods for Cleaning Up	Soak up with inert absorbent material. Pick up and transfer to properly labeled containers.

7. HANDLING AND STORAGE

Precautions for Safe Handling

Handling	To avoid risks to human health and the environment, comply with the instructions for use. Wear personal protective equipment. Avoid breathing dust/fume/gas/mist/vapors/spray Ensure adequate ventilation, especially in confined areas.
Hygiene Considerations	Handle in accordance with good industrial hygiene and safety practice.

Conditions for Safe Storage, Including any Incompatibilities

Storage	Keep container tightly closed in a dry and well-ventilated place. Store at room temperature in the original container. Keep away from direct sunlight.
Incompatible Products	No information available.

Specific end use(s)

Specific use	Calibration and storage of pH meters/probes.
Risk Management Methods (RMM)	The information required is contained in this Safety Data Sheet.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Guidelines	This product does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Appropriate Engineering Controls

Engineering Measures	Showers Eyewash stations Ventilation systems

Individual protection measures, such as personal protective equipment

Eye/face Protection	Wear chemical splash goggles. If splashes are likely to occur, wear: Face-shield.
Skin and Body Protection	Wear protection gloves/clothing
Respiratory Protection	None required under normal usage. In case of inadequate ventilation wear respiratory protection.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties.

Physical State	Liquid
Appearance	Clear
Odor	None
Odor Threshold	No information available
pH Range	4.7 – 7.8

Property	**Values**	**Remarks * Method**
Melting point/freezing point	No information available	
Boiling Point/Range	~ 100 °C / 212 °F	
Flash Point (High in °C)	No information available	
Evaporation Rate	No information available	
Flammability (solid, gas)	No information available	
Flammability Limit in Air		
Upper flammability limit:	No information available	
Lower flammability limit:	No information available	
Vapor pressure	No information available	
Vapor Density	No information available	
Specific Gravity	No information available	
Water Solubility	soluble	
Solubility in other solvents	No information available	
Partition coefficient	No information available	
Autoignition Temperature		
Decomposition Temperature	No information available	
Kinematic Viscosity	No information available	
Dynamic Viscosity	No information available	
Explosive Properties	No information available	
Oxidizing Properties	No information available	

Other Information

Softening Point	No information available
Molecular Weight	No information available
VOC Content (%)	No information available
Density	No information available
Bulk Density	No information available

10. STABILITY AND REACTIVITY

Reactivity

No information available

Chemical Stability

Stable under normal conditions

Possibility of Hazardous Reactions

None under normal processing

Conditions to Avoid

Extremes of temperature and direct sunlight

Incompatible Materials

No information available

Hazardous Decomposition Products

Thermal decomposition can lead to release of irritating gases and vapors.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation	No information available
Eye Contact	No information available
Skin Contact	No information available
Ingestion	No information available

Information on Toxicological Effects

Symptoms	No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Sensitization	No information available
Mutagenic Effects	No information available
Carcinogenicity	No information available
Reproductive Effects	No information available
STOT – single exposure	No information available
STOT – repeated exposure	No information available
Aspiration hazard	No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity

This material is not expected to be harmful to aquatic life.

Persistence and Degradability

No information available

Bioaccumulation/Accumulation

No information available

Mobility

No information available

Results of PBT and vPvB assessment

No information available

Other adverse effects

No information available

Endocrine Disruptor Information

No information available

13. DISPOSAL CONSIDERATIONS

Waste Treatment Methods

Waste Disposal Methods	Disposal should be in accordance with applicable regional, national and local laws and regulations.
Contaminated Packaging	Improper disposal or reuse of this container may be dangerous and illegal.

14. TRANSPORT INFORMATION

DOT	Not regulated
TDG	Not regulated
MEX	Not regulated
ICAO	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated
RID	Not regulated
ADR	Not regulated
ADN	Not regulated

15. REGULATORY INFORMATION

European Union Regulations

Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work.

International Inventories

USINV	Complies
CANINV	Complies
EINECS/ELINCS	Complies
ENCS	Does not comply
IECSC	Complies
KECL	Complies
PICCS	Complies
AICS	Complies

USINV/ TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
CANINV/ DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
ENCS - Japanese Existing and New Chemical Substances
IECSC - Chinese Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances

U.S. Federal Regulations

This product is not known to be a “Hazardous Chemical” as defined by the OSHA Hazardous Communication Standard, 29 CFR 1910.1200.

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40n of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazardous Categorization

Acute Health Hazard	No
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act
Not applicable

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional or state level pertaining to releases of this material.

U.S. State Regulations

California Proposition 65
This product is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

State Right-to-Know

Massachusetts Right-to-Know Act – Substance List	Not regulated
New Jersey Worker and Community Right-to-Know Act	Not regulated
Pennsylvania Right-to-Know Act – Hazardous Substance	Not regulated
Rhode Island Right-to-Know Act	Not regulated

U.S. EPA Label Information
No information available

16. OTHER INFORMATION

Revision Date: 25-September-2018

Disclaimer:
IMPORTANT: The information contained in this SDS is correct to the best of our knowledge as of the issue date (or subsequent revision date, if any), and is to be used only as a guide. This SDS does not constitute a guarantee (express or implied) of any kind and we make no warranties of any kind as to the accuracy or completeness of the information contained herein or the merchantability or fitness of the product or this information for a particular purpose. It is the responsibility of each individual buyer/user to determine the suitability of this information and the product for its intended purposes. This information relates only to the designated product as shipped and may not be valid if the product is used in combination with any other materials or is not used in accordance with our instructions, or is altered in any way. It is the responsibility of the buyer/user to ensure that its activities comply with all applicable government requirements. Since conditions of use of the product are not under direct control of Traceable Products, it is the duty of the buyer/user to determine the necessary conditions for the safe use of the product. Traceable Products will not be liable for any injuries or damages resulting from handling, use, misuse or contact with the product.

Safety Data Sheet

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

DIESEL FUEL No. 2

Product Use: Fuel [See Section 16 for Additional Product Numbers]
Synonyms: 15 S Diesel Fuel 2; Alternative Low Aromatic Diesel (ALAD); CAL ULS S R6-20 B0-5 DF2; CAL ULS S R6-20 B0-5 DF2DY; Calco LS Diesel 2; CALCO ULS C-B0-B5 DF2; CALCO ULS C-B0-B5 DF2 DYED; CALCO ULS C-B2 DF2; CALCO ULS C-B2 DF2 DYED; CALCO ULS C-B5 DF2; CALCO ULS C-B5 DF2 DYED; Calco ULS DF2; Calco ULS Diesel 2; CALCO ULS S R6-20 DF2; CALCO ULS S R6-20 DF2 DYED; CALCO ULS S-B0-B5 DF2 DYED; Calco ULS S-B5 DF2; Calco ULS S-B5 DF2 DYED; CALCO ULS TC-B0-B5 DF2; CALCO ULS TC-B0-B5 DF2 DYD; CALCO ULS TC-B1 DF2; CALCO ULS TC-B1 DF2 DYED; CALCO ULS TC-B2 DF2; CALCO ULS TC-B2 DF2 DYED; CALCO ULS TC-B3 DF2; CALCO ULS TC-B3 DF2 DYED; CALCO ULS TC-B4 DF2; CALCO ULS TC-B4 DF2 DYED; CALCO ULS TC-B5 DF2; CALCO ULS TC-B5 DF2 DYED; CALCO ULS TX-B0-B5 DF2; CALCO ULS TX-B0-B5 DF2 DYD; CALCO ULS TX-B1 DF2; CALCO ULS TX-B1 DF2 DYED; CALCO ULS TX-B2 DF2; CALCO ULS TX-B2 DF2 DYED; CALCO ULS TX-B3 DF2; CALCO ULS TX-B3 DF2 DYED; CALCO ULS TX-B4 DF2; CALCO ULS TX-B4 DF2 DYED; CALCO ULS TX-B5 DF2; CALCO ULS TX-B5 DF2 DYED; Chevron LS Diesel 2; Chevron ULS Diesel 2; CT ULS C-B0-B5 DF2; CT ULS C-B0-B5 DF2 DYED; CT ULS C-B2 DF2; CT ULS C-B5 DF2; CT ULS S R6-20 B0-5 DF2; CT ULS S R6-20 DF2; CT ULS S R6-20 DF2 DYED; CT ULS S-B0-B5 DF2 DYED; CT ULS S-B5 DF2; CT ULS S-B5 DF2 DYED; CT ULS S-BO-B5 DF2; CT ULS SPECIAL DF2 DYED; CT ULS TC-B0-B5 DF2; CT ULS TC-B1 DF2; CT ULS TC-B2 DF2; CT ULS TC-B3 DF2; CT ULS TC-B4 DF2; CT ULS TC-B5 DF2; CT ULS TX-B0-B5 DF2; CT ULS TX-B1 DF2; CT ULS TX-B2 DF2; CT ULS TX-B3 DF2; CT ULS TX-B4 DF2; CT ULS TX-B5 DF2; Diesel Fuel Oil; Diesel Grade No. 2; Diesel No. 2-D S15; Diesel No. 2-D S500; Diesel No. 2-D S5000; Distillates, straight run; Gas Oil; HS Diesel 2; HS Heating Fuel 2; Light Diesel Oil Grade No. 2-D; LS Diesel 2; LS Heating Fuel 2; Marine Diesel; RR Diesel Fuel; Texaco Diesel; Texaco Diesel No. 2; ULS C-B0-B5 DF2; ULS C-B0-B5 DF2 DYED; ULS C-B2 DF2; ULS C-B2 DF2 DYED; ULS C-B5 DF2; ULS C-B5 DF2 DYED; ULS S R6-20 B0-5 DF2; ULS S R6-20 B0-5 DF2 DYED; ULS S R6-20 DF2; ULS S R6-20 DF2 DYED; ULS S-B0-B5 DF2 DYED; ULS S-B5 DF2; ULS S-BO-B5 DF2; ULS TC-B0-B5 DF2; ULS TC-B0-B5 DF2 DYED; ULS TC-B1 DF2; ULS TC-B1 DF2 DYED; ULS TC-B2 DF2; ULS TC-B2 DF2 DYED; ULS TC-B3 DF2; ULS TC-B3 DF2 DYED; ULS TC-B4 DF2; ULS TC-B4 DF2 DYED; ULS TC-B5 DF2; ULS TC-B5 DF2 DYED; ULS TX-B0-B5 DF2; ULS TX-B0-B5 DF2 DYED; ULS TX-B1 DF2; ULS TX-B1 DF2 DYED; ULS TX-B3 DF2; ULS TX-B3 DF2 DYED; ULS TX-B4 DF2; ULS TX-B4 DF2 DYED; ULS TX-B5 DF2; ULS TX-B5 DF2 DYED; Ultra Low Sulfur Diesel 2

Company Identification
Chevron Products Company
6001 Bollinger Canyon Rd.
San Ramon, CA 94583
United States of America

Transportation Emergency Response
CHEMTREC: (800) 424-9300 or (703) 527-3887

Health Emergency
Chevron Emergency & Information Center: Located in the USA. International collect calls accepted. (800) 231-0623 or (510) 231-0623

Product Information

Product Information: (800) 582-3835
SDS Requests: lubemsds@chevron.com

SPECIAL NOTES: This SDS covers all Chevron, Texaco and Calco CARB & non-CARB Diesel No. 2 Fuels. The sulfur content is less than 0.5% (mass). Red dye is added to non-taxable fuel. (SDS 6894)

SECTION 2 HAZARDS IDENTIFICATION

CLASSIFICATION: Flammable liquid: Category 3. Aspiration toxicant: Category 1. Carcinogen: Category 1B. Skin irritation: Category 2. Target organ toxicant (repeated exposure): Category 2. Target organ toxicant (central nervous system): Category 3. Acute inhalation toxicant: Category 4. Acute aquatic toxicant: Category 2. Chronic aquatic toxicant: Category 2.

Signal Word: Danger

Physical Hazards: Flammable liquid and vapor.

Health Hazards: May be fatal if swallowed and enters airways. May cause cancer. Causes skin irritation. Harmful if inhaled. May cause drowsiness or dizziness.

Target Organs: May cause damage to organs (Blood/Blood Forming Organs, Liver, Thymus) through prolonged or repeated exposure.

Environmental Hazards: Toxic to aquatic life with long lasting effects.

PRECAUTIONARY STATEMENTS:
General: Keep out of reach of children. Read label before use.
Prevention: Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep away from heat/sparks/open flames/hot surfaces. -- No smoking. Ground/bond container and receiving equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Keep container tightly closed. Use explosion-proof electrical/ventilating/lighting/equipment. Do not breathe dust/fume/gas/mist/vapours/spray. Use only outdoors or in a well-ventilated area. Wear protective gloves/protective clothing/eye protection/face protection. Use personal protective equipment as required. Wash thoroughly after handling. Avoid release to the environment.
Response: IF INHALED: Call a poison center or doctor/physician if you feel unwell. Remove person to fresh air and keep comfortable for breathing. IF ON SKIN (or hair): Take off immediately all contaminated clothing and wash it before reuse. Rinse skin with water/shower. If skin irritation occurs: Get medical advice/attention. IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. Do NOT induce vomiting. In case of fire: Use media specified in the SDS to extinguish. Specific treatment (see Notes to Physician on this label). Collect spillage. IF exposed or concerned: Get medical advice/attention.
Storage: Store in a well-ventilated place. Keep cool. Keep container tightly closed. Store locked up.
Disposal: Dispose of contents/container in accordance with applicable local/regional/national/international regulations.

HAZARDS NOT OTHERWISE CLASSIFIED: Not Applicable

SECTION 3 COMPOSITION/ INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	AMOUNT
Total sulfur	Mixture	0 - 5000 ppm

Diesel Fuel No. 2	68476-34-6	95 - 100 %volume
Renewable Diesel	Mixture	0 - 20 %volume
Fatty Acid Methyl Esters (FAME)	Mixture	0 - 5 %volume
Naphthalene	91-20-3	0.02 - < 0.2 %volume

SECTION 4 FIRST AID MEASURES

Description of first aid measures
Eye: No specific first aid measures are required. As a precaution, remove contact lenses, if worn, and flush eyes with water.
Skin: Wash skin with water immediately and remove contaminated clothing and shoes. Get medical attention if any symptoms develop. To remove the material from skin, use soap and water. Discard contaminated clothing and shoes or thoroughly clean before reuse.
Ingestion: If swallowed, get immediate medical attention. Do not induce vomiting. Never give anything by mouth to an unconscious person.
Inhalation: Move the exposed person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if breathing difficulties continue or if any other symptoms develop.

Most important symptoms and effects, both acute and delayed
IMMEDIATE HEALTH EFFECTS
Eye: Not expected to cause prolonged or significant eye irritation.
Skin: Contact with the skin causes irritation. Symptoms may include pain, itching, discoloration, swelling, and blistering. Contact with the skin is not expected to cause an allergic skin response.
Ingestion: Highly toxic; may be fatal if swallowed. Because of its low viscosity, this material can directly enter the lungs, if swallowed, or if subsequently vomited. Once in the lungs it is very difficult to remove and can cause severe injury or death. May be irritating to mouth, throat, and stomach. Symptoms may include pain, nausea, vomiting, and diarrhea.
Inhalation: May be harmful if inhaled. Excessive or prolonged breathing of this material may cause central nervous system effects. Central nervous system effects may include headache, dizziness, nausea, vomiting, weakness, loss of coordination, blurred vision, drowsiness, confusion, or disorientation. At extreme exposures, central nervous system effects may include respiratory depression, tremors or convulsions, loss of consciousness, coma or death.

DELAYED OR OTHER HEALTH EFFECTS:
Cancer: Whole diesel engine exhaust has been classified as a Group 2A carcinogen (probably carcinogenic to humans) by the International Agency for Research on Cancer (IARC). Prolonged or repeated exposure to this material may cause cancer. Contains naphthalene, which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
Target Organs: Contains material that may cause damage to the following organ(s) following repeated inhalation at concentrations above the recommended exposure limit based on animal data:Liver Blood/Blood Forming Organs Thymus See Section 11 for additional information. Risk depends on duration and level of exposure.

Indication of any immediate medical attention and special treatment needed
Note to Physicians: Ingestion of this product or subsequent vomiting may result in aspiration of light hydrocarbon liquid, which may cause pneumonitis.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA: Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish flames.
Unusual Fire Hazards: See Section 7 for proper handling and storage.

PROTECTION OF FIRE FIGHTERS:
Fire Fighting Instructions: For fires involving this material, do not enter any enclosed or confined fire space

without proper protective equipment, including self-contained breathing apparatus.
Combustion Products: Highly dependent on combustion conditions. A complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved when this material undergoes combustion.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures: Eliminate all sources of ignition in the vicinity of the spill or released vapor. If this material is released into the work area, evacuate the area immediately. Monitor area with combustible gas indicator.
Spill Management: Stop the source of the release if you can do it without risk. Contain release to prevent further contamination of soil, surface water or groundwater. Clean up spill as soon as possible, observing precautions in Exposure Controls/Personal Protection. Use appropriate techniques such as applying non-combustible absorbent materials or pumping. All equipment used when handling the product must be grounded. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Where feasible and appropriate, remove contaminated soil. Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations.
Reporting: Report spills to local authorities and/or the U.S. Coast Guard's National Response Center at (800) 424-8802 as appropriate or required.

SECTION 7 HANDLING AND STORAGE

General Handling Information: Avoid contaminating soil or releasing this material into sewage and drainage systems and bodies of water.
Precautionary Measures: Liquid evaporates and forms vapor (fumes) which can catch fire and burn with explosive force. Invisible vapor spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, and electrical motors and switches.
Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Do not breathe vapor or fumes. Do not breathe mist. Wash thoroughly after handling. Keep out of the reach of children.
Unusual Handling Hazards: WARNING! Do not use as portable heater or appliance fuel. Toxic fumes may accumulate and cause death. Slow heat generation may occur with oil-soaked rags, spent filter aids and spent absorbent material and may cause spontaneous combustion if stored near combustibles and not handled properly. Store biodiesel soaked rags, filter aids, and spill absorbent material in approved safety disposal containers and dispose of properly. Biodiesel soaked rags may be washed with soap and water and allowed to dry in well ventilated area.
Static Hazard: Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating and accumulating an electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures.
Container Warnings: Container is not designed to contain pressure. Do not use pressure to empty container or it may rupture with explosive force. Empty containers retain product residue (solid, liquid, and/or vapor) and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. They may explode and cause injury or death. Empty containers should be completely drained, properly closed, and promptly returned to a drum reconditioner or disposed of properly.

General Storage Information: DO NOT USE OR STORE near heat, sparks, flames, or hot surfaces . USE AND STORE ONLY IN WELL VENTILATED AREA. Keep container closed when not in use.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

GENERAL CONSIDERATIONS:

Consider the potential hazards of this material (see Section 2), applicable exposure limits, job activities, and other substances in the work place when designing engineering controls and selecting personal protective equipment. If engineering controls or work practices are not adequate to prevent exposure to harmful levels of this material, the personal protective equipment listed below is recommended. The user should read and understand all instructions and limitations supplied with the equipment since protection is usually provided for a limited time or under certain circumstances.

ENGINEERING CONTROLS:
Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below the recommended exposure limits.

PERSONAL PROTECTIVE EQUIPMENT
Eye/Face Protection: No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as a good safety practice.
Skin Protection: Wear protective clothing to prevent skin contact. Selection of protective clothing may include gloves, apron, boots, and complete facial protection depending on operations conducted. Suggested materials for protective gloves include: Chlorinated Polyethylene (or Chlorosulfonated Polyethylene), Nitrile Rubber, Polyurethane, Viton.
Respiratory Protection: Determine if airborne concentrations are below the recommended occupational exposure limits for jurisdiction of use. If airborne concentrations are above the acceptable limits, wear an approved respirator that provides adequate protection from this material, such as: Air-Purifying Respirator for Organic Vapors.
When used as a fuel, this material can produce carbon monoxide in the exhaust. Determine if airborne concentrations are below the occupational exposure limit for carbon monoxide. If not, wear an approved positive-pressure air-supplying respirator.
Use a positive pressure air-supplying respirator in circumstances where air-purifying respirators may not provide adequate protection.

Occupational Exposure Limits:

Component	Agency	Form	TWA	STEL	Ceiling	Notation
Diesel Fuel No. 2	ACGIH	Inhalable fraction and vapor	100 mg/m3	--	--	Skin total hydrocarbon
Diesel Fuel No. 2	ACGIH	Vapor	100 mg/m3	--	--	Skin
Diesel Fuel No. 2	ACGIH	Vapor and aerosol	100 mg/m3	--	--	Skin total hydrocarbon
Diesel Fuel No. 2	CVX	Vapor and aerosol	100 mg/m3	--	--	Skin total hydrocarbon
Naphthalene	ACGIH	Vapor	10 ppm	15 ppm	--	A4 Skin
Naphthalene	ACGIH	--	10 ppm	--	--	Skin
Naphthalene	OSHA Z-1	--	50 mg/m3	--	--	--

Consult local authorities for appropriate values.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Attention: the data below are typical values and do not constitute a specification.

Color: Varies depending on specification
Physical State: Liquid
Odor: Petroleum odor
Odor Threshold: No data available
pH: Not Applicable
Vapor Pressure: 0.04 kPa (Approximate) @ 40 °C (104 °F)
Vapor Density (Air = 1): >1
Initial Boiling Point: 175.6°C (348.1°F) - 370°C (698°F)
Solubility: Soluble in hydrocarbons; insoluble in water

Freezing Point: Not Applicable
Melting Point: Not Applicable
Specific Gravity: 0.80 - 0.88 @ 15.6°C (60.1°F) (Typical)
Density: No data available
Viscosity: 1.90 cSt - 4.10 cSt @ 40°C (104°F)
Coefficient of Therm. Expansion / °F: No data available
Evaporation Rate: No data available
Decomposition temperature: No data available
Octanol/Water Partition Coefficient: No data available

FLAMMABLE PROPERTIES:
Flammability (solid, gas): No Data Available

Flashpoint: (Pensky-Martens Closed Cup) 52 °C (125 °F) (Minimum)
Autoignition: 257 °C (494 °F)
Flammability (Explosive) Limits (% by volume in air): Lower: 0.6 Upper: 4.7

SECTION 10 STABILITY AND REACTIVITY

Reactivity: May react with strong acids or strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.
Chemical Stability: This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Conditions to Avoid: Avoid contact with heat, sparks, fire and oxidizing agents
Incompatibility With Other Materials: Not applicable
Hazardous Decomposition Products: None known (None expected)
Hazardous Polymerization: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects
Serious Eye Damage/Irritation: The eye irritation hazard is based on evaluation of data for similar materials.

Skin Corrosion/Irritation: The skin irritation hazard is based on evaluation of data for similar materials.

Skin Sensitization: The skin sensitization hazard is based on evaluation of data for similar materials.

Acute Dermal Toxicity: The acute dermal toxicity hazard is based on evaluation of data for similar materials.

Acute Oral Toxicity: The acute oral toxicity hazard is based on evaluation of data for similar materials.

Acute Inhalation Toxicity: The acute inhalation toxicity hazard is based on evaluation of data for similar materials.
Acute Toxicity Estimate (inhalation): 1.2 mg/l

Germ Cell Mutagenicity: The hazard evaluation is based on data for components or a similar material.

Carcinogenicity: The hazard evaluation is based on data for components or a similar material. Whole diesel engine exhaust has been classified as a Group 2A carcinogen (probably carcinogenic to humans) by the International Agency for Research on Cancer (IARC). Contains naphthalene, which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Reproductive Toxicity: The hazard evaluation is based on data for components or a similar material.

Specific Target Organ Toxicity - Single Exposure: The hazard evaluation is based on data for components or a similar material.

Specific Target Organ Toxicity - Repeated Exposure: The hazard evaluation is based on data for components or a similar material.

ADDITIONAL TOXICOLOGY INFORMATION:

This product contains gas oils.
CONCAWE (product dossier 95/107) has summarized current health, safety and environmental data available for a number of gas oils, typically hydrodesulfurized middle distillates, CAS 64742-80-9, straight-run middle distillates, CAS 64741-44-2, and/or light cat-cracked distillate CAS 64741-59-9. CARCINOGENICITY: All materials tested have caused the development of skin tumors in mice, but all featured severe skin irritation and sometimes a long latency period before tumors developed. Straight-run and cracked gas oil samples were studied to determine the influence of dermal irritation on the carcinogenic activity of middle distillates. At non-irritant doses the straight-run gas oil was not carcinogenic, but at irritant doses, weak activity was demonstrated. Cracked gas oils, when diluted with mineral oil, demonstrated carcinogenic activity irrespective of the occurrence of skin irritation. Gas oils were tested on male mice to study tumor initiating/promoting activity. The results demonstrated that while a straight-run gas oil sample was neither an initiator or promotor, a blend of straight-run and FCC stock was both a tumor initiator and a promoter.

GENOTOXICITY: Hydrotreated & hydrodesulfurized gas oils range in activity from inactive to weakly positive in in-vitro bacterial mutagenicity assays. Mouse lymphoma assays on straight-run gas oils without subsequent hydrodesulphurization gave positive results in the presence of S9 metabolic activation. In-vivo bone marrow cytogenetics and sister chromatic exchange assay exhibited no activity for straight-run components with or without hydrodesulphurization. Thermally or catalytically cracked gas oils tested with in-vitro bacterial mutagenicity assays in the presence of S9 metabolic activation were shown to be mutagenic. In-vitro sister chromatic exchange assays on cracked gas oil gave equivocal results both with and without S9 metabolic activation. In-vivo bone marrow cytogenetics assay was inactive for two cracked gas oil samples. Three hydrocracked gas oils were tested with in-vitro bacterial mutagenicity assays with S9, and one of the three gave positive results. Twelve distillate fuel samples were tested with in-vitro bacterial mutagenicity assays & with S9 metabolic activation and showed negative to weakly positive results. In one series, activity was shown to be related to the PCA content of samples tested. Two in-vivo studies were also conducted. A mouse dominant lethal assay was negative for a sample of diesel fuel. In the other study, 9 samples of No 2 heating oil containing 50% cracked stocks caused a slight increase in the number of chromosomal aberrations in bone marrow cytogenetics assays. DEVELOPMENTAL TOXICITY: Diesel fuel vapor did not cause fetotoxic or teratogenic effects when pregnant rats were exposed on days 6-15 of pregnancy. Gas oils were applied to the skin of pregnant rats daily on days 0-19 of gestation. All but one (coker light gas oil) caused fetotoxicity (increased resorptions, reduced litter weight, reduced litter size) at dose levels that were also maternally toxic.

The National Institute of Occupational Safety and Health (NIOSH) has recommended that whole diesel exhaust be regarded as potentially causing cancer. This recommendation was based on test results showing increased lung cancer in laboratory animals exposed to whole diesel exhaust.

This product contains naphthalene.
GENERAL TOXICITY: Exposure to naphthalene has been reported to cause methemoglobinemia and/or hemolytic anemia, especially in humans deficient in the enzyme glucose-6-phosphate dehydrogenase. Laboratory animals given repeated oral doses of naphthalene have developed cataracts. REPRODUCTIVE TOXICITY AND BIRTH DEFECTS: Naphthalene did not cause birth defects when administered orally to rabbits, rats, and mice during pregnancy, but slightly reduced litter size in mice at dose levels that were lethal to the pregnant females. Naphthalene has been reported to cross the human placenta. GENETIC TOXICITY: Naphthalene caused chromosome aberrations and sister chromatid exchanges in Chinese hamster ovary cells, but was not a mutagen in several other in-vitro tests.CARCINOGENICITY: In a study conducted by the National Toxicology Program (NTP), mice exposed to 10 or 30 ppm of naphthalene by inhalation daily for two years had chronic inflammation of the nose and lungs and increased incidences of metaplasia in those tissues. The incidence of benign lung tumors (alveolar/bronchiolar adenomas) was significantly increased in the high-dose female group but not in the male groups. In another two-year inhalation study conducted by NTP, exposure of rats to 10, 30, and 60 ppm naphthalene caused increases in the incidences of a variety of nonneoplastic lesions in the nose. Increases in nasal tumors were seen in both sexes, including olfactory neuroblastomas in females at 60 ppm and adenomas of the respiratory epithelium in males at all exposure levels. The relevance of these effects to humans has not been established.
No carcinogenic effect was reported in a 2-year feeding study in rats receiving naphthalene at 41 mg/kg/day.

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY
A series of studies on the acute toxicity of 4 diesel fuel samples were conducted by one laboratory using water accommodated fractions. The range of effective (EC50) or lethal concentrations (LC50) expressed as loading rates were: This material is expected to be toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment.

72 hour(s) EC50: 2.6-25 mg/l (Selenastrum capricornutum)
96 hour(s) LC50: 21-210 mg/l (Salmo gairdneri)
48 hour(s) EC50: 20-210 mg/l (Daphnia magna)

MOBILITY
No data available.

PERSISTENCE AND DEGRADABILITY
This material is not expected to be readily biodegradable. On release to the environment the lighter components of diesel fuel will generally evaporate but depending on local environmental conditions (temperature, wind, mixing or wave action, soil type, etc.) the remainder may become dispersed in the water column or absorbed to soil or sediment. Diesel fuel would not be expected to be readily biodegradable. In a modified Strum test (OECD method 301B) approximately 40% biodegradation was recorded over 28 days. However, it has been shown that most hydrocarbon components of diesel fuel are degraded in soil in the presence of oxygen. Under anaerobic conditions, such as in anoxic sediments, rates of biodegradation are negligible.
The product has not been tested. The statement has been derived from products of a similar structure and composition.

POTENTIAL TO BIOACCUMULATE
Bioconcentration Factor: No data available.
Octanol/Water Partition Coefficient: No data available

SECTION 13 DISPOSAL CONSIDERATIONS

Use material for its intended purpose or recycle if possible. This material, if it must be discarded, may meet the criteria of a hazardous waste as defined by international, country, or local laws and regulations.

SECTION 14 TRANSPORT INFORMATION

The description shown may not apply to all shipping situations. Consult 49CFR, or appropriate Dangerous Goods Regulations, for additional description requirements (e.g., technical name) and mode-specific or quantity-specific shipping requirements.

DOT Shipping Description: For packages with an Initial Boiling Point > 35 deg C and a Flash Point (PM Closed Cup) >/= 23 deg C but </= 60 deg C: UN1202, GAS OIL, 3, III; OPTIONAL DISCLOSURE: UN1202, GAS OIL, 3, III, MARINE POLLUTANT (DIESEL FUEL) Optional disclosure per 49 CFR when Flash Point (PM Closed Cup) >/= 38 deg C < 93 deg C per 49 173.150 (f): UN1202, GAS OIL, COMBUSTIBLE LIQUID, III; NON-BULK PACKAGES ARE EXEMPTED FROM THE PROVISIONS OF 49 CFR IN USA JURISDICTIONS Optional disclosure as a GHS Environmental Hazard/Marine Pollutant when Flash Point (PM Closed Cup) > 60 deg C: UN3082, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.(DIESEL FUEL), 9, III, MARINE POLLUTANT (DIESEL FUEL)

IMO/IMDG Shipping Description: For packages with an Initial Boiling Point > 35 deg C and a Flash Point (PM Closed Cup) >/= 23 deg C, </= 60 deg C: UN1202, GAS OIL, 3, III, FLASH POINT SEE SECTION 5 OR 9, MARINE POLLUTANT (DIESEL FUEL); OPTIONAL DISCLOSURE: UN1268, PETROLEUM DISTILLATES, N.O.S. (DIESEL FUEL), 3, III, FLASH POINT SEE SECTION 5 OR 9, MARINE

POLLUTANT (DIESEL FUEL) For packages with a Flash Point (PM Closed Cup) > 60 deg C: UN3082, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (DIESEL FUEL), 9, III, MARINE POLLUTANT (DIESEL FUEL)

ICAO/IATA Shipping Description: For packages with an Initial Boiling Point > 35 deg C and a Flash Point (PM Closed Cup) >/= 23 deg C, </= 60 deg C: UN1202, GAS OIL, 3, III For packages with a Flash Point (PM Closed Cup) > 60 deg C: UN3082, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (DIESEL FUEL), 9, III, MARINE POLLUTANT (DIESEL FUEL)

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC code:
Not applicable

SECTION 15 REGULATORY INFORMATION

EPCRA 311/312 CATEGORIES:
Acute toxicity (any route of exposure)
Aspiration Hazard
Carcinogenicity
Flammable (gases, aerosols, liquids, or solids)
Skin Corrosion or Irritation
Specific target organ toxicity (single or repeated exposure)

REGULATORY LISTS SEARCHED:

01-1=IARC Group 1
01-2A=IARC Group 2A
01-2B=IARC Group 2B
02=NTP Carcinogen
03=EPCRA 313
04=CA Proposition 65
05=MA RTK
06=NJ RTK
07=PA RTK

The following components of this material are found on the regulatory lists indicated.

Diesel Fuel No. 2	07
Naphthalene	01-2B, 02, 04, 06

CHEMICAL INVENTORIES:
All components comply with the following chemical inventory requirements: DSL (Canada), TSCA (United States).

NEW JERSEY RTK CLASSIFICATION:
Under the New Jersey Right-to-Know Act L. 1983 Chapter 315 N.J.S.A. 34:5A-1 et. seq., the product is to be identified as follows: DIESEL FUEL

SECTION 16 OTHER INFORMATION

NFPA RATINGS: Health: 1 Flammability: 2 Reactivity: 0

HMIS RATINGS: Health: 2* Flammability: 2 Reactivity: 0
(0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme, PPE:- Personal Protection Equipment Index recommendation, *- Chronic Effect Indicator). These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint and Coating Association (for HMIS ratings).

Additional Product Number(s): 203408, 203410, 203413, 203417, 203431, 203436, 203437, 203441, 203443, 203447, 203449, 203450, 203477990, 203480990, 203481990, 203482990, 203483990, 203484990, 203485990, 203486990, 203487990, 203488990, 203489990, 220122, 225114, 225115, 225150, 266176, 270000, 270005, 270006990, 270007990, 270008990, 270009990, 270010990, 270013990, 270014990, 270015990, 270016990, 270017990, 270030, 270031, 270032, 270033, 270034, 270040, 270041, 270042, 270043, 270044, 270045, 270046, 270047, 270048, 270049, 270050, 270051, 270052, 270053, 270054, 270058, 270059, 270060, 270062, 270063, 270064, 270065, 270068, 270069, 270070, 270081, 270082, 270083, 270084, 270085, 270086, 270087, 270088, 270089, 270090, 270091, 270094, 270095, 270096, 270100, 270101, 270102, 270103, 270104, 270105, 270106, 270107, 270108, 270109, 270110, 270111, 270112, 270113, 270114, 270115, 270116, 270117, 270118, 270119, 270120, 270121, 270122, 270123, 270124, 271006, 272006, 272007, 272008, 272009, 272010, 272011, 272012, 272013, 272093, 272102, 272126, 272129, 272130, 272131, 272152, 272185, 272190, 272195, 272593, 272601, 272602, 272693, 272793, 273003, 273030, 273053, 275000

REVISION STATEMENT: SECTION 03 - Composition information was modified.
SECTION 04 - Immediate Health Effects - Inhalation information was modified.
SECTION 07 - Precautionary Measures information was modified.
SECTION 08 - General Considerations information was modified.
SECTION 08 - Occupational Exposure Limit Table information was modified.
SECTION 09 - Physical/Chemical Properties information was modified.
SECTION 11 - Additional Toxicology Information information was modified.
SECTION 12 - Ecological Information information was modified.
SECTION 15 - Chemical Inventories information was modified.
SECTION 15 - New Jersey Right To Know information was modified.
SECTION 15 - Regulatory Information information was deleted.
SECTION 15 - SARA 311 EPCRA Score information was modified.

Revision Date: April 16, 2020

ABBREVIATIONS THAT MAY HAVE BEEN USED IN THIS DOCUMENT:

TLV - Threshold Limit Value	TWA - Time Weighted Average
STEL - Short-term Exposure Limit	PEL - Permissible Exposure Limit
GHS - Globally Harmonized System	CAS - Chemical Abstract Service Number
ACGIH - American Conference of Governmental Industrial Hygienists	IMO/IMDG - International Maritime Dangerous Goods Code
API - American Petroleum Institute	SDS - Safety Data Sheet
HMIS - Hazardous Materials Information System	NFPA - National Fire Protection Association (USA)
DOT - Department of Transportation (USA)	NTP - National Toxicology Program (USA)
IARC - International Agency for Research on Cancer	OSHA - Occupational Safety and Health Administration
NCEL - New Chemical Exposure Limit	EPA - Environmental Protection Agency
SCBA - Self-Contained Breathing Apparatus	

Prepared according to the 29 CFR 1910.1200 (2012) by Chevron Energy Technology Company, 6001 Bollinger Canyon Road, San Ramon, CA 94583.

Safety Data Sheet

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

Chevron and Texaco Unleaded Gasolines (All Grades)

Product Use: Fuel
Synonyms: Automotive; Calco Mid-Grade Unleaded Gasoline; Calco Premium Gasoline; Calco Regular Unleaded Gasoline; CHEVRON and TEXACO MID-GRADE UNLEADED GASOLINES; CHEVRON and TEXACO PREMIUM UNLEADED GASOLINES; CHEVRON and TEXACO REGULAR UNLEADED GASOLINES; Chevron Mid-Grade Unleaded Gasoline; Chevron Plus Unleaded Gasoline; Chevron Premium Unleaded Gasoline; Chevron Regular Unleaded Gasoline; Chevron Supreme Plus Unleaded Gasoline; Chevron Supreme Unleaded Gasoline; Chevron UL/CQ Gasoline; GASOLINE (GENERIC); Gasolines; Texaco Power Plus Gasoline; Texaco Power Premium Unleaded Gasoline; Texaco Unleaded Gasoline; UNLEADED GASOLINE FOR EXPORT
Company Identification
Chevron Products Company
6001 Bollinger Canyon Rd.
San Ramon, CA 94583
United States of America

Transportation Emergency Response
CHEMTREC: (800) 424-9300 or (703) 527-3887
Health Emergency
Chevron Emergency & Information Center: Located in the USA. International collect calls accepted. (800) 231-0623 or (510) 231-0623
Product Information
Product Information: (800) 582-3835
SDS Requests: lubemsds@chevron.com

SPECIAL NOTES: This MSDS applies to: all motor gasoline.

SECTION 2 HAZARDS IDENTIFICATION

CLASSIFICATION:

- Flammable liquid: Category 1.
- Aspiration toxicant: Category 1.
- Carcinogen: Category 1B.
- Eye irritation: Category 2A.
- Germ Cell Mutagen: Category 1B.
- Reproductive toxicant (developmental): Category 2.
- Skin irritation: Category 2.
- Target organ toxicant (central nervous system): Category 3.
- Target organ toxicant (repeated exposure): Category 1.
- Acute aquatic toxicant: Category 2.
- Chronic aquatic toxicant: Category 2.

Signal Word: Danger

Physical Hazards:
- Extremely flammable liquid and vapour.

Health Hazards:
- May be fatal if swallowed and enters airways.
- Causes skin irritation.
- Causes serious eye irritation.
- May cause drowsiness or dizziness.
- May cause genetic defects.
- May cause cancer.
- Suspected of damaging the unborn child.
- Causes damage to organs (Blood/Blood Forming Organs) through prolonged or repeated exposure.

Environmental Hazards:
- Toxic to aquatic life with long lasting effects.

PRECAUTIONARY STATEMENTS:

General:
- Keep out of reach of children.
- Read label before use.

Prevention:
- Obtain special instructions before use.
- Do not handle until all safety precautions have been read and understood.
- Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
- Keep container tightly closed.
- Keep cool.
- Ground/bond container and receiving equipment.
- Use explosion-proof electrical/ventilating/lighting/equipment.
- Use only non-sparking tools.
- Take precautionary measures against static discharge.
- Do not breathe dust/fume/gas/mist/vapours/spray.
- Wash thoroughly after handling.
- Do not eat, drink or smoke when using this product.
- Use only outdoors or in a well-ventilated area.
- Avoid release to the environment.
- Wear protective gloves/protective clothing/eye protection/face protection.
- Use personal protective equipment as required.

Response:
- IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
- IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
- IF INHALED: Remove person to fresh air and keep comfortable for breathing.
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- IF exposed or concerned: Get medical advice/attention.
- Specific treatment (see Notes to Physician on this label).
- Do NOT induce vomiting.
- If skin irritation occurs: Get medical advice/attention.

- If eye irritation persists: Get medical advice/attention.
- Wash contaminated clothing before reuse.
- In case of fire: Use media specified in the SDS to extinguish.
- Collect spillage.

Storage:

- Store in a well-ventilated place. Keep container tightly closed.
- Store locked up.

Disposal:

- Dispose of contents/container in accordance with applicable local/regional/national/international regulations.

HAZARDS NOT OTHERWISE CLASSIFIED: Not Applicable

SECTION 3 COMPOSITION/ INFORMATION ON INGREDIENTS

Hazardous Substance(s) or Complex Substance(s) required for disclosure

COMPONENTS	CAS NUMBER	AMOUNT
Gasoline	86290-81-5	100 %volume

Hazardous Constituent(s) Contained in Complex Substance(s) required for disclosure

COMPONENTS	CAS NUMBER	AMOUNT
Toluene	108-88-3	1 - 35 %volume
Pentane, 2,2,4-trimethyl-	540-84-1	10 - 15 %volume
Xylene	1330-20-7	1 - 15 %volume
Trimethylbenzene (3 isomers: 1,2,3-; 1,2,4-; 1,3,5-isomer)	25551-13-7	5 - 10 %volume
Pentane isomers (pentanes)	Mixture	1 - 13 %volume
Butane	106-97-8	1 - 12 %volume
Ethanol	64-17-5	0 - 10 %volume
Hexane	110-54-3	1 - 5 %volume
Benzene	71-43-2	0.1 - 5 %volume
Heptane	142-82-5	1 - 4 %volume
Cyclohexane	110-82-7	1 - 3 %volume
Ethylbenzene	100-41-4	0.1 - 3 %volume
Methylcyclohexane	108-87-2	1 - 2 %volume
Naphthalene	91-20-3	0.1 - 2 %volume

Motor gasoline is considered a mixture by EPA under the Toxic Substances Control Act (TSCA). The refinery streams used to blend motor gasoline are all on the TSCA Chemical Substances Inventory. The appropriate CAS number for refinery blended motor gasoline is 86290-81-5. The product specifications of motor gasoline sold in your area will depend on applicable Federal and State regulations.

SECTION 4 FIRST AID MEASURES

Description of first aid measures

Eye: Flush eyes with water immediately while holding the eyelids open. Remove contact lenses, if worn, after initial flushing, and continue flushing for at least 15 minutes. Get immediate medical attention.

Skin: Wash skin with water immediately and remove contaminated clothing and shoes. Get medical attention if any symptoms develop. To remove the material from skin, use soap and water. Discard contaminated clothing and shoes or thoroughly clean before reuse.

Ingestion: If swallowed, get immediate medical attention. Do not induce vomiting. Never give anything by mouth to an unconscious person.

Inhalation: Move the exposed person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if breathing difficulties continue or if any other symptoms develop.

Most important symptoms and effects, both acute and delayed
IMMEDIATE HEALTH EFFECTS
Eye: Contact with the eyes causes severe irritation. Symptoms may include pain, tearing, reddening, swelling and impaired vision.
Skin: Contact with the skin causes irritation. Skin contact may cause drying or defatting of the skin. Symptoms may include pain, itching, discoloration, swelling, and blistering. Contact with the skin is not expected to cause an allergic skin response.
Ingestion: Highly toxic; may be fatal if swallowed. Because of its low viscosity, this material can directly enter the lungs, if swallowed, or if subsequently vomited. Once in the lungs it is very difficult to remove and can cause severe injury or death. May be irritating to mouth, throat, and stomach. Symptoms may include pain, nausea, vomiting, and diarrhea.
Inhalation: Excessive or prolonged breathing of this material may cause central nervous system effects. Central nervous system effects may include headache, dizziness, nausea, vomiting, weakness, loss of coordination, blurred vision, drowsiness, confusion, or disorientation. At extreme exposures, central nervous system effects may include respiratory depression, tremors or convulsions, loss of consciousness, coma or death.

DELAYED OR OTHER HEALTH EFFECTS:
Reproduction and Birth Defects: Contains material that may cause harm to the unborn child if inhaled above the recommended exposure limit.
Cancer: Prolonged or repeated exposure to this material may cause cancer. Gasoline has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Whole gasoline exhaust has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Contains benzene, which has been classified as a carcinogen by the National Toxicology Program (NTP) and a Group 1 carcinogen (carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
Contains naphthalene, which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC). Contains ethylbenzene which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Genetic Toxicity: Contains material that may cause heritable genetic damage based on animal data.
Target Organs: Contains material that may cause damage to the following organ(s) following repeated inhalation at concentrations above the recommended exposure limit: Blood/Blood Forming Organs See Section 11 for additional information. Risk depends on duration and level of exposure.

Indication of any immediate medical attention and special treatment needed
Note to Physicians: Ingestion of this product or subsequent vomiting may result in aspiration of light hydrocarbon liquid, which may cause pneumonitis.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA: Dry Chemical, CO2, Aqueous Film Forming Foam (AFFF) or alcohol resistant foam.
Unusual Fire Hazards: See Section 7 for proper handling and storage.

PROTECTION OF FIRE FIGHTERS:
Fire Fighting Instructions: For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment, including self-contained breathing apparatus.
Combustion Products: Highly dependent on combustion conditions. A complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved when this material undergoes combustion.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures: Eliminate all sources of ignition in the vicinity of the spill or released vapor. If this material is released into the work area, evacuate the area immediately. Monitor area with combustible gas indicator.
Spill Management: Stop the source of the release if you can do it without risk. Contain release to prevent further contamination of soil, surface water or groundwater. Clean up spill as soon as possible, observing precautions in Exposure Controls/Personal Protection. Use appropriate techniques such as applying non-combustible absorbent materials or pumping. All equipment used when handling the product must be grounded. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Where feasible and appropriate, remove contaminated soil. Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations.
Reporting: Report spills to local authorities and/or the U.S. Coast Guard's National Response Center at (800) 424-8802 as appropriate or required.

SECTION 7 HANDLING AND STORAGE

General Handling Information: Avoid contaminating soil or releasing this material into sewage and drainage systems and bodies of water.
Precautionary Measures: This product presents an extreme fire hazard. Liquid very quickly evaporates, even at low temperatures, and forms vapor (fumes) which can catch fire and burn with explosive violence. Invisible vapor spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, and electrical motors and switches. Never siphon gasoline by mouth. Do not store in open or unlabeled containers. READ AND OBSERVE ALL PRECAUTIONS ON PRODUCT LABEL. Use only as a motor fuel. Do not use for cleaning, pressure appliance fuel, or any other such use. Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Do not breathe vapor or fumes. Wash thoroughly after handling. Keep out of the reach of children.
Static Hazard: Improper filling of portable gasoline containers creates danger of fire. Only dispense gasoline into approved and properly labeled gasoline containers. Always place portable containers on the ground. Be sure pump nozzle is in contact with the container while filling. Do not use a nozzle's lock-open device. Do not fill portable containers that are inside a vehicle or truck/trailer bed.

Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating and accumulating an electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures.
Container Warnings: Container is not designed to contain pressure. Do not use pressure to empty container or it may rupture with explosive force. Empty containers retain product residue (solid, liquid, and/or vapor) and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. They may explode and cause injury or death. Empty containers should be completely drained, properly closed, and promptly returned to a drum reconditioner or disposed of properly.

General Storage Information: DO NOT USE OR STORE near heat, sparks, flames, or hot surfaces .

USE AND STORE ONLY IN WELL VENTILATED AREA. Keep container closed when not in use.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

GENERAL CONSIDERATIONS:

Consider the potential hazards of this material (see Section 2), applicable exposure limits, job activities, and other substances in the work place when designing engineering controls and selecting personal protective equipment. If engineering controls or work practices are not adequate to prevent exposure to harmful levels of this material, the personal protective equipment listed below is recommended. The user should read and understand all instructions and limitations supplied with the equipment since protection is usually provided for a limited time or under certain circumstances.

ENGINEERING CONTROLS:

Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below the recommended exposure limits.

PERSONAL PROTECTIVE EQUIPMENT

Eye/Face Protection: Wear protective equipment to prevent eye contact. Selection of protective equipment may include safety glasses, chemical goggles, face shields, or a combination depending on the work operations conducted.
Skin Protection: Wear protective clothing to prevent skin contact. Selection of protective clothing may include gloves, apron, boots, and complete facial protection depending on operations conducted. Suggested materials for protective gloves include: Chlorinated Polyethylene (or Chlorosulfonated Polyethylene), Nitrile Rubber, Polyurethane, Viton.
Respiratory Protection: Determine if airborne concentrations are below the recommended occupational exposure limits for jurisdiction of use. If airborne concentrations are above the acceptable limits, wear an approved respirator that provides adequate protection from this material, such as: Air-Purifying Respirator for Organic Vapors.
When used as a fuel, this material can produce carbon monoxide in the exhaust. Determine if airborne concentrations are below the occupational exposure limit for carbon monoxide. If not, wear an approved positive-pressure air-supplying respirator.
Use a positive pressure air-supplying respirator in circumstances where air-purifying respirators may not provide adequate protection.

Occupational Exposure Limits:

Component	**Agency**	**Form**	**TWA**	**STEL**	**Ceiling**	**Notation**
Gasoline	ACGIH	Vapor	300 ppm	500 ppm	--	A3
Gasoline	ACGIH	--	300 ppm	500 ppm	--	--
Toluene	ACGIH	--	20 ppm	--	--	--
Toluene	OSHA Z-2	--	200 ppm	--	300 ppm	--
Pentane, 2,2,4-trimethyl-	ACGIH	--	300 ppm	--	--	--
Pentane, 2,2,4-trimethyl-	OSHA Z-1	--	2350 mg/m3	--	--	--
Xylene	ACGIH	--	100 ppm	150 ppm	--	--
Xylene	OSHA Z-1	--	435 mg/m3	--	--	--
Trimethylbenzene (3 isomers: 1,2,3-; 1,2,4-; 1,3,5- isomer)	ACGIH	--	25 ppm	--	--	--
Butane	ACGIH	--	--	1000 ppm	--	--
Ethanol	ACGIH	--	1000 ppm	1000 ppm	--	A4
Ethanol	OSHA Z-1	--	1900 mg/m3	--	--	--
Hexane	ACGIH	--	50 ppm	--	--	Skin
Hexane	OSHA Z-1	--	1800 mg/m3	--	--	--

Benzene	ACGIH	Vapor	0.50 ppm	2.50 ppm	--	--
Benzene	ACGIH	--	0.50 ppm	2.50 ppm	--	Skin
Benzene	CVX	Vapor	0.50 ppm	2.50 ppm	--	--
Benzene	OSHA SRS	--	1 ppm	5 ppm	--	29 CFR 1910.1028
Benzene	OSHA Z-2	--	10 ppm	--	25 ppm	--
Heptane	ACGIH	--	400 ppm	500 ppm	--	--
Heptane	OSHA Z-1	--	2000 mg/m3	--	--	--
Cyclohexane	ACGIH	--	100 ppm	--	--	--
Cyclohexane	OSHA Z-1	--	1050 mg/m3	--	--	--
Ethylbenzene	ACGIH	Vapor	100 ppm	--	--	--
Ethylbenzene	ACGIH	--	20 ppm	--	--	--
Ethylbenzene	OSHA Z-1	--	435 mg/m3	--	--	--
Methylcyclohexane	ACGIH	--	400 ppm	--	--	--
Methylcyclohexane	OSHA Z-1	--	2000 mg/m3	--	--	--
Naphthalene	ACGIH	Vapor	10 ppm	15 ppm	--	A4 Skin
Naphthalene	ACGIH	--	10 ppm	--	--	Skin
Naphthalene	OSHA Z-1	--	50 mg/m3	--	--	--

Consult local authorities for appropriate values.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Attention: the data below are typical values and do not constitute a specification.

Color: Colorless to yellow
Physical State: Liquid
Odor: Petroleum odor
Odor Threshold: No data available
pH: Not Applicable
Vapor Pressure: 5 psi - 15.50 psi (Typical) @ 37.8 °C (100 °F)
Vapor Density (Air = 1): 3 - 4 (Typical)
Initial Boiling Point: 27.2°C (81°F) - 52.8°C (127°F) (Typical)
Solubility: Negligible
Freezing Point: Not Applicable
Melting Point: Not Applicable
Specific Gravity: 0.70 g/ml - 0.80 g/ml @ 15.6°C (60.1°F) (Typical)
Density: No data available
Viscosity: <1 SUS @ 37.8°C (100°F)
Evaporation Rate: No data available
Decomposition temperature: No data available
Octanol/Water Partition Coefficient: 2 - 7

FLAMMABLE PROPERTIES:
Flammability (solid, gas): Not Applicable

Flashpoint: (Tagliabue Closed Cup ASTM D56) < -45 °C (< -49 °F)
Autoignition: > 280 °C (> 536 °F)
Flammability (Explosive) Limits (% by volume in air): Lower: 1.4 Upper: 7.6

SECTION 10 STABILITY AND REACTIVITY

Reactivity: May react with strong acids or strong oxidizing agents, such as chlorates, nitrates,

peroxides, etc.
Chemical Stability: This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Incompatibility With Other Materials: Not applicable
Hazardous Decomposition Products: None known (None expected)
Hazardous Polymerization: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects
Serious Eye Damage/Irritation: This material causes serious eye irritation. The product has not been tested. The statement is based on evaluation of data for product components.

Skin Corrosion/Irritation: For a 4-hour exposure, the Primary Irritation Index (PII) in rabbits is: 4.8/8.0.

Skin Sensitization: This material did not cause skin sensitization reactions in a Buehler guinea pig test.

Acute Dermal Toxicity: LD50: >3.75 g/kg (rabbit).

Acute Oral Toxicity: LD50: >5 ml/kg (rat).

Acute Inhalation Toxicity: 4 hour(s) LD50: >20000 mg/m3 (rat).
Acute Toxicity Estimate: Not Determined

Germ Cell Mutagenicity: This material may cause genetic defects. The product has not been tested. The statement is based on evaluation of data for similar materials or product components.

Carcinogenicity: This material may cause cancer. The product has not been tested. The statement is based on evaluation of data for similar materials or product components. Gasoline has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Whole gasoline exhaust has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Contains benzene, which has been classified as a carcinogen by the National Toxicology Program (NTP) and a Group 1 carcinogen (carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
Contains naphthalene, which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC). Contains ethylbenzene which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Reproductive Toxicity: This material is suspected of damaging the unborn child. The product has not been tested. The statement is based on evaluation of data for similar materials or product components.

Specific Target Organ Toxicity - Single Exposure: This material may cause drowsiness or dizziness. The product has not been tested. The statement is based on evaluation of data for similar materials or product components.

Specific Target Organ Toxicity - Repeated Exposure: This material causes damage to organs through prolonged or repeated exposure. The product has not been tested. The statement is based on evaluation of data for similar materials or product components.

Aspiration Hazard: This material is considered an aspiration hazard based on the kinematic viscosity of the material.

ADDITIONAL TOXICOLOGY INFORMATION:

Gasolines are highly volatile and can produce significant concentrations of vapor at ambient temperatures. Gasoline vapor is heavier than air and at high concentrations may accumulate in confined spaces to present both safety and health hazards. When vapor exposures are low, or short duration and infrequent, such as during refueling and tanker loading/unloading, neither total hydrocarbon nor components such as benzene are likely to result in any adverse health effects. In situations such as accidents or spills where exposure to gasoline vapor is potentially high, attention should be paid to potential toxic effects of specific components. Information about specific components in gasoline can be found in Sections 2/3, 8 and 15 of this MSDS. More detailed information on the health hazards of specific gasoline components can be obtained calling the Chevron Emergency Information Center (see Section 1 for phone numbers).

Pathological misuse of solvents and gasoline, involving repeated and prolonged exposure to high concentrations of vapor is a significant exposure on which there are many reports in the medical literature. As with other solvents, persistent abuse involving repeated and prolonged exposures to high concentrations of vapor has been reported to result in central nervous system damage and eventually, death. In a study in which ten human volunteers were exposed for 30 minutes to approximately 200, 500 or 1000 ppm concentrations of gasoline vapor, irritation of the eyes was the only significant effect observed, based on both subjective and objective assessments.

Lifetime inhalation of wholly vaporized unleaded gasoline at 2056 ppm has caused increased liver tumors in female mice and kidney cancer in male rats. In their 1988 review of carcinogenic risk from gasoline, The International Agency for Research on Cancer (IARC) noted that, because published epidemiology studies did not include any exposure data, only occupations where gasoline exposure may have occurred were reviewed. These included gasoline service station attendants and automobile mechanics. IARC also noted that there was no opportunity to separate effects of combustion products from those of gasoline itself. Although IARC allocated gasoline a final overall classification of Group 2B, i.e. possibly carcinogenic to humans, this was based on limited evidence in experimental animals plus supporting evidence including the presence in gasoline of benzene. The actual evidence for carcinogenicity in humans was considered inadequate.

MUTAGENICITY: Gasoline was not mutagenic, with or without activation, in the Ames assay (Salmonella typhimurium), Saccharamyces cerevisesae, or mouse lymphoma assays. In addition, point mutations were not induced in human lymphocytes. Gasoline was not mutagenic when tested in the mouse dominant lethal assay. Administration of gasoline to rats did not cause chomosomal aberrations in their bone marrow cells. EPIDEMIOLOGY: To explore the health effects of workers potentially exposed to gasoline vapors in the marketing and distribution sectors of the petroleum industry, the American Petroleum Institute sponsored a cohort mortality study (Publication 4555), a nested case-control study (Publication 4551), and an exposure assessment study (Publication 4552). Histories of exposure to gasoline were reconstructed for cohort of more than 18,000 employees from four companies for the time period between 1946 and 1985. The results of the cohort mortality study indicated that there was no increased mortality from either kidney cancer or leukemia among marketing and marine distribution employees who were exposed to gasoline in the petroleum industry, when compared to the general population. More importantly, based on internal comparisons, there was no association between mortality from kidney cancer or leukemia and various indices of gasoline exposure. In particular, neither duration of employment, duration of exposure, age at first exposure, year of first exposure, job category, cumulative exposure, frequency of peak exposure, nor average intensity of exposure had any effect on kidney cancer or leukemia mortality. The results of the nested case-control study confirmed the findings of the original cohort study. That is, exposure to gasoline at the levels experienced by this cohort of distribution workers is not a significant risk factor for leukemia (all cell types), acute myeloid leukemia, kidney cancer or multiple myeloma.

This product contains ethylbenzene.

BIRTH DEFECTS AND REPRODUCTION: Ethylbenzene is not expected to cause birth defects or other developmental effects based on well-conducted studies in rabbits and rats sponsored by NIOSH. Other studies in rats and mice which reported urinary tract malformations have many deficiencies and have limited usefulness in evaluating human risk. Reproductive effects are not expected based on a NIOSH study of fertility, and lack of effects observed for sperm counts and motility, estrous cycle and pathology of reproductive organs following repeated exposures. HEARING: Statistically significant losses in outer hair cells (OHCs) were observed in rats exposed to >=200 ppm ethylbenzene, 6 hours/day, 6 days/week for 13 weeks, after an 8-week recovery period. Following longer exposure, inner hair cells losses were also observed in rats exposed to >= 600 ppm ethylbenzene, but only occasionally in rats exposed to 400 ppm. The Lowest Observed Adverse Effect Level in rats (LOAEL) was 200 ppm for losses of OHCs. Guinea pigs exposed to ethylbenzene at 2,500 ppm, 6 hours/day for 5 days did not show auditory deficits or losses in OHCs. The concentration of ethylbenzene used in the JP-8 study was approximately 10 ppm. GENETIC TOXICITY: Ethylbenzene tested negative in the bacterial mutation test, Chinese Hamster Ovary (CHO) cell in vitro assay, sister chromatid exchange assay and an unscheduled DNA synthesis assay. Conflicting results have been reported for the mouse lymphoma cell assay. Increased micronuclei were reported in an in vitro Syrian hamster embryo cell assay; however, two in vivo micronuclei studies in mice were negative. In Syrian hamster embryo cells in vitro, cell transformation was observed at 7 days of incubation but not at 24 hours. Based on these results, ethylbenzene is not expected to be mutagenic or clastogenic. CARCINOGENICITY: In studies conducted by the National Toxicology Program, rats and mice were exposed to ethylbenzene at 25, 250 and 750 ppm for six hours per day, five days per week for 103 weeks. In rats exposed to 750 ppm, the incidence of kidney tubule hyperplasia and tumors was increased. Testicular tumors develop spontaneously in nearly all rats if allowed to complete their natural life span; in this study, the development of these tumors appeared to be enhanced in male rats exposed to 750 ppm. In mice, the incidences of lung tumors in males and liver tumors in females exposed to 750 ppm were increased as compared to control mice but were within the range of incidences observed historically in control mice. Other liver effects were observed in male mice exposed to 250 and 750 ppm. The incidences of hyperplasia were increased in the pituitary gland in female mice at 250 and 750 ppm and in the thyroid in male and female mice at 750 ppm.

This product contains toluene.
GENERAL TOXICITY: The primary effects of exposure to toluene in animals and humans are on the central nervous system. Solvent abusers, who typically inhale high concentrations (thousands of ppm) for brief periods of time, in addition to experiencing respiratory tract irritation, often suffer permanent central nervous system effects that include tremors, staggered gait, impaired speech, hearing and vision loss, and changes in brain tissue. Death in some solvent abusers has been attributed to cardiac arrhythmias, which appear to be have been triggered by epinephrine acting on solvent sensitized cardiac tissue. Although liver and kidney effects have been seen in some solvent abusers, results of animal testing with toluene do not support these as primary target organs.

HEARING: Humans who were occupationally exposed to concentrations of toluene as low as 100 ppm for long periods of time have experienced hearing deficits. Hearing loss, as demonstrated using behavioral and electrophysiological testing as well as by observation of structural damage to cochlear hair cells, occurred in experimental animals exposed to toluene. It also appears that toluene exposure and noise may interact to produce hearing deficits.

COLOR VISION: In a single study of workers exposed to toluene at levels under 50 ppm, small decreases in the ability to discriminate colors in the blue-yellow range have been reported for female workers. This effect, which should be investigated further, is very subtle and would not likely have been noticed by the people tested.

REPRODUCTIVE/DEVELOPMENTAL TOXICITY: Toluene may also cause mental and/or growth retardation in the children of female solvent abusers who directly inhale toluene (usually at thousands of ppm) when they are pregnant. Toluene caused growth retardation in rats and rabbits when administered at doses that were toxic to the mothers. In rats, concentrations of up to 5000 ppm did not cause birth defects. No effects were observed in the offspring at doses that did not intoxicate the pregnant animals. The exposure level at which no effects were seen (No Observed Effect Level, NOEL) is 750 ppm in the rat and 500 ppm in the rabbit.

This product contains xylene.

ACUTE TOXICITY: The primary effects of exposure to xylene in animals and humans are on the central nervous system. In addition,in some individuals, xylene exposure can sensitize cardiac tissue to epinephrine which may precipitate fatal ventricular fibrillation. DEVELOPMENTAL TOXICITY: Xylene has been reported to cause developmental toxicity in rats and mice exposed by inhalation during pregnancy. The effects noted consisted of delayed development and minor skeletal variations. In addition, when pregnant mice were exposed by ingestion to a level that killed nearly one-third of the test group, lethality (resorptions) and malformations (primarily cleft palate) occurred. Since xylene can cross the placenta, it may be appropriate to prevent exposure during pregnancy. GENETIC TOXICITY/CARCINOGENICITY: Xylene was not genotoxic in several mutagenicity testing assays including the Ames test. In a cancer study sponsored by the National Toxicology Program (NTP),technical grade xylene gave no evidence of carcinogenicity in rats or mice dosed daily for two years. HEARING: Mixed xylenes have been shown to cause measurable hearing loss in rats exposed to 800 ppm in the air for 14 hours per day for six weeks. Exposure to 1450 ppm xylene for 8 hours caused hearing loss while exposure to 1700 ppm for 4 hours did not. Although no information is available for lower concentrations, other chemicals that cause hearing loss in rats at relatively high concentrations do not cause hearing loss in rats at low concentrations. Worker exposure to xylenes at the permissible exposure limit (100 ppm, time-weighted average) is not expected to cause hearing loss.

This product contains naphthalene.
GENERAL TOXICITY: Exposure to naphthalene has been reported to cause methemoglobinemia and/or hemolytic anemia, especially in humans deficient in the enzyme glucose-6-phosphate dehydrogenase. Laboratory animals given repeated oral doses of naphthalene have developed cataracts. REPRODUCTIVE TOXICITY AND BIRTH DEFECTS: Naphthalene did not cause birth defects when administered orally to rabbits, rats, and mice during pregnancy, but slightly reduced litter size in mice at dose levels that were lethal to the pregnant females. Naphthalene has been reported to cross the human placenta. GENETIC TOXICITY: Naphthalene caused chromosome aberrations and sister chromatid exchanges in Chinese hamster ovary cells, but was not a mutagen in several other in-vitro tests.CARCINOGENICITY: In a study conducted by the National Toxicology Program (NTP), mice exposed to 10 or 30 ppm of naphthalene by inhalation daily for two years had chronic inflammation of the nose and lungs and increased incidences of metaplasia in those tissues. The incidence of benign lung tumors (alveolar/bronchiolar adenomas) was significantly increased in the high-dose female group but not in the male groups. In another two-year inhalation study conducted by NTP, exposure of rats to 10, 30, and 60 ppm naphthalene caused increases in the incidences of a variety of nonneoplastic lesions in the nose. Increases in nasal tumors were seen in both sexes, including olfactory neuroblastomas in females at 60 ppm and adenomas of the respiratory epithelium in males at all exposure levels. The relevance of these effects to humans has not been established. No carcinogenic effect was reported in a 2-year feeding study in rats receiving naphthalene at 41 mg/kg/day.

This product contains cyclohexane.
Cyclohexane primarily affects the central nervous systems of laboratory animals and humans. Acute or prolonged inhalation of cyclohexane at levels below the recommended exposure limits does not result in toxic effects while acute exposures to levels above these recommended limits can cause reversible central nervous system depression. Prolonged exposures of laboratory animals to high levels (up to low thousands of parts per million) have also caused reversible effects which included hyperactivity, diminished response to stimuli, and adaptive liver changes while very high levels (high thousands of parts per million) were fatal. No developmental effects were seen in rats or rabbits following exposures of up to 7000 ppm cyclohexane. No reproductive effects occurred in rats, although postnatal pup growth was reduced at 7000 ppm in a similar manner as observed in the parental animals. Cyclohexane has not been shown to be mutagenic in several in vitro and in vivo assays and has not produced tumors in several dermal application long-term bioassays. Based on these results and the lack of any mutagenic or genotoxic metabolites, cyclohexane is not expected to be mutagenic or genotoxic. Following dermal exposure, cyclohexane is rapidly absorbed, metabolized,and excreted.

This product contains ethanol (ethyl alcohol).

Chronic ingestion of ethanol can damage the liver, nervous system and heart. Chronic heavy consumption of alcoholic beverages has been associated with an increased risk of cancer. Ingestion of ethanol during pregnancy can cause human birth defects such as fetal alcohol syndrome.

This product contains butane.

An atmospheric concentration of 100,000 ppm (10%) butane is not noticeably irritating to the eyes, nose or respiratory tract, but will produce slight dizziness in a few minutes of exposure. No chronic systemic effect has been reported from occupational exposure.

This product contains benzene.

GENETIC TOXICITY/CANCER: Repeated or prolonged breathing of benzene vapor has been associated with the development of chromosomal damage in experimental animals and various blood diseases in humans ranging from aplastic anemia to leukemia (a form of cancer). All of these diseases can be fatal. In some individuals, benzene exposure can sensitize cardiac tissue to epinephrine which may precipitate fatal ventricular fibrillation.

REPRODUCTIVE/DEVELOPMENTAL TOXICITY: No birth defects have been shown to occur in pregnant laboratory animals exposed to doses not toxic to the mother. However, some evidence of fetal toxicity such as delayed physical development has been seen at such levels. The available information on the effects of benzene on human pregnancies is inadequate but it has been established that benzene can cross the human placenta.

OCCUPATIONAL: The OSHA Benzene Standard (29 CFR 1910.1028) contains detailed requirements for training, exposure monitoring, respiratory protection and medical surveillance triggered by the exposure level. Refer to the OSHA Standard before using this product.

This product contains n-hexane.

TARGET ORGAN TOXICITY: Prolonged or repeated ingestion, skin contact or breathing of vapors of n-hexane has been shown to cause peripheral neuropathy. Recovery ranges from no recovery to complete recovery depending upon the severity of the nerve damage. Exposure to 1000 ppm n-hexane for 18 hr/day for 61 days has been shown to cause testicular damage in rats. However, when rats were exposed to higher concentrations for shorter daily periods (10,000 ppm for 6 h/day, 5 days/wk for 13 weeks), no testicular lesions were seen.

CARCINOGENICITY: Chronic exposure to commercial hexane (52% n-hexane) at a concentration of 9000ppm was not carcinogenic to rats or to male mice, but did result in an increased incidence of liver tumors in female mice. No carcinogenic effects were observed in female mice exposed to 900 or 3000 ppm hexane or in male mice. The relevance for humans of these hexane-induced mouse liver tumors is questionable.

GENETIC TOXICITY: n-Hexane caused chromosome aberrations in bone marrow of rats, but was negative in the AMES and mouse lymphoma tests.

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY

Gasoline studies have been conducted in the laboratory under a variety of test conditions with a range of fish and invertebrate species. An even more extensive database is available on the aquatic toxicity of individual aromatic constituents. The majority of published studies do not identify the type of gasoline evaluated, or even provide distinguishing characteristics such as aromatic content or presence of lead alkyls. As a result, comparison of results among studies using open and closed vessels, different ages and species of test animals and different gasoline types, is difficult.

The bulk of the available literature on gasoline relates to the environmental impact of monoaromatic (BTEX) and diaromatic (naphthalene, methylnaphthalenes) constituents. In general, non-oxygenated gasoline exhibits some short-term toxicity to freshwater and marine organisms, especially under closed vessel or flow-through exposure conditions in the laboratory. The components which are the most prominent in the water soluble fraction and cause aquatic toxicity, are also highly volatile and can be readily biodegraded by microorganisms.

This material is expected to be toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment.

48 hour(s) LC50: 3.0 mg/l (Daphnia magna)
96 hour(s) LC50: 1.8 mg/l (Mysidopsis bahia)
96 hour(s) LC50: 8.3 mg/l (Cyprinodon variegatus)
96 hour(s) LC50: 2.7 mg/l (Oncorhynchus mykiss)

MOBILITY
No data available.

PERSISTENCE AND DEGRADABILITY
This material is expected to be readily biodegradable. Following spillage, the more volatile components of gasoline will be rapidly lost, with concurrent dissolution of these and other constituents into the water. Factors such as local environmental conditions (temperature, wind, mixing or wave action, soil type, etc), photo-oxidation, biodegradation and adsorption onto suspended sediments, can contribute to the weathering of spilled gasoline.

The aqueous solubility of non-oxygenated unleaded gasoline, based on analysis of benzene, toluene, ethylbenzene+xylenes and naphthalene, is reported to be 112 mg/l. Solubility data on individual gasoline constituents also available.

The product has not been tested. The statement has been derived from the properties of the individual components.

POTENTIAL TO BIOACCUMULATE
Bioconcentration Factor: No data available.
Octanol/Water Partition Coefficient: 2 - 7

SECTION 13 DISPOSAL CONSIDERATIONS

Use material for its intended purpose or recycle if possible. This material, if it must be discarded, may meet the criteria of a hazardous waste as defined by international, country, or local laws and regulations.

SECTION 14 TRANSPORT INFORMATION

The description shown may not apply to all shipping situations. Consult 49CFR, or appropriate Dangerous Goods Regulations, for additional description requirements (e.g., technical name) and mode-specific or quantity-specific shipping requirements.

DOT Shipping Description: UN1203, GASOLINE, 3, II; OPTIONAL DISCLOSURE: UN1203, GASOLINE, 3, II, MARINE POLLUTANT (GASOLINE)

IMO/IMDG Shipping Description: UN1203, GASOLINE, 3, II, FLASH POINT SEE SECTION 9, MARINE POLLUTANT (GASOLINE)

ICAO/IATA Shipping Description: UN1203, GASOLINE, 3, II

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC code:
Not applicable

SECTION 15 REGULATORY INFORMATION

EPCRA 311/312 CATEGORIES:

Aspiration Hazard
Carcinogenicity
Flammable (gases, aerosols, liquids, or solids)
Germ cell mutagenicity
Reproductive toxicity
Serious eye damage or eye irritation
Skin Corrosion or Irritation
Specific target organ toxicity (single or repeated exposure)

REGULATORY LISTS SEARCHED:

01-1=IARC Group 1
01-2A=IARC Group 2A
01-2B=IARC Group 2B
02=NTP Carcinogen
03=EPCRA 313
04=CA Proposition 65
05=MA RTK
06=NJ RTK
07=PA RTK
08-1=TSCA 5(e)
08-2=TSCA 12(b)

The following components of this material are found on the regulatory lists indicated.

Gasoline	01-2B, 07
Toluene	03, 04, 05, 06, 07
Pentane, 2,2,4-trimethyl-	05, 06, 07
Xylene	03, 05, 06, 07
Trimethylbenzene (3 isomers: 1,2,3-; 1,2,4-; 1,3,5-isomer)	05, 06, 07
Butane	04, 05, 06, 07
Ethanol	01-1, 02, 04, 05, 06, 07
Hexane	03, 04, 05, 06, 07
Benzene	01-1, 02, 03, 04, 05, 06, 07
Heptane	05, 06, 07
Cyclohexane	03, 05, 06, 07
Ethylbenzene	01-2B, 03, 04, 05, 06, 07
Methylcyclohexane	05, 06
Naphthalene	01-1, 01-2B, 02, 03, 04, 05, 06, 07

CHEMICAL INVENTORIES:

All components comply with the following chemical inventory requirements: AIIC (Australia), DSL (Canada), EINECS (European Union), KECI (Korea), NZIoC (New Zealand), PICCS (Philippines), TCSI (Taiwan).

SECTION 16 OTHER INFORMATION

NFPA RATINGS: Health: 1 Flammability: 3 Reactivity: 0

HMIS RATINGS: Health: 2* Flammability: 3 Reactivity: 0
(0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme, PPE:- Personal Protection Equipment Index recommendation, *- Chronic Effect Indicator). These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint and Coating Association (for HMIS ratings).

REVISION STATEMENT: SECTION 02 - Environmental Classification information was added.

SECTION 02 - Environmental Classification information was deleted.
SECTION 02 - Hazard Statements information was added.
SECTION 02 - Hazard Statements information was deleted.
SECTION 02 - Health Classification information was added.
SECTION 02 - Health Classification information was deleted.
SECTION 02 - Health Hazard information was deleted.
SECTION 02 - Physical/Chemical Classification information was added.
SECTION 02 - Physical/Chemical Classification information was deleted.
SECTION 02 - Pictogram information was added.
SECTION 02 - Pictogram information was deleted.
SECTION 02 - Precautionary Statements information was added.
SECTION 02 - Precautionary Statements information was deleted.
SECTION 02 - Signal Word information was added.
SECTION 02 - Signal Word information was deleted.
SECTION 03 - Composition information was modified.
SECTION 08 - Occupational Exposure Limit Table information was modified.
SECTION 09 - Physical/Chemical Properties information was added.
SECTION 09 - Physical/Chemical Properties information was modified.
SECTION 11 - Carcinogenicity information was added.
SECTION 11 - Germ Cell Mutagenicity information was added.
SECTION 11 - Reproductive Toxicity information was added.
SECTION 11 - Specific Target Organ Toxicity - Repeated Exposure information was added.
SECTION 11 - Specific Target Organ Toxicity - Single Exposure information was added.
SECTION 11 - Toxicological Information information was added.
SECTION 11 - Toxicological Information information was modified.
SECTION 12 - Ecological Information information was added.
SECTION 14 - DOT Classification information was modified.
SECTION 14 - IMO Classification information was modified.
SECTION 15 - Chemical Inventories information was modified.
SECTION 15 - Regulatory Information information was added.
SECTION 15 - Regulatory Information information was modified.

Revision Date: May 11, 2022

ABBREVIATIONS THAT MAY HAVE BEEN USED IN THIS DOCUMENT:

TLV - Threshold Limit Value	TWA - Time Weighted Average
STEL - Short-term Exposure Limit	PEL - Permissible Exposure Limit
GHS - Globally Harmonized System	CAS - Chemical Abstract Service Number
ACGIH - American Conference of Governmental Industrial Hygienists	IMO/IMDG - International Maritime Dangerous Goods Code
API - American Petroleum Institute	SDS - Safety Data Sheet
HMIS - Hazardous Materials Information System	NFPA - National Fire Protection Association (USA)
DOT - Department of Transportation (USA)	NTP - National Toxicology Program (USA)
IARC - International Agency for Research on Cancer	OSHA - Occupational Safety and Health Administration
NCEL - New Chemical Exposure Limit	EPA - Environmental Protection Agency
SCBA - Self-Contained Breathing Apparatus	

Prepared according to the 29 CFR 1910.1200 (2012) by Chevron Technical Center, 6001 Bollinger Canyon Road, San Ramon, CA 94583.

The above information is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our

control and with which we may be unfamiliar and since data made available subsequent to the date hereof may suggest modifications of the information, we do not assume any responsibility for the results of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose.

SAFETY DATA SHEET

Version 5.7
Revision Date 06/08/2018
Print Date 08/05/2018

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name : Hexane

Product Number : 296090
Brand : Sigma-Aldrich
Index-No. : 601-037-00-0

CAS-No. : 110-54-3

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA

Telephone : +1 800-325-5832
Fax : +1 800-325-5052

1.4 Emergency telephone number

Emergency Phone # : +1-703-527-3887 (CHEMTREC)

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 2), H225
Skin irritation (Category 2), H315
Reproductive toxicity (Category 2), H361
Specific target organ toxicity - single exposure (Category 3), Central nervous system, H336
Specific target organ toxicity - repeated exposure, Oral (Category 2), Nervous system, H373
Aspiration hazard (Category 1), H304
Acute aquatic toxicity (Category 2), H401
Chronic aquatic toxicity (Category 2), H411

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H304	May be fatal if swallowed and enters airways.
H315	Causes skin irritation.
H336	May cause drowsiness or dizziness.
H361	Suspected of damaging fertility or the unborn child.
H373	May cause damage to organs (Nervous system) through prolonged or repeated exposure if swallowed.

H411	Toxic to aquatic life with long lasting effects.

Precautionary statement(s)

P201	Obtain special instructions before use.
P202	Do not handle until all safety precautions have been read and understood.
P210	Keep away from heat/sparks/open flames/hot surfaces. No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P260	Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P273	Avoid release to the environment.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P310	IF SWALLOWED: Immediately call a POISON CENTER/doctor.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell.
P308 + P313	IF exposed or concerned: Get medical advice/ attention.
P331	Do NOT induce vomiting.
P332 + P313	If skin irritation occurs: Get medical advice/ attention.
P362	Take off contaminated clothing and wash before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P391	Collect spillage.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms : n-Hexane

Formula : C_6H_{14}
Molecular weight : 86.18 g/mol
CAS-No. : 110-54-3
EC-No. : 203-777-6
Index-No. : 601-037-00-0
Registration number : 01-2119480412-44-XXXX

Hazardous components

Component	Classification	Concentration
n-Hexane		
	Flam. Liq. 2; Skin Irrit. 2; Repr. 2; STOT SE 3; STOT RE 2; Asp. Tox. 1; Aquatic Acute 2; Aquatic Chronic 2; H225, H304, H315, H336, H361f, H373, H411	90 - 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

No data available

5.3 Advice for firefighters

Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information

Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up

Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections

For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Flash back possible over considerable distance.Container explosion may occur under fire conditions.Use explosion-proof equipment.Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Storage class (TRGS 510): 3: Flammable liquids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
n-Hexane	110-54-3	TWA	50 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Central Nervous System impairment Eye irritation Peripheral neuropathy Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		TWA	50 ppm 180 mg/m3	USA. NIOSH Recommended Exposure Limits
		TWA	500 ppm 1,800 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
		PEL	50 ppm 180 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		Skin		

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
	-	2,5-Hexanedione	0.4 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift at end of workweek			

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.4 mm
Break through time: 480 min
Material tested:Camatril® (KCL 730 / Aldrich Z677442, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.2 mm
Break through time: 59 min
Material tested:Dermatril® P (KCL 743 / Aldrich Z677388, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

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9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid Colour: colourless
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	7.0
e)	Melting point/freezing point	Melting point/range: -95 °C (-139 °F)
f)	Initial boiling point and boiling range	69 °C (156 °F)
g)	Flash point	-26.0 °C (-14.8 °F) - closed cup
h)	Evaporation rate	15.8
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 7.7 %(V) Lower explosion limit: 1.2 %(V)
k)	Vapour pressure	341.3 hPa (256.0 mmHg) at 37.7 °C (99.9 °F) 176.0 hPa (132.0 mmHg) at 20.0 °C (68.0 °F)
l)	Vapour density	No data available
m)	Relative density	0.659 g/mL at 25 °C (77 °F)
n)	Water solubility	insoluble
o)	Partition coefficient: n-octanol/water	log Pow: 3.90 - 4.11
p)	Auto-ignition temperature	234.0 °C (453.2 °F)

q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information

No data available

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10. STABILITY AND REACTIVITY

10.1 Reactivity

No data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

Vapours may form explosive mixture with air.

10.4 Conditions to avoid

Exposure to moisture may affect product quality.
Heat, flames and sparks.

10.5 Incompatible materials

Oxidizing agents

10.6 Hazardous decomposition products

Other decomposition products - No data available
Hazardous decomposition products formed under fire conditions. - Carbon oxides
In the event of fire: see section 5

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11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity

LD50 Oral - Rat - male and female - 16,000 mg/kg
(OECD Test Guideline 401)

LC50 Inhalation - Rat - 4 h - 172 mg/l
Remarks: (RTECS)

LD50 Dermal - Rabbit - > 2,000 mg/kg
Remarks: (ECHA)

Skin corrosion/irritation
Serious eye damage/eye irritation
Respiratory or skin sensitisation
Germ cell mutagenicity
In vitro mammalian cell gene mutation test
Mouse lymphoma test
Result: Positive results were obtained in some in vitro tests.

Ames test
Salmonella typhimurium
Result: negative

Result: negative
(National Toxicology Program)

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

Reproductive toxicity
Suspected of damaging the unborn child.

Suspected of damaging fertility.

Specific target organ toxicity - single exposure
May cause drowsiness or dizziness. - Central nervous system

Specific target organ toxicity - repeated exposure
Inhalation - May cause damage to organs through prolonged or repeated exposure. - Nervous system

Aspiration hazard
Aspiration hazard, Aspiration may cause pulmonary oedema and pneumonitis.

Additional Information
RTECS: MN9275000

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.
Drowsiness, irritant effects, somnolence
narcosis, Nausea, Tiredness, CNS disorders, paralysis symptoms
Risk of corneal clouding.
It generally applies for aliphatic hydrocarbons with 6 - 18 carbon atoms that they may cause pneumonia, in some cases also pulmonary oedema, upon direct inhalation, i.e. in conditions that can occur only in very special circumstances (nebulizations, spraying, inhalation of aerosols and similar). After absorption of very large quantities: narcosis.

Testes. - Irregularities - Based on Human Evidence

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12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish	LC50 - Pimephales promelas (fathead minnow) - 2.5 mg/l - 96 h Remarks: (ECOTOX Database)
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 2.1 mg/l - 48 h Remarks: (Lit.)

12.2 Persistence and degradability

12.3 Bioaccumulative potential

12.4 Mobility in soil

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Toxic to aquatic life with long lasting effects.

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13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1208 Class: 3 Packing group: II
Proper shipping name: Hexanes
Reportable Quantity (RQ): 5000 lbs
Poison Inhalation Hazard: No

IMDG
UN number: 1208 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: HEXANES
Marine pollutant:yes

IATA
UN number: 1208 Class: 3 Packing group: II
Proper shipping name: Hexanes

15. REGULATORY INFORMATION

SARA 302 Components
No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
n-Hexane	110-54-3	2007-07-01

Massachusetts Right To Know Components

	CAS-No.	Revision Date
n-Hexane	110-54-3	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
n-Hexane	110-54-3	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
n-Hexane	110-54-3	2007-07-01

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Aquatic Acute	Acute aquatic toxicity
Aquatic Chronic	Chronic aquatic toxicity
Asp. Tox.	Aspiration hazard
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H304	May be fatal if swallowed and enters airways.
H315	Causes skin irritation.
H336	May cause drowsiness or dizziness.
H361	Suspected of damaging fertility or the unborn child.
H361f	Suspected of damaging fertility.
H373	May cause damage to organs (/$/*_2ORG_REP_ORA/$/) through prolonged or repeated exposure if swallowed.
H401	Toxic to aquatic life.
H411	Toxic to aquatic life with long lasting effects.

HMIS Rating
Health hazard: 2

Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 5.7 Revision Date: 06/08/2018 Print Date: 08/05/2018

SAFETY DATA SHEET

Version 6.3
Revision Date 08/27/2022
Print Date 09/24/2022

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name	:	Isopropyl alcohol
Product Number	:	I9030
Brand	:	SIGALD
Index-No.	:	603-117-00-0
CAS-No.	:	67-63-0

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses	:	Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company	:	Sigma-Aldrich Inc. 3050 SPRUCE ST ST. LOUIS MO 63103 UNITED STATES
Telephone	:	+1 314 771-5765
Fax	:	+1 800 325-5052

1.4 Emergency telephone

Emergency Phone #	:	800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Flammable liquids (Category 2), H225
Eye irritation (Category 2A), H319
Specific target organ toxicity - single exposure (Category 3), Central nervous system, H336

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal Word Danger

Hazard statement(s)

H225	Highly flammable liquid and vapor.
H319	Causes serious eye irritation.
H336	May cause drowsiness or dizziness.

Precautionary statement(s)

P210	Keep away from heat/ sparks/ open flames/ hot surfaces. No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P261	Avoid breathing mist or vapors.
P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ eye protection/ face protection.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor if you feel unwell.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337 + P313	If eye irritation persists: Get medical advice/ attention.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

May form explosive peroxides.

SECTION 3: Composition/information on ingredients

3.1 Substances

Synonyms : 2-Propanol
sec-Propyl alcohol
Isopropyl alcohol
Isopropanol

Formula : C_3H_8O
Molecular weight : 60.10 g/mol
CAS-No. : 67-63-0
EC-No. : 200-661-7
Index-No. : 603-117-00-0

Component	Classification	Concentration
2-Propanol		
	Flam. Liq. 2; Eye Irrit. 2A; STOT SE 3; H225, H319,	<= 100 %

	H336 Concentration limits: >= 20 %: STOT SE 3, H336;	

For the full text of the H-Statements mentioned in this Section, see Section 16.

SECTION 4: First aid measures

4.1 Description of first-aid measures

General advice
Show this material safety data sheet to the doctor in attendance.

If inhaled
After inhalation: fresh air. Call in physician.

In case of skin contact
In case of skin contact: Take off immediately all contaminated clothing. Rinse skin with water/ shower.

In case of eye contact
After eye contact: rinse out with plenty of water. Call in ophthalmologist. Remove contact lenses.

If swallowed
After swallowing: immediately make victim drink water (two glasses at most). Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Carbon dioxide (CO2) Foam Dry powder

Unsuitable extinguishing media
For this substance/mixture no limitations of extinguishing agents are given.

5.2 Special hazards arising from the substance or mixture

Carbon oxides
Combustible.
Pay attention to flashback.
Vapors are heavier than air and may spread along floors.
Development of hazardous combustion gases or vapours possible in the event of fire.
Forms explosive mixtures with air at ambient temperatures.

5.3 Advice for firefighters

In the event of fire, wear self-contained breathing apparatus.

5.4 Further information

Remove container from danger zone and cool with water. Prevent fire extinguishing water from contaminating surface water or the ground water system.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Advice for non-emergency personnel: Do not breathe vapors, aerosols. Avoid substance contact. Ensure adequate ventilation. Keep away from heat and sources of ignition. Evacuate the danger area, observe emergency procedures, consult an expert.
For personal protection see section 8.

6.2 Environmental precautions

Do not let product enter drains. Risk of explosion.

6.3 Methods and materials for containment and cleaning up

Cover drains. Collect, bind, and pump off spills. Observe possible material restrictions (see sections 7 and 10). Take up with liquid-absorbent material (e.g. Chemizorb®). Dispose of properly. Clean up affected area.

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Advice on safe handling

Work under hood. Do not inhale substance/mixture. Avoid generation of vapours/aerosols.

Advice on protection against fire and explosion

Flash back possible over considerable distance.Container explosion may occur under fire conditions.**Advice on protection against fire and explosion**
Keep away from open flames, hot surfaces and sources of ignition.Take precautionary measures against static discharge.

Hygiene measures

Change contaminated clothing. Wash hands after working with substance.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Storage conditions

Handle under nitrogen, protect from moisture. Store under nitrogen.
Keep container tightly closed in a dry and well-ventilated place. Keep away from heat and sources of ignition.

Handle and store under inert gas. Hygroscopic.

Storage class

Storage class (TRGS 510): 3: Flammable liquids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Ingredients with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
2-Propanol	67-63-0	TWA	200 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Not classifiable as a human carcinogen		
		STEL	400 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Not classifiable as a human carcinogen		
		ST	500 ppm 1,225 mg/m3	USA. NIOSH Recommended Exposure Limits
		TWA	400 ppm 980 mg/m3	USA. NIOSH Recommended Exposure Limits
		TWA	400 ppm 980 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		PEL	400 ppm 980 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		STEL	500 ppm 1,225 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
2-Propanol	67-63-0	Acetone	40 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift at end of workweek			

Predicted No Effect Concentration (PNEC)

Compartment	Value
Soil	28 mg/kg
Sea water	140.9 mg/l
Fresh water	140.9 mg/l
Sea sediment	552 mg/kg
Fresh water sediment	552 mg/kg

8.2 Exposure controls

Appropriate engineering controls

Change contaminated clothing. Wash hands after working with substance.

Personal protective equipment

Eye/face protection

Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU). Safety glasses

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.4 mm
Break through time: 480 min
Material tested:Camatril® (KCL 730 / Aldrich Z677442, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.2 mm
Break through time: 60 min
Material tested:Dermatril® P (KCL 743 / Aldrich Z677388, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the EC approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Flame retardant antistatic protective clothing.

Respiratory protection
required when vapours/aerosols are generated. Our recommendations on filtering respiratory protection are based on the following standards: DIN EN 143, DIN 14387 and other accompanying standards relating to the used respiratory protection system.

Control of environmental exposure
Do not let product enter drains. Risk of explosion.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid Color: colorless
b)	Odor	alcohol-like
c)	Odor Threshold	1 ppm
d)	pH	at 20 °C (68 °F)neutral
e)	Melting point/freezing point	Melting point/range: -89.5 °C (-129.1 °F) - lit.
f)	Initial boiling point and boiling range	82 °C 180 °F - lit.
g)	Flash point	12.0 °C (53.6 °F) - closed cup
h)	Evaporation rate	3.0

i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 13.4 %(V) Lower explosion limit: 2 %(V)
k)	Vapor pressure	43 hPa at 20 °C (68 °F)
l)	Vapor density	2.07
m)	Density	0.785 g/cm3 at 25 °C (77 °F) - lit.
	Relative density	No data available
n)	Water solubility	soluble
o)	Partition coefficient: n-octanol/water	log Pow: 0.05 - Bioaccumulation is not expected.
p)	Autoignition temperature	425.0 °C (797.0 °F)
q)	Decomposition temperature	Distillable in an undecomposed state at normal pressure.
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	none

9.2 Other safety information

Minimum ignition energy	0.65 mJ
Conductivity	< 0.1 μS/cm
Surface tension	20.8 mN/m at 25.0 °C (77.0 °F)
Relative vapor density	2.07

SECTION 10: Stability and reactivity

10.1 Reactivity

Vapors may form explosive mixture with air.

10.2 Chemical stability

The product is chemically stable under standard ambient conditions (room temperature) .
May form peroxides of unknown stability.
Test for peroxide formation before distillation or evaporation. Test for peroxide formation or discard after 1 year.
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

Vapors may form explosive mixture with air.

10.4 Conditions to avoid

Warming.

10.5 Incompatible materials

rubber, various plastics, oils

10.6 Hazardous decomposition products

In the event of fire: see section 5

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

LD50 Oral - Rat - 5,840 mg/kg
(OECD Test Guideline 401)
LC50 Inhalation - Rat - male and female - 4 h - 37.5 mg/l - vapor

(OECD Test Guideline 403)
LD50 Dermal - Rabbit - 12,800 mg/kg
Remarks: (RTECS)
No data available

Skin corrosion/irritation

Skin - Rabbit
Result: No skin irritation - 4 h
(OECD Test Guideline 404)

Serious eye damage/eye irritation

Eyes - Rabbit
Result: Eye irritation
(OECD Test Guideline 405)
(Regulation (EC) No 1272/2008, Annex VI)

Respiratory or skin sensitization

Buehler Test - Guinea pig
Result: negative
(OECD Test Guideline 406)

Germ cell mutagenicity

Test Type: Ames test
Test system: Salmonella typhimurium
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 471
Result: negative
Test Type: In vitro mammalian cell gene mutation test
Test system: Chinese hamster ovary cells
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 476
Result: negative

Test Type: In vivo micronucleus test
Species: Mouse
Cell type: Bone marrow
Application Route: Intraperitoneal injection
Method: OECD Test Guideline 474
Result: negative

Carcinogenicity
This product is or contains a component that is not classifiable as to its carcinogenicity based on its IARC, ACGIH, NTP, or EPA classification.

IARC:	No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
NTP:	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

Reproductive toxicity
No data available

Specific target organ toxicity - single exposure
Inhalation, Oral - May cause drowsiness or dizziness. - Central nervous system
Remarks: Classified according to Regulation (EU) 1272/2008, Annex VI (Table 3.1/3.2)

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

11.2 Additional Information

RTECS: NT8050000
Central nervous system depression, prolonged or repeated exposure can cause:, Nausea, Headache, Vomiting, narcosis, Drowsiness, Overexposure may cause mild, reversible liver effects., Aspiration may lead to:, Lung edema, Pneumonia
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

After absorption:

Headache
Dizziness
inebriation
Unconsciousness
narcosis

After uptake of large quantities:

Coma

Handle in accordance with good industrial hygiene and safety practice.

Kidney - Irregularities - Based on Human Evidence

Kidney - Irregularities - Based on Human Evidence

SECTION 12: Ecological information

12.1 Toxicity

Toxicity to fish	flow-through test LC50 - Pimephales promelas (fathead minnow) - 9,640 mg/l - 96 h (OECD Test Guideline 203)
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 13,299 mg/l - 48 h Remarks: (IUCLID)
Toxicity to algae	IC50 - Desmodesmus subspicatus (green algae) - > 1,000 mg/l - 72 h Remarks: (IUCLID)
Toxicity to bacteria	EC5 - Pseudomonas putida - 1,050 mg/l - 16 h Remarks: (Lit.)

12.2 Persistence and degradability

Biodegradability	aerobic - Exposure time 5 d Result: 53 % - Readily biodegradable. (Directive 67/548/EEC, Annex V, C.6)
Theoretical oxygen demand	2,400 mg/g Remarks: (Lit.)
Ratio BOD/ThBOD	49 % Remarks: (IUCLID)

12.3 Bioaccumulative potential

No bioaccumulation is to be expected (log Pow <= 4).

12.4 Mobility in soil

No data available

12.5 Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Endocrine disrupting properties

No data available

12.7 Other adverse effects

No data available

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product

Waste material must be disposed of in accordance with the national and local regulations. Leave chemicals in original containers. No mixing with other waste. Handle uncleaned containers like the product itself.

SECTION 14: Transport information

DOT (US)

UN number: 1219 Class: 3 Packing group: II

Proper shipping name: Isopropanol

Reportable Quantity (RQ):
Poison Inhalation Hazard: No

IMDG
UN number: 1219 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: ISOPROPANOL

IATA
UN number: 1219 Class: 3 Packing group: II
Proper shipping name: Isopropanol

SECTION 15: Regulatory information

SARA 302 Components
This material does not contain any components with a section 302 EHS TPQ.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
2-Propanol	67-63-0	2007-03-01

SARA 311/312 Hazards
Fire Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

SECTION 16: Other information

Further information
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

The branding on the header and/or footer of this document may temporarily not visually match the product purchased as we transition our branding. However, all of the information in the document regarding the product remains unchanged and matches the product ordered. For further information please contact mlsbranding@sial.com.

Version: 6.3 Revision Date: 08/27/2022 Print Date: 09/24/2022

Safety Data Sheet

Effective date: 11 May 2020 **Revision** : 11 May 2020

Trade Name: Liquinox®

1 Identification of the substance/mixture and of the supplier

1.1 GHS Product identifier

Trade Name: Liquinox®
Product number: 1201, 1201-1, 1205, 1215, 1230, 1232, 1232-1, 1255

1.2 Application of the substance / the mixture: Cleaning material/Detergent

1.2.1 Recommended dilution ratio: 1 - 2% in water

1.3 Details of the supplier of the Safety Data Sheet

Manufacturer:

Alconox Inc.
30 Glenn St
White Plains, NY 10603
(914) 948-4040

Supplier:

Emergency telephone number:
ChemTel Inc
North America: 1-888-255-3924
International: +1 813-248-0573

2 Hazards identification

2.1 Classification of the substance or mixture:

In compliance with EC regulation No. 1272, 29CFR1910/1200 and GHS requirements.

Hazard-determining components of labeling:
Alcohol ethoxylate
Sodium alkylbenzene sulfonate
Sodium xylenesulphonate
Lauramine oxide

2.2 Label elements:

Eye damage, category 1.
Skin irritation, category 2.

Product at recommended dilution:

Eye irritation, category 2B

Hazard pictograms:

Signal word: Danger

Hazard statements:
H315 Causes skin irritation.
H318 Causes serious eye damage.

Precautionary statements:
P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.

P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P332+P313 If skin irritation occurs: Get medical advice/attention.
P501 Dispose of contents and container as instructed in Section 13.

Hazardous Elements at Use Dilution:

Hazard pictograms:

Signal word: Warning

Hazard statements:

H320 Causes eye irritation

Precautionary statements:

P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P501 Dispose of contents and container as instructed in Section 13

Additional information: None.

Hazard description

Hazards Not Otherwise Classified (HNOC): May cause surfaces to become slippery. Use caution in areas of foot traffic if on floors.

Information concerning particular hazards for humans and environment:

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to EC regulation No. 1272, 29CFR1910/1200 and GHS, and extended by company and literature data. The classification is in accordance with the latest editions of international substances lists and is supplemented by information from technical literature and by information provided by the company.

3 Composition/information on ingredients

3.1 Chemical characterization: None

3.2 Description: None

3.3 Hazardous components (percentages by weight)

Identification	Chemical Name	Classification	Wt. %
CAS number: 68081-81-2 or 68411-30-3	Sodium Alkylbenzene Sulfonate	Acute Tox. 4; H303 Skin Irrit. 2 ; H315 Eye Dam. 1; H318	10-25
CAS number: 1300-72-7	Sodium Xylenesulphonate	Eye Irrit. 2;H319	2.5-10
CAS number: 84133-50-6	Alcohol Ethoxylate	Skin Irrit. 2 ; H315 Eye Dam. 1; H318	2.5-10
CAS number: 1643-20-5	Lauramine oxide	Skin Irrit. 2 ; H315 Eye Dam. 1; H318	1-2

At use dilution:

CAS number: 68081-81-2 or 68411-30-3	Sodium Alkylbenzene Sulfonate	Eye Irr. 2B; H319	0.1-0.25

3.4 Additional Information: None.

4 First aid measures

4.1 Description of first aid measures

General information: None.

After inhalation:
Maintain an unobstructed airway.
Loosen clothing as necessary and position individual in a comfortable position.

After skin contact:
Wash affected area with soap and water.
Seek medical attention if symptoms develop or persist.

After eye contact:
Rinse/flush exposed eye(s) gently using water for 15-20 minutes.
Remove contact lens(es) if able to do so during rinsing.
Seek medical attention if irritation persists or if concerned.

After swallowing:
Rinse mouth thoroughly.
Seek medical attention if irritation, discomfort, or vomiting persists.

4.2 Most important symptoms and effects, both acute and delayed

None

4.3 Indication of any immediate medical attention and special treatment needed:

No additional information.

First aid measure at recommended dilution:

General information: None.

After inhalation:
Maintain an unobstructed airway.
Loosen clothing as necessary and position individual in a comfortable position.

After skin contact:
Wash affected area with soap and water.

After eye contact:
Rinse/flush exposed eye(s) gently using water for 15-20 minutes.
Remove contact lens(es) if able to do so during rinsing.

After swallowing:
Rinse mouth thoroughly. Seek medical attention if irritation, discomfort, or vomiting develops.

5 Firefighting measures

5.1 Extinguishing media

Suitable extinguishing agents:

Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition.

For safety reasons unsuitable extinguishing agents: None

5.2 Special hazards arising from the substance or mixture:

Thermal decomposition can lead to release of irritating gases and vapors.

5.3 Advice for firefighters

Protective equipment:

Wear protective eye wear, gloves and clothing.
Refer to Section 8.

5.4 Additional information:

Avoid inhaling gases, fumes, dust, mist, vapor and aerosols.
Avoid contact with skin, eyes and clothing.

6 Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Ensure adequate ventilation.
Ensure air handling systems are operational.

6.2 Environmental precautions:

Should not be released into the environment.
Prevent from reaching drains, sewer or waterway.

6.3 Methods and material for containment and cleaning up:

Wear protective eye wear, gloves and clothing.

6.4 Reference to other sections: None

7 Handling and storage

7.1 Precautions for safe handling:

Avoid breathing mist or vapor.
Do not eat, drink, smoke or use personal products when handling chemical substances.

7.2 Conditions for safe storage, including any incompatibilities

Store in a cool, well-ventilated area.

7.3 Specific end use(s):

No additional information.

8 Exposure controls/personal protection

8.1 Control parameters :

25322-68-3, Poly(ethylene oxide), AIHA TWA 10 mg/m3 (<0.15% present in concentrate)

8.2 Exposure controls

Appropriate engineering controls:

Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use or handling.

Respiratory protection:

Not needed under normal conditions.

Protection of skin:

Select glove material impermeable and resistant to the substance.

Eye protection:

Safety goggles or glasses, or appropriate eye protection.

General hygienic measures:

Wash hands before breaks and at the end of work.
Avoid contact with skin, eyes and clothing.

Exposure Control and Personal Protective Equipment at recommended dilution:

Under normal use and operational conditions, no special personal protective equipment or engineering controls will be necessary. Handle with care.

9 Physical and chemical properties

Appearance (physical state, color):	Pale yellow liquid	**Explosion limit lower**: **Explosion limit upper**:	Not determined or not available. Not determined or not available.
Odor:	Not determined or not available.	**Vapor pressure at 20°C**:	Not determined or not available.
Odor threshold:	Not determined or not available.	**Vapor density**:	Not determined or not available.
pH-value:	8.5 (as is)	**Relative density**:	Not determined or not available.
Melting/Freezing point:	Not determined or not available.	**Solubilities**:	Not determined or not available.
Boiling point/Boiling range:	Not determined or not available.	**Partition coefficient (n-octanol/water)**:	Not determined or not available.
Flash point (closed cup):	Not determined or not available.	**Auto/Self-ignition temperature**:	Not determined or not available.
Evaporation rate:	Not determined or not available.	**Decomposition temperature**:	Not determined or not available.
Flammability (solid, gaseous):	Not flammable	**Viscosity**:	a. Kinematic: Not determined or not available. b. Dynamic: Not determined or not available.
Density at 20°C:	1.08 g/mL		

10 Stability and reactivity

10.1 Reactivity: Not determined or not available.
10.2 Chemical stability: Not determined or not available.
10.3 Possibility hazardous reactions: Not determined or not available.
10.4 Conditions to avoid: Not determined or not available.
10.5 Incompatible materials: Not determined or not available.
10.6 Hazardous decomposition products: Not determined or not available.

11 Toxicological information

11.1 Information on toxicological effects:

Acute Toxicity:

Oral:

: LD50 >5000 mg per kg (Rat, Oral) - product.

Chronic Toxicity: No additional information.

Skin corrosion/irritation (raw materials):

Alcohol Ethoxylate: May cause mild to moderate skin irritation.

Sodium Alkylbenzene Sulfonate: Causes skin irritation.

Lauramine oxide: Causes skin irritation.

Serious eye damage/irritation (raw materials):

Sodium Alkylbenzene Sulfonate: Causes serious eye damage.

Alcohol Ethoxylate: Causes moderate to severe eye irritation and conjunctivitis.

Sodium xylenesulphonate: irritating to eyes.

Lauramine oxide: Causes serious eye damage.

Product information at recommended dilution:

Eye irritation may occur upon direct contact with eyes. No specific hazards for skin contact, inhalation, or chronic exposure are expected within normal use parameters.

Respiratory or skin sensitization: No additional information.

Carcinogenicity: No additional information.

IARC (International Agency for Research on Cancer): None of the ingredients are listed.

NTP (National Toxicology Program): None of the ingredients are listed.

Germ cell mutagenicity: No additional information.

Reproductive toxicity: No additional information.

STOT-single and repeated exposure: No additional information.

Additional toxicological information: No additional information.

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12 Ecological information

12.1 Toxicity:

Sodium Alkylbenzene Sulfonate: Fish, LC50 1.67 mg/l, 96 hours.
Sodium Alkylbenzene Sulfonate: Aquatic invertebrates, EC50 Daphnia 2.9 mg/l, 48 hours. Sodium Alkylbenzene Sulfonate: Aquatic Plants, EC50 Algae 29 mg/l, 96 hours.
Lauramine oxide: Fish, LC50 24.3 mg/l, 96h [Killifish (Cyprinodontidae)]
Lauramine oxide: Aquatic invertebrates, (LC50): 3.6 mg/l 96 hours [Daphnia (Daphnia)].
Lauramine oxide: Aquatic plants, EC50 Algae 0.31 mg/l 72 hours [Algae]
Alcohol Ethoxylate: Aquatic invertebrates, (LC50): 4.01 mg/l 48 hours [Daphnia (daphnia)].

12.2 Persistence and degradability: No additional information.

12.3 Bioaccumulative potential: No additional information.

12.4 Mobility in soil: No additional information.

General notes: No additional information.

12.5 Results of PBT and vPvB assessment:

PBT: No additional information.

vPvB: No additional information.

12.6 Other adverse effects: No additional information.

13 Disposal considerations

13.1 Waste treatment methods (consult local, regional and national authorities for proper disposal)

Relevant Information:

It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities. (US 40CFR262.11).

14 Transport information

14.1 UN Number: ADR, ADN, DOT, IMDG, IATA	None
14.2 UN Proper shipping name: ADR, ADN, DOT, IMDG, IATA	None
14.3 Transport hazard classes: ADR, ADN, DOT, IMDG, IATA	**Class:** None **Label:** None **LTD. QTY:** None
US DOT **Limited Quantity Exception:**	None

Bulk: **RQ (if applicable):** None **Proper shipping Name:** None **Hazard Class:** None **Packing Group:** None **Marine Pollutant (if applicable):** No additional information. **Comments:** None	**Non Bulk:** **RQ (if applicable):** None **Proper shipping Name:** None **Hazard Class:** None **Packing Group:** None **Marine Pollutant (if applicable):** No additional information. **Comments:** None
14.4 Packing group: ADR, ADN, DOT, IMDG, IATA	None
14.5 Environmental hazards:	None
14.6 Special precautions for user:	None
Danger code (Kemler):	None
EMS number:	None
Segregation groups:	None
14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code: Not applicable.	
14.8 Transport/Additional information:	
Transport category:	None
Tunnel restriction code:	None
UN "Model Regulation":	None

15 Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture.

North American

SARA

Section 313 (specific toxic chemical listings): None of the ingredients are listed.
Section 302 (extremely hazardous substances): None of the ingredients are listed.

CERCLA (Comprehensive Environmental Response, Clean up and Liability Act)

Reportable Spill Quantity: None of the ingredients are listed.

TSCA (Toxic Substances Control Act):

Inventory: All ingredients are listed as active.
Rules and Orders: Not applicable.

Proposition 65 (California):

Chemicals known to cause cancer: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for females: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for males: None of the ingredients are listed.

Chemicals known to cause developmental toxicity: None of the ingredients are listed.

Canadian

Canadian Domestic Substances List (DSL):
All ingredients are listed.

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Asia Pacific

Australia

Australian Inventory of Chemical Substances (AICS): All ingredients are listed.

China

Inventory of Existing Chemical Substances in China (IECSC): All ingredients are listed.

Japan

Inventory of Existing and New Chemical Substances (ENCS): All ingredients are listed.

Korea

Existing Chemicals List (ECL): All ingredients are listed.

New Zealand

New Zealand Inventory of Chemicals (NZOIC): All ingredients are listed.

Philippines

Philippine Inventory of Chemicals and Chemical Substances (PICCS): All ingredients are listed.

Taiwan

Taiwan Chemical Substance Inventory (TSCI): All ingredients are listed.

EU

REACH Article 57 (SVHC): None of the ingredients are listed.

Germany MAK: Not classified.

16 Other information

Abbreviations and Acronyms: None

Summary of Phrases

Hazard statements:

H315 Causes skin irritation.
H318 Causes serious eye damage.

Precautionary statements:

P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P332+P313 If skin irritation occurs: Get medical advice/attention.
P501 Dispose of contents and container as instructed in Section 13.

Manufacturer Statement:

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

	At recommended dilution:
NFPA: 1-0-0 HMIS: 1-0-0	NFPA: 1-0-0 HMIS: 1-0-0

SAFETY DATA SHEET

Version 6.11
Revision Date 08/27/2022
Print Date 10/08/2022

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name : Methanol

Product Number : 34860
Brand : SIGALD
Index-No. : 603-001-00-X
CAS-No. : 67-56-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Inc.
3050 SPRUCE ST
ST. LOUIS MO 63103
UNITED STATES

Telephone : +1 314 771-5765
Fax : +1 800 325-5052

1.4 Emergency telephone

Emergency Phone # : 800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Flammable liquids (Category 2), H225
Acute toxicity, Oral (Category 3), H301
Acute toxicity, Inhalation (Category 3), H331
Acute toxicity, Dermal (Category 3), H311
Specific target organ toxicity - single exposure (Category 1), Eyes, Central nervous system, H370

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal Word	Danger
Hazard statement(s)	
H225	Highly flammable liquid and vapor.
H301 + H311 + H331	Toxic if swallowed, in contact with skin or if inhaled.
H370	Causes damage to organs (Eyes, Central nervous system).
Precautionary statement(s)	
P210	Keep away from heat/ sparks/ open flames/ hot surfaces. No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P260	Do not breathe mist or vapors.
P264	Wash skin thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ eye protection/ face protection.
P301 + P310 + P330	IF SWALLOWED: Immediately call a POISON CENTER/ doctor. Rinse mouth.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340 + P311	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor.
P307 + P311	IF exposed: Call a POISON CENTER or doctor/ physician.
P362	Take off contaminated clothing and wash before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

SECTION 3: Composition/information on ingredients

3.1 Substances

Synonyms : Methyl alcohol

Formula : CH_4O
Molecular weight : 32.04 g/mol
CAS-No. : 67-56-1
EC-No. : 200-659-6
Index-No. : 603-001-00-X

Component	Classification	Concentration
Methanol		
	Flam. Liq. 2; Acute Tox. 3; STOT SE 1; H225, H301, H331, H311, H370	<= 100 %

	Concentration limits: >= 10 %: STOT SE 1, H370; 3 - < 10 %: STOT SE 2, H371;	

For the full text of the H-Statements mentioned in this Section, see Section 16.

SECTION 4: First aid measures

4.1 Description of first-aid measures

General advice
First aiders need to protect themselves. Show this material safety data sheet to the doctor in attendance.

If inhaled
After inhalation: fresh air. Immediately call in physician. If breathing stops: immediately apply artificial respiration, if necessary also oxygen.

In case of skin contact
In case of skin contact: Take off immediately all contaminated clothing. Rinse skin with water/ shower. Call a physician immediately.

In case of eye contact
After eye contact: rinse out with plenty of water. Call in ophthalmologist. Remove contact lenses.

If swallowed
After swallowing: fresh air. Make victim drink ethanol (e.g. 1 drinking glass of a 40% alcoholic beverage). Call a doctor immediately (mention methanol ingestion). Only in exceptional cases, if no medical care is available within one hour, induce vomiting (only in fully conscious persons) and make victim drink ethanol again (approx. 0.3 ml of a 40% alcoholic beverage/kg body weight/hour).

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Water Foam Carbon dioxide (CO_2) Dry powder

Unsuitable extinguishing media
For this substance/mixture no limitations of extinguishing agents are given.

5.2 Special hazards arising from the substance or mixture

Carbon oxides
Combustible.
Pay attention to flashback.
Vapors are heavier than air and may spread along floors.

Development of hazardous combustion gases or vapours possible in the event of fire. Forms explosive mixtures with air at ambient temperatures.

5.3 Advice for firefighters

Stay in danger area only with self-contained breathing apparatus. Prevent skin contact by keeping a safe distance or by wearing suitable protective clothing.

5.4 Further information

Remove container from danger zone and cool with water. Prevent fire extinguishing water from contaminating surface water or the ground water system.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Advice for non-emergency personnel: Do not breathe vapors, aerosols. Avoid substance contact. Ensure adequate ventilation. Keep away from heat and sources of ignition. Evacuate the danger area, observe emergency procedures, consult an expert.
For personal protection see section 8.

6.2 Environmental precautions

Do not let product enter drains. Risk of explosion.

6.3 Methods and materials for containment and cleaning up

Cover drains. Collect, bind, and pump off spills. Observe possible material restrictions (see sections 7 and 10). Take up carefully with liquid-absorbent material (e.g. Chemizorb®). Dispose of properly. Clean up affected area.

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Advice on safe handling
Work under hood. Do not inhale substance/mixture. Avoid generation of vapours/aerosols.

Advice on protection against fire and explosion
Keep away from open flames, hot surfaces and sources of ignition.Take precautionary measures against static discharge.

Hygiene measures
Immediately change contaminated clothing. Apply preventive skin protection. Wash hands and face after working with substance.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Storage conditions
Keep container tightly closed in a dry and well-ventilated place. Keep away from heat and sources of ignition. Keep locked up or in an area accessible only to qualified or authorized persons.

Storage class
Storage class (TRGS 510): 3: Flammable liquids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Ingredients with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Methanol	67-56-1	TWA	200 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Danger of cutaneous absorption		
		STEL	250 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Danger of cutaneous absorption		
		ST	250 ppm 325 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		TWA	200 ppm 260 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		TWA	200 ppm 260 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		PEL	200 ppm 260 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		Skin		
		C	1,000 ppm	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		Skin		
		STEL	250 ppm 325 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)
		Skin		

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Methanol	67-56-1	Methanol	15 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift (As soon as possible after exposure ceases)			

Derived No Effect Level (DNEL)

Application Area	Routes of exposure	Health effect	Value
Workers	Skin contact	Long-term systemic effects	40mg/kg BW/d
Consumers	Skin contact	Long-term systemic effects	8mg/kg BW/d

Consumers	Ingestion	Long-term systemic effects	8mg/kg BW/d
Workers	Skin contact	Acute systemic effects	40mg/kg BW/d
Consumers	Skin contact	Acute systemic effects	8mg/kg BW/d
Consumers	Ingestion	Acute systemic effects	8mg/kg BW/d
Workers	Inhalation	Acute systemic effects	260 mg/m3
Workers	Inhalation	Acute local effects	260 mg/m3
Workers	Inhalation	Long-term systemic effects	260 mg/m3
Workers	Inhalation	Long-term local effects	260 mg/m3
Consumers	Inhalation	Acute systemic effects	50 mg/m3
Consumers	Inhalation	Acute local effects	50 mg/m3
Consumers	Inhalation	Long-term systemic effects	50 mg/m3
Consumers	Inhalation	Long-term local effects	50 mg/m3

Predicted No Effect Concentration (PNEC)

Compartment	Value
Soil	23.5 mg/kg
Sea water	15.4 mg/l
Fresh water	154 mg/l
Fresh water sediment	570.4 mg/kg
Onsite sewage treatment plant	100 mg/kg

8.2 Exposure controls

Appropriate engineering controls

Immediately change contaminated clothing. Apply preventive skin protection. Wash hands and face after working with substance.

Personal protective equipment

Eye/face protection

Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU). Safety glasses

Skin protection

This recommendation applies only to the product stated in the safety data sheet, supplied by us and for the designated use. When dissolving in or mixing with other substances and under conditions deviating from those stated in EN374 please contact the supplier of CE-approved gloves (e.g. KCL GmbH, D-36124 Eichenzell, Internet: www.kcl.de).
Full contact
Material: butyl-rubber
Minimum layer thickness: 0.7 mm
Break through time: 480 min
Material tested:Butoject® (KCL 898)

This recommendation applies only to the product stated in the safety data sheet, supplied by us and for the designated use. When dissolving in or mixing with other substances and under conditions deviating from those stated in EN374 please contact the supplier of CE-approved gloves (e.g. KCL GmbH, D-36124 Eichenzell, Internet: www.kcl.de).
Splash contact
Material: Viton®
Minimum layer thickness: 0.7 mm
Break through time: 120 min
Material tested:Vitoject® (KCL 890 / Aldrich Z677698, Size M)

Body Protection
Flame retardant antistatic protective clothing.

Respiratory protection
required when vapours/aerosols are generated.
Our recommendations on filtering respiratory protection are based on the following standards: DIN EN 143, DIN 14387 and other accompanying standards relating to the used respiratory protection system.

Control of environmental exposure
Do not let product enter drains. Risk of explosion.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid Color: colorless
b)	Odor	characteristic
c)	Odor Threshold	10 ppm
d)	pH	No data available
e)	Melting point/freezing point	Melting point/range: -98 °C (-144 °F)
f)	Initial boiling point and boiling range	64.7 °C 148.5 °F
g)	Flash point	9.7 °C (49.5 °F) - closed cup - Regulation (EC) No. 440/2008, Annex, A.9
h)	Evaporation rate	6.3 - Diethyl ether1.9 - n-butyl acetate
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 44 %(V) Lower explosion limit: 5.5 %(V)
k)	Vapor pressure	169.27 hPa at 25 °C (77 °F)
l)	Vapor density	1.11
m)	Density	0.791 g/mL at 25 °C (77 °F)
	Relative density	0.79 - 0.820 °C
n)	Water solubility	1,000 g/l at 20 °C (68 °F) - completely misciblesoluble
o)	Partition coefficient: n-octanol/water	log Pow: -0.77 - (Lit.), Bioaccumulation is not expected.
p)	Autoignition temperature	455.0 °C (851.0 °F) at 1,013 hPa - DIN 51794
q)	Decomposition temperature	Distillable in an undecomposed state at normal pressure.
r)	Viscosity	0.54 - 0.59 mm2/s at 20 °C (68 °F) -

s)	Explosive properties	No data available
t)	Oxidizing properties	none

9.2 Other safety information

Minimum ignition energy	0.14 mJ
Conductivity	< 1 µS/cm
Relative vapor density	1.11

SECTION 10: Stability and reactivity

10.1 Reactivity

Vapors may form explosive mixture with air.

10.2 Chemical stability

The product is chemically stable under standard ambient conditions (room temperature) .

10.3 Possibility of hazardous reactions

Risk of explosion with:
Oxidizing agents
perchloric acid
perchlorates
salts of oxyhalogenic acids
chromium(VI) oxide
halogen oxides
nitrogen oxides
nonmetallic oxides
chromosulfuric acid
chlorates
hydrides
zinc diethyl
halogens
powdered magnesium
hydrogen peroxide
Nitric acid
sulfuric acid
permanganic acid
sodium hypochlorite
Exothermic reaction with:
acid halides
Acid anhydrides
Reducing agents
acids
Bromine
Chlorine
Chloroform
magnesium
tetrachloromethane
Risk of ignition or formation of inflammable gases or vapours with:
Fluorine
Oxides of phosphorus

Raney-nickel
Generates dangerous gases or fumes in contact with:
Alkaline earth metals
Alkali metals

10.4 Conditions to avoid

Warming.

10.5 Incompatible materials

various plastics, magnesium, zinc alloys

10.6 Hazardous decomposition products

In the event of fire: see section 5

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
Acute toxicity estimate Oral - 100.1 mg/kg
(Expert judgment)
Remarks: Classified according to Regulation (EU) 1272/2008, Annex VI (Table 3.1/3.2)
Symptoms: Nausea, Vomiting
Acute toxicity estimate Inhalation - 4 h - 3.1 mg/l - vapor

(Expert judgment)
Remarks: Classified according to Regulation (EU) 1272/2008, Annex VI (Table 3.1/3.2)
Symptoms: Irritation symptoms in the respiratory tract.
Acute toxicity estimate Dermal - 300.1 mg/kg
(Expert judgment)
Remarks: Classified according to Regulation (EU) 1272/2008, Annex VI (Table 3.1/3.2)

Skin corrosion/irritation
Skin - Rabbit
Result: No skin irritation
Remarks: (ECHA)
Drying-out effect resulting in rough and chapped skin.

Serious eye damage/eye irritation
Eyes - Rabbit
Result: No eye irritation
Remarks: (ECHA)

Respiratory or skin sensitization
Sensitisation test: - Guinea pig
Result: negative
(OECD Test Guideline 406)

Germ cell mutagenicity
Based on available data the classification criteria are not met.
Test Type: Ames test
Test system: Salmonella typhimurium
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 471
Result: negative
Test Type: In vitro mammalian cell gene mutation test

Test system: Chinese hamster lung cells
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 476
Result: negative

Test Type: Micronucleus test
Species: Mouse
Cell type: Bone marrow
Application Route: Intraperitoneal injection
Method: OECD Test Guideline 474
Result: negative

Carcinogenicity
Did not show carcinogenic effects in animal experiments.

IARC:	No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
NTP:	No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is on OSHA’s list of regulated carcinogens.

Reproductive toxicity
Based on available data the classification criteria are not met.

Specific target organ toxicity - single exposure
Causes damage to organs. - Eyes, Central nervous system
Remarks: Classified according to Regulation (EU) 1272/2008, Annex VI (Table 3.1/3.2)

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

11.2 Additional Information

RTECS: PC1400000
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Systemic effects:

acidosis
drop in blood pressure
agitation, spasms
inebriation
Dizziness
Drowsiness
Headache
Impairment of vision
Blindness
narcosis
Coma

Symptoms may be delayed.

Damage to:

Liver
Kidney
Cardiac
Irreversible damage of the optical nerve.

Other dangerous properties can not be excluded.

This substance should be handled with particular care.

Stomach - Irregularities - Based on Human Evidence

Stomach - Irregularities - Based on Human Evidence

SECTION 12: Ecological information

12.1 Toxicity

Toxicity to fish	flow-through test LC50 - Lepomis macrochirus (Bluegill) - 15,400.0 mg/l - 96 h (US-EPA)
Toxicity to daphnia and other aquatic invertebrates	semi-static test EC50 - Daphnia magna (Water flea) - 18,260 mg/l - 96 h (OECD Test Guideline 202)
Toxicity to algae	static test ErC50 - Pseudokirchneriella subcapitata (green algae) - ca. 22,000.0 mg/l - 96 h (OECD Test Guideline 201)
Toxicity to bacteria	static test IC50 - activated sludge - > 1,000 mg/l - 3 h (OECD Test Guideline 209)

12.2 Persistence and degradability

Biodegradability	Result: 99 % - Readily biodegradable. (OECD Test Guideline 301D)
Biochemical Oxygen Demand (BOD)	600 - 1,120 mg/g Remarks: (IUCLID)
Chemical Oxygen Demand (COD)	1,420 mg/g Remarks: (IUCLID)
Theoretical oxygen demand	1,500 mg/g Remarks: (Lit.)
Ratio BOD/ThBOD	76 % Remarks: Closed Bottle test(IUCLID)

12.3 Bioaccumulative potential

Bioaccumulation	Cyprinus carpio (Carp) - 72 d at 20 °C - 5 mg/l(Methanol) Bioconcentration factor (BCF): 1.0

12.4 Mobility in soil

Will not adsorb on soil.

12.5 Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Endocrine disrupting properties

No data available

12.7 Other adverse effects

Additional ecological information	Avoid release to the environment.
Stability in water	at 19 °C83 - 91 % - 72 h Remarks: Hydrolyzes on contact with water.Hydrolyzes readily.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product

Waste material must be disposed of in accordance with the national and local regulations. Leave chemicals in original containers. No mixing with other waste. Handle uncleaned containers like the product itself. See www.retrologistik.com for processes regarding the return of chemicals and containers, or contact us there if you have further questions.

SECTION 14: Transport information

DOT (US)

UN number: 1230 Class: 3 Packing group: II
Proper shipping name: Methanol
Reportable Quantity (RQ): 5000 lbs
Poison Inhalation Hazard: No

IMDG

UN number: 1230 Class: 3 (6.1) Packing group: II EMS-No: F-E, S-D
Proper shipping name: METHANOL

IATA

UN number: 1230 Class: 3 (6.1) Packing group: II
Proper shipping name: Methanol
IATA Passenger: Not permitted for transport
IATA Cargo: Not permitted for transport

SECTION 15: Regulatory information

SARA 302 Components

This material does not contain any components with a section 302 EHS TPQ.

SARA 313 Components

The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Methanol	67-56-1	2007-07-01

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

SECTION 16: Other information

Further information
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

The branding on the header and/or footer of this document may temporarily not visually match the product purchased as we transition our branding. However, all of the information in the document regarding the product remains unchanged and matches the product ordered. For further information please contact mlsbranding@sial.com.

Version: 6.11 Revision Date: 08/27/2022 Print Date: 10/08/2022

Safety Data Sheet

Blue Silica Gel Desiccant Beads

AES-3228

Section 1. Identification

GHS product identifier	Blue Silica Gel Desiccant Beads
Stock Number	AES-3228
Chemical name	Blue Indicating Silica Gel
Other means of identification	Amorphous Silica, Silica Gel, Desiccant
Product type	Solid, Crystals

Identified uses
Control and reduction of moisture level in a humid environment.

Uses advised against	**Reason**
Not available.	

Supplier's details	A to Z Products Co., Inc. 2008 National Guard Drive Plant City, FL 33563 USA Support: 800-237-1264
Emergency telephone number (with hours of operation)	24 hr. CHEMTREC 1-800-424-9300 / International 1-703-527-3887

Section 2. Hazards identification

Classification

Classification of the substance or mixture in accordance with 29 CFR 1910 (OSHA HCS)

	**GHS07 Health Hazard** Acute Tox. 4 H302 Harmful if swallowed. Skin Sens. 1 H317 May cause an allergic skin reaction.

	**GHS08 Health Hazard** Resp. Sens. 1 H334 May cause allergy or asthma symptoms or breathing difficulties if inhaled. Muta. 2 H341 Suspected of causing genetic defects. Carc. 1B H350 May cause cancer. Repr. 1B H360 May damage fertility or the unborn child.

Hazards not otherwise classified: No information known.

Label Elements

GHS07

GHS08

Signal word: Danger

Hazard statements:

H302 Harmful if swallowed.
H334 May cause allergy or asthma symptoms or breathing difficulties if inhaled.
H317 May cause an allergic skin reaction.
H341 Suspected of causing genetic defects.
H350 May cause cancer.
H360 May damage fertility or the unborn child.

Precautionary statements:
P284 In case of inadequate ventilation wear respiratory protection.
P261 Avoid breathing dust/fume/gas/mist/vapors/spray.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P342+P311 If experiencing respiratory symptoms call a poison center or seek medical attention.
P405 Store locked up.
P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

Section 3. Composite/information on ingredients

Molecular Formula $SiO_2 \cdot nH_2O+CoCl_2$

CAS Number/other identifiers

Ingredient name	%	CAS number	Hazardous
Silica Gel	>99.7	112926-00-8	No
Cobalt Chloride	<0.3	7646-79-9	Yes

Section 4. First aid measures

Description of necessary first aid measures

Eye Contact	Check for presence of contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.
Inhalation	Remove to fresh air. If breathing becomes difficult, get medical attention.
Skin Contact	Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation occurs.
Ingestion	Give several glasses of water to drink and dilute. If large amounts swallowed, seek medical advice.

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media	Use an extinguishing agent suitable for the surrounding fire.
Unsuitable extinguishing media	No specific data.
Specific hazards arising from the chemical	Not considered a fire hazard.
Hazardous thermal decomposition products	No specific data.
Special protective actions for fire-fighters	Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.
Special protective equipment for fire-fighters	Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel	No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
For emergency responders	If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".
Environmental precautions	Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill	Gather spilled beads with broom and dustpan and dispense into waste disposal container.
Large spill	Gather spilled beads with shovel and dispense into waste disposal container.

Section 7. Handling and storage

Precautions for safe handling

Protective measures	Put on appropriate personal protective equipment (see Section 8). Do not swallow. Avoid contact with eyes, skin and clothing. Avoid breathing dust. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product dust and residue and can be hazardous. Do not reuse container.
Advice on general occupational hygiene	Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.
Conditions for safe storage, including any incompatibilities	Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent unintentional spillage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Chemical name	Silica (synthetic, amorphous)

Ingredient name	Exposure limits
Silica (synthetic, amorphous):	**ACGIH TLV:** TWA: 10 mg/m^3
Inorganic Cobalt Compounds:	TWA: 0.02 mg/m^3 as Co, A3: Animal Carcinogen **OSHA PEL:** TWA: 80 / (%SiO_2) mg/m^3

Appropriate engineering controls	Good general ventilation should be sufficient to control worker exposure to airborne contaminants.
Environmental exposure	Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures	Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.
Eye/face protection	Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side shields.

Skin protection

Hand protection	Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.
Body protection	Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Other skin protection	Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
Respiratory protection	Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state	Solid, Crystals
Color	Blue
Odor	Odorless
Specific Gravity	2.1 (Water=1)
pH	5.5 - 9.0 (in 5% slurry)
% Volatiles by volume @ 21°C (70°f)	0
Melting point	Not applicable.
Boiling point	Not applicable.
Flash point	Not applicable.
Evaporation rate	Not applicable.
Flammability (solid, gas)	Not available.
Lower and upper explosive (flammable) limits	Not available.
Vapor pressure	Not applicable.
Vapor density	Not applicable.
Relative density	Not available.
Solubility	Insoluble, Chloride may leach out.
Auto-ignition temperature	Not applicable.
Decomposition temperature	Not applicable.
Viscosity	Not applicable.

Section 10. Stability and reactivity

Reactivity	No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	The product is stable.
Possibility of hazardous reactions	Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to avoid	Moisture, extreme heat
Incompatible materials	No specific data.
Hazardous decomposition products	Oxides of carbon and silicon may be formed when heated.
Incompatibility with powerful oxidizers	Reacts with hydrogen fluoride, fluorine, oxygen difluoride, chlorine trifluoride, strong acids, strong bases and oxidizers

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
Silica (synthetic, amorphous)	LC50 Inhalation Dusts and mists LD50 Dermal LD50 Oral	Not Available Not Available Not Available	Not Available Not Available Not Available	- - -
Inorganic Cobalt Compounds	LC50 Inhalation Dusts and mists LD50 Dermal LD50 Oral	Not Available Not Available Not Available	Not Available Not Available Not Available	- - -

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Cobalt and its compounds have been shown to cause cancer in laboratory animals.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure Not available.

Potential acute health effects

Eye Contact	No known significant effects or critical hazards.
Inhalation	No known significant effects or critical hazards.
Skin contact	No known significant effects or critical hazards.
Ingestion	May be fatal if swallowed and enters airways.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact	No specific data.
Inhalation	No specific data.
Skin contact	No specific data.
Ingestion	No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects	Not available.
Potential delayed effects	Not available.

Long term exposure

Potential immediate effects	Not available.
Potential delayed effects	Not available.

Potential chronic health effects

General	No known significant effects or critical hazards.
Carcinogenicity	No known significant effects or critical hazards.
Mutagenicity	No known significant effects or critical hazards.
Teratogenicity	No known significant effects or critical hazards.
Developmental effects	No known significant effects or critical hazards.
Fertility effects	No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Eco toxicity	Not expected to be toxic to aquatic life.

Section 13. Disposal considerations

Disposal methods	The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and contact with soil, waterways, drains and sewers.
RCRA classification	Not regulated.

Section 14. Transport information

	DOT Classification	TDG Classification	IMDG	IATA
UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.

Special precautions for user	Transport within user’s premises: always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.
Transport in bulk according to Annex II or MARPOL 73/78 and the IBC Code	Not available.

Section 15. Regulatory information

U.S. Federal regulations	TSCA 8(a) CDR Exempt/Partial exemption: This material is listed or exempted.
Clean Air Act Section 112	Not listed.
Clean Air Act Section 602 Class I Substances	Not listed.
Clean Air Act Section 602 Class II Substances	Not listed.
DEA List I Chemicals (Precursor Chemicals)	Not listed.

DEA List II Chemicals (Essential Chemicals) Not listed.

SARA 302/304

Composition/information on ingredients

No Products were found.

SARA 304 RQ Not applicable.

SARA 311/312

Classification Not applicable.

Composition/information on ingredients

No Products were found.

State regulations

Massachusetts	This material is listed.
New York	This material is not listed.
New Jersey	This material is listed.
Pennsylvania	This material is not listed.

California Prop. 65

This product is known to contain chemicals currently listed as carcinogens or reproductive toxins.

International lists

National inventory

Australia	This material is listed or exempted.
Canada	This material is listed or exempted.
China	This material is listed or exempted.
Europe	This material is listed or exempted.
Japan	This material is listed or exempted.
Malaysia	Not determined.
New Zealand	This material is listed or exempted.
Philippines	This material is listed or exempted.
Republic of Korea	This material is listed or exempted.
Taiwan	This material is listed or exempted.

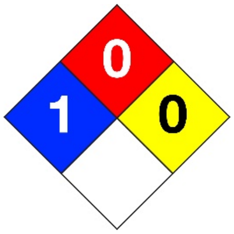
Section 16. Other information

HMIS (USA)

Health Hazard	**1**
Fire Hazard	**0**
Reactivity	**0**
Personal Protection	**0**

National Fire Protection Association (USA)

Health	**1**
Flammability	**0**
Reactivity	**0**



Date of issue/Date of revision 09/23/2016

Version 1.1

Key to abbreviations

ATE = Acute Toxicity Estimate
BCF = Bio concentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("MARPOL" = marine pollution)
UN = United Nations

Notice to reader

SAFETY DATA SHEET

acc. To OSHA HCS (29CFR 1910.1200) and WHMIS 2015 Regulation

Revision Date: 13-June-2019 Revision 2

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Product Identifier

Product Name	pH 4.01 Buffer, Red
Product Number(s)	00654-00, 05942-21, 05942-10, 05942-22, 05942-24, 05942-25, 05942-15, 00653-08, 00653-14, 00651-06, 00651-36, 00651-76, 98767-77, 98767-80 This SDS applies to pH 4.01 buffers with Lot # starting with CC.
Pure Substance/mixture	Mixture

Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Use as laboratory reagent
Uses advised against	No information available

Manufacture/Supplier

Cole-Parmer™
North America
625 East Bunker Court
Vernon Hills, IL
60061 USA
Tel: 1-800-323-4340

E-mail address	info@coleparmer.com
Made In	USA
Emergency Telephone	888-358-4717

2. HAZARDS IDENTIFICATION

Classification

Classification - Mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP]

This mixture is classified as not hazardous according to regulation (EC) 1272/2008 [GHS]

Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases and H-Statements mentioned in this Section, see Section 16.

Symbol(s)

Not dangerous goods.

Label Elements

Emergency Overview

The product contains no substances which at their given concentration, are considered hazardous to health.

Appearance Light Red **Physical State** Liquid **Odor** None

EUH210 - Safety data sheet available upon request.

Precautionary Statements

P202 - Do not handle until all safety information has been read and understood.

Hazards not otherwise classified (HNOC)

No information available

Other Information

No information available

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	Chemical Formula	EC-No.	CAS-No	Weight %	Trade Secret
Water	-	-	7732-18-5	90-100 %	*
Potassium Acid Phthalate	-	212-889-4	877-24-7	0-10 %	*
Cetylpyridinium Chloride	C21 H38 NCl	204-593-9	123-03-5	0-10 %	*
Methyl Red Solution 0.1%	-	-	845-10-3	0-10 %	*

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. FIRST AID MEASURES

First Aid Measures

General Advice	Use first aid treatment according to the nature of the injury. For further assistance, contact your local Poison Control Center. Show this safety data sheet to the doctor in attendance.
Eye Contact	In case of eye contact, remove contact lens and rinse thoroughly with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.
Skin Contact	Wash off immediately with soap and plenty of water while removing all contaminated clothing and shoes. If skin reactions occur, contact a physician.
Inhalation	Move to fresh air. If breathing is difficult, give oxygen. If symptoms persist, obtain medical attention.
Ingestion	Clean mouth with water and drink afterwards plenty of water. Do not include vomiting. Call a physician or Poison Control Center immediately.
Production of First-Aiders	Use personal protective equipment. See Section 8 for more detail. Do not use mouth to mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical devices.

Most important symptoms and effects, both acute and delayed

Most important symptoms/effects	No information available

Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media

Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable Extinguishing Media

No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors.

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures

Personal Precautions	Use personal protective equipment. Refer to Section 8. Evacuate personnel to safe areas.
Environmental Precautions	Beware of vapors accumulating to form explosives concentrations. Vapors can accumulate in low areas.

Method and Material for Containment and Cleaning Up

Methods for Containment	Prevent further leakage or spillage if safe to do so.
Methods for Cleaning Up	Soak up with inert absorbent material. Pick up and transfer to properly labeled containers.

7. HANDLING AND STORAGE

Precautions for Safe Handling

Handling	To avoid risks to human health and the environment, comply with the instructions for use. Wear personal protective equipment. Avoid breathing dust/fume/gas/mist/vapors/spray Ensure adequate ventilation, especially in confined areas.
Hygiene Considerations	Handle in accordance with good industrial hygiene and safety practice.

Conditions for Safe Storage, Including any Incompatibilities

Storage	Keep container tightly closed in a dry and well-ventilated place. Store at room temperature in the original container. Keep away from direct sunlight.
Incompatible Products	No information available.

Specific end use(s)

Specific use	Laboratory reagent
Risk Management Methods (RMM)	The information required is contained in this Safety Data Sheet.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Guidelines	This product does not contain any hazardous materials with occupational exposure limits established by the region-specific regulatory bodies.

Appropriate Engineering Controls

Engineering Measures	Showers Eyewash stations Ventilation systems

Individual protection measures, such as personal protective equipment

Eye/face Protection	Wear chemical splash goggles. If splashes are likely to occur, wear: Face-shield.
Skin and Body Protection	Wear protection gloves/clothing
Respiratory Protection	None required under normal usage. In case of inadequate ventilation wear respiratory protection.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties.

Physical State	Liquid
Appearance	Light red
Odor	None
Odor Threshold	No information available
pH Range	3.51-5.51

Property	**Values**	**Remarks * Method**
Melting point/freezing point	No information available	
Boiling Point/Range	~ 100 °C / 212 °F	
Flash Point (High in °C)	No information available	
Evaporation Rate	No information available	
Flammability (solid, gas)	No information available	
Flammability Limit in Air		
Upper flammability limit:	No information available	
Lower flammability limit:	No information available	
Vapor pressure	No information available	
Vapor Density	No information available	
Specific Gravity	No information available	

Water Solubility	soluble
Solubility in other solvents	No information available
Partition coefficient	No information available
Autoignition Temperature	
Decomposition Temperature	No information available
Kinematic Viscosity	No information available
Dynamic Viscosity	No information available
Explosive Properties	No information available
Oxidizing Properties	No information available

Other Information

Softening Point	No information available
Molecular Weight	No information available
VOC Content (%)	No information available
Density	No information available
Bulk Density	No information available

10. STABILITY AND REACTIVITY

Reactivity

No information available

Chemical Stability

Stable under normal conditions

Possibility of Hazardous Reactions

None under normal processing

Conditions to Avoid

Extremes of temperature and direct sunlight

Incompatible Materials

No information available

Hazardous Decomposition Products

Thermal decomposition can lead to release of irritating gases and vapors.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation	No information available
Eye Contact	No information available
Skin Contact	No information available
Ingestion	No information available

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Water 7732-18-5	>90 mL/kg (Rat)	-	-
Cetylpyridinium Chloride 123-03-5	LD50 200mg/kg (rat)	-	LC50/4 H 0.05 mg/L (ATE)

Information on Toxicological Effects

Symptoms	No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Sensitization	No information available
Mutagenic Effects	No information available
Carcinogenicity	No information available
Reproductive Effects	No information available
STOT – single exposure	No information available
STOT – repeated exposure	No information available
Aspiration hazard	No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity
This material is not expected to be harmful to aquatic life.

Persistence and Degradability
No information available

Bioaccumulation/Accumulation
No information available

Mobility
No information available

Results of PBT and vPvB assessment
No information available

Other adverse effects
No information available

Endocrine Disruptor Information
No information available

13. DISPOSAL CONSIDERATIONS

Waste Treatment Methods

Waste Disposal Methods	Disposal should be in accordance with applicable regional, national and local laws and regulations. Do not discharge to sewer.
Contaminated Packaging	Improper disposal or reuse of this container may be dangerous and illegal.

14. TRANSPORT INFORMATION

DOT	Not regulated
TDG	Not regulated
MEX	Not regulated
ICAO	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated
RID	Not regulated
ADR	Not regulated
ADN	Not regulated

15. REGULATORY INFORMATION

European Union
Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work.

International Inventories

USINV	Component listed
CANINV	Component listed
EINECS/ELINCS	Component listed
IECSC	Component listed
AICS	Component listed

USINV/TSCA – United States Toxic Substances Control Act Section 8(b) Inventory
CANINV/DSL/NDSL – Canadian Domestic Substances List/Non-Domestic Substance List
EINECS/ELINCS – European Inventory of Existing Commercial Chemical Substance / EU List of Notified Chemical Substances
IECSC – Chinese Inventory of Existing Chemical Substances

AICS – Australian Inventory of Chemical Substances

U.S. Federal Regulations

This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazardous Communication Standard, 29 CFR 1910.1200.

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40n of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazardous Categorization

Acute Health Hazard	No
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act

Not applicable

CERCLA

This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional or state level pertaining to releases of this material.

U.S. State Regulations

California Proposition 65

This product is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

State Right-to-Know

Massachusetts Right-to-Know Act – Substance List	Not regulated	
New Jersey Worker and Community Right-to-Know Act	Potassium hydrogen phthalate	CAS 877-24-7
Pennsylvania Right-to-Know Act – Hazardous Substance	Potassium hydrogen phthalate	CAS 877-24-7
Rhode Island Right-to-Know Act	Not regulated	

U.S. EPA Label Information

No information available

16. OTHER INFORMATION

Revision Date: 13-June-2019

Disclaimer:

IMPORTANT: The information contained in this SDS is correct to the best of our knowledge as of the issue date (or subsequent revision date, if any), and is to be used only as a guide. This SDS does not constitute a guarantee (express or implied) of any kind and we make no warranties of any kind as to the accuracy or completeness of the information contained herein or the merchantability or fitness of the product or this information for a particular purpose. It is the responsibility of each individual buyer/user to determine the suitability of this information and the product for its intended purposes. Product sales are subject to Cole Parmer standard terms and conditions of sale. This information relates only to the designated product as shipped and may not be valid if the product is used in combination with any other materials or is not used in accordance with our instructions, or is altered in any way. It is the responsibility of the buyer/user to ensure that its activities comply with all applicable government requirements. Since conditions of use of the product are not under direct control of Cole Parmer, it is the duty of the buyer/user to determine the necessary conditions for the safe use of the product. Cole Parmer will not be liable for any injuries or damages resulting from handling, use, misuse or contact with the product.

OAKTON® MATERIAL SAFETY DATA SHEET

Section 1. Chemical Product and Company Identification

Catalog Number(s) 00654-00, 05942-21, 05942-22, 05942-24, 05942-25, 05942-26, 05942-27, 35653-01, 35654-00	
Product Identity BUFFER, Standard, pH 4.01; BUFFER, High Accuracy, pH 4.000 (Color Coded Red)	
Manufacturer's Name RICCA CHEMICAL COMPANY	Emergency Telephone Number (24 hr) CHEMTREC®: 800-424-9300
Address (Number, Street, City, State, and ZIP Code) P.O. Box 13090	Telephone Number For Information 817-461-5601
Arlington, Texas 76094	Date Prepared 3-7-2000

Section 2. Composition / Information on Ingredients

Component	CAS Registry #	Percent Concentration	Exposure Limits ACGIH TLV	Exposure Limits OSHA PEL
Potassium Acid Phthalate	877-24-7	0.95 – 1.05	N/A	N/A
Preservative* *(No Mercury compounds or Formaldehyde)	proprietary	<0.5	N/A	N/A
Inert Dye	proprietary	<0.1	N/A	N/A
Water, Deionized	7732-18-5	Balance	N/A	N/A

Section 3. Hazards Identification

☆☆

EMERGENCY OVERVIEW

Non-flammable, non-toxic, non-corrosive. Does not present any significant health hazards. Wash areas of contact with water.

☆☆

POTENTIAL HEALTH EFFECTS:

TARGET ORGANS: eyes, skin.

EYE CONTACT: May cause slight irritation.

INHALATION: Not likely to be hazardous by inhalation.

SKIN CONTACT: May cause slight irritation.

INGESTION: Large doses may cause nausea, vomiting, diarrhea and cramps.

CHRONIC EFFECTS / CARCINOGENICITY:

IARC – No
NTP – No
OSHA – No

TERATOLOGY (BIRTH DEFECT) INFORMATION:

No information found in “Registry of Toxic Effects of Chemical Substances” or other information sources.

REPRODUCTION INFORMATION:

No information found in “Registry of Toxic Effects of Chemical Substances” or other information sources.

Section 4. First Aid Measures – In all cases, seek qualified evaluation.

EYE CONTACT: Irrigate immediately with large quantity of water for at least 15 minutes. Call a physician if irritation develops.

INHALATION: Remove to fresh air. Give artificial respiration if necessary. If breathing is difficult, give oxygen.

SKIN CONTACT: Flush with plenty of water for at least 15 minutes. Call a physician if irritation develops.

INGESTION: Dilute with water or milk. Call a physician if necessary.

Section 5. Fire Fighting Measures

FLAMMABLE PROPERTIES:

FLASH POINT:	N/A	METHOD USED:	N/A

FLAMMABLE LIMITS

LFL:	N/A	UFL:	N/A

EXTINGUISHING MEDIA: Use any means suitable for extinguishing surrounding fire.

FIRE & EXPLOSION HAZARDS: Not considered to be a fire or explosion hazard.

FIRE FIGHTING INSTRUCTIONS: Use normal procedures/instructions.

FIRE FIGHTING EQUIPMENT: Use protective clothing and breathing equipment appropriate for the surrounding fire.

Section 6. Accidental Release Measures

Absorb with suitable material and dispose of in accordance with local regulations.

Section 7. Handling and Storage

As with all chemicals, wash hands thoroughly after handling. Avoid contact with eyes and skin. Protect from freezing and physical damage. SAFETY STORAGE CODE: GENERAL

Section 8. Exposure Controls / Personal Protection

ENGINEERING CONTROLS: No specific controls are needed. Normal room ventilation is adequate.

RESPIRATORY PROTECTION: Normal room ventilation is adequate.

SKIN PROTECTION: Chemical resistant gloves.

EYE PROTECTION: Safety glasses or goggles.

Section 9. Physical and chemical Properties

APPEARANCE:	Clear, red colored liquid	**pH:**	4
ODOR:	odorless	**BOILING POINT (^{O}C):**	approximately 100
SOLUBILITY IN WATER:	infinite	**MELTING POINT (^{O}C):**	approximately 0
SPECIFIC GRAVITY:	approximately 1	**VAPOR PRESSURE:**	N/A

Section 10. Stability and Reactivity

CHEMICAL STABILITY: Stable under normal conditions of use and storage.

INCOMPATIBILITY: Nitric Acid

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of Carbon and Potassium.

HAZARDOUS POLYMERIZATION: Will not occur.

Section 11. Toxicological Information

LD50, Oral, Rat: >3200 mg/kg (Potassium Acid Phthalate), details of toxic effects not reported other than lethal dose value.

Section 12. Ecological Information

ECOTOXICOLOGICAL INFORMATION: No information found.

CHEMICAL FATE INFORMATION: No information found.

Section 13. Disposal Considerations

Dilute with water, neutralize with weak sodium hydroxide solution, and then flush to sewer if local regulations allow. If not allowed, save for recovery or recycling in an approved waste disposal facility. Always dispose of in accordance with local, state and federal regulations.

Section 14. Transport Information (Not meant to be all inclusive)

D.O.T. SHIPPING NAME: Not regulated
D.O.T. HAZARD CLASS: None
U.N. / N.A. NUMBER: None
PACKING GROUP: None
D.O.T. LABEL: None

Section 15. Regulatory Information (Not meant to be all inclusive - selected regulation represented)

OSHA STATUS: The above items either do not contain any specifically hazardous material or the potentially hazardous material is present in such low concentration that the items do not present any immediate threat to health and safety. These items do not meet the OSHA Hazard Communication Standard (29 CFR 1910.1200) definition of a hazardous material.

TSCA STATUS: All components of this solution are listed on the TSCA Inventory.
CERCLA REPORTABLE QUANTITY: Not reportable
SARA TITLE III:
  SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES: No
  SECTION 311/312 HAZARDOUS CATEGORIES: No
  SECTION 313 TOXIC CHEMICALS: No
RCRA STATUS: No

CALIFORNIA PROPOSITION 65: Not listed

Section 16. Other Information

NFPA® Ratings:	**Health: 1**	**Flammability: 0**	**Reactivity: 0**	**Special Notice Key: None**
HMIS® Ratings:	**Health: 1**	**Flammability: 0**	**Reactivity: 0**	**Protective Equipment: B** **(Protective eyewear, gloves)**

Rev 1, 10-16-2000: (Section 1) added catalog number 35653-01.
Rev 2, 03-25-2003: Reviewed and approved.
Rev 3, 03-20-2006: Reviewed and approved.

When handled properly by qualified personnel, the product described herein does not present a significant health or safety hazard. Alteration of its characteristics by concentration, evaporation, addition of other substances, or other means may present hazards not specifically addressed herein and which must be evaluated by the user. The information furnished herein is believed to be accurate and represents the best data currently available to us. No warranty, expressed or implied, is made and RICCA CHEMICAL COMPANY assumes no legal responsibility or liability whatsoever resulting from its use.

SAFETY DATA SHEET

acc. To OSHA HCS (29CFR 1910.1200) and WHMIS 2015 Regulation

Revision Date: 12-June-2019

Revision 2

1. IDENTIFICATION

Product Identifier

Product Name	pH 7.00 Buffer, Yellow
Product Number(s)	00654-04, 05942-10, 05942-41, 05942-42, 05942-44, 05942-45, 05942-15, 00653-09, 00653-14, 00651-08, 00651-38, 00651-78, 98767-78, 98767-80 This SDS applies to pH 7.00 buffers with Lot # starting with CC.
Pure Substance/mixture	Mixture

Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Use as laboratory reagent
Uses advised against	No information available

Manufacture/Supplier

Cole-Parmer Instrument Company
625 East Bunker Court
Vernon Hills, IL
60061 USA
Tel: 1-800-323-4340

E-mail address	info@coleparmer.com
Made In	USA
Emergency Telephone	888-358-4717 8:00 am – 6:00 pm CST

2. HAZARDS IDENTIFICATION

Classification

Classification - Mixture
Classification according to Regulation (EC) No. 1272/2008 [CLP]
This mixture is classified as not hazardous according to regulation (EC) 1272/2008 [GHS]

Classification according to EU Directives 67/548/EEC or 1999/45/EC.

Label Elements

Emergency Overview

The product contains no substances which at their given concentration, are considered hazardous to health.

Appearance Light yellow **Physical State** Liquid **Odor** None

EUH210 - Safety data sheet available upon request.

Precautionary Statements

P202 - Do not handle until all safety information has been read and understood.

Hazards not otherwise classified (HNOC)

No information available

Other Information

No information available

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	Weight %	Trade Secret
Water	7732-18-5	90-100 %	*
Potassium Dihydrogen Phosphate	7778-77-0	0-10 %	*
Cetylpyridinium Chloride	123-03-5	0-10 %	*
Sodium Hydrogen Phosphate	7558-79-4	0-10 %	*
Methyl Orange Solution 0.1%	547-58-0	0-10 %	*

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. FIRST AID MEASURES

First Aid Measures

General Advice	Use first aid treatment according to the nature of the injury. For further assistance, contact your local Poison Control Center. Show this safety data sheet to the doctor in attendance.
Eye Contact	In case of eye contact, remove contact lens and rinse thoroughly with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.
Skin Contact	Wash off immediately with soap and plenty of water while removing all contaminated clothing and shoes. If skin reactions occur, contact a physician.
Inhalation	Move to fresh air. If breathing is difficult, give oxygen. If symptoms persist, obtain medical attention.
Ingestion	Clean mouth with water and drink afterwards plenty of water. Do not include vomiting. Call a physician or Poison Control Center immediately.
Production of First-Aiders	Use personal protective equipment. See Section 8 for more detail. Do not use mouth to mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical devices.

Most important symptoms and effects, both acute and delayed

Most important symptoms/effects	No information available

Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable Extinguishing Media
No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures

Personal Precautions	Use personal protective equipment. Refer to Section 8. Evacuate personnel to safe areas.

Environmental Precautions	Beware of vapors accumulating to form explosives concentrations. Vapors can accumulate in low areas.

Method and Material for Containment and Cleaning Up

Methods for Containment	Prevent further leakage or spillage if safe to do so.
Methods for Cleaning Up	Soak up with inert absorbent material. Pick up and transfer to properly labeled containers.

7. HANDLING AND STORAGE

Precautions for Safe Handling

Handling	To avoid risks to human health and the environment, comply with the instructions for use. Wear personal protective equipment. Avoid breathing dust/fume/gas/mist/vapors/spray. Ensure adequate ventilation, especially in confined areas.
Hygiene Considerations	Handle in accordance with good industrial hygiene and safety practice.

Conditions for Safe Storage, Including any Incompatibilities

Storage	Keep container tightly closed in a dry and well-ventilated place. Store at room temperature in the original container. Keep away from direct sunlight.
Incompatible Products	No information available.

Specific end use(s)

Specific use	Laboratory reagent
Risk Management Methods (RMM)	The information required is contained in this Safety Data Sheet.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Guidelines	This product does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Appropriate Engineering Controls

Engineering Measures	Showers Eyewash stations Ventilation systems

Individual protection measures, such as personal protective equipment

Eye/face Protection	Wear chemical splash goggles. If splashes are likely to occur, wear: Face-shield.
Skin and Body Protection	Wear protection gloves/clothing
Respiratory Protection	None required under normal usage. In case of inadequate ventilation wear respiratory protection.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties.

Physical State	Liquid
Appearance	Light yellow
Odor	None
Odor Threshold	No information available
pH Range	5.8 - 8.2

Property	**Values**	**Remarks * Method**
Melting point/freezing point	No information available	

Boiling Point/Range	~ 100 °C / 212 °F
Flash Point (High in °C)	No information available
Evaporation Rate	No information available
Flammability (solid, gas)	No information available
Flammability Limit in Air	
Upper flammability limit:	No information available
Lower flammability limit:	No information available
Vapor pressure	No information available
Vapor Density	No information available
Specific Gravity	No information available
Water Solubility	soluble
Solubility in other solvents	No information available
Partition coefficient	No information available
Autoignition Temperature	
Decomposition Temperature	No information available
Kinematic Viscosity	No information available
Dynamic Viscosity	No information available
Explosive Properties	No information available
Oxidizing Properties	No information available

Other Information

Softening Point	No information available
Molecular Weight	No information available
VOC Content (%)	No information available
Density	No information available
Bulk Density	No information available

10. STABILITY AND REACTIVITY

Reactivity
No information available

Chemical Stability
Stable under normal conditions

Possibility of Hazardous Reactions
None under normal processing

Conditions to Avoid
Extremes of temperature and direct sunlight

Incompatible Materials
No information available

Hazardous Decomposition Products
Thermal decomposition can lead to release of irritating gases and vapors.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation	No information available
Eye Contact	No information available
Skin Contact	No information available
Ingestion	No information available

Component		LD50 Oral	LD50 Dermal	LC50 Inhalation
Water	7732-18-5	>90 mL/kg (Rat)	-	-
Cetylpyridinium Chloride	123-03-5	200 mg/kg (Rat)	-	LC50/4 H 0.05 mg/L (ATE)
Sodium Hydrogen Phosphate	7558-79-4	17000 mg/kg (Rat)	-	-
Potassium Dihydrogen Phosphate	7778-77-0	1700 mg/kg (Mouse)	-	-

Information on Toxicological Effects

Symptoms	No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Sensitization	No information available
Mutagenic Effects	No information available
Carcinogenicity	No information available
Reproductive Effects	No information available
STOT – single exposure	No information available
STOT – repeated exposure	No information available
Aspiration hazard	No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity
Contains a substance which causes risk of hazardous effects to the environment.

Persistence and Degradability
This product is 100% inorganic and will not biodegrade

Bioaccumulation/Accumulation
No information available

Mobility
No information available

Results of PBT and vPvB assessment
No information available

Other adverse effects
No information available

Endocrine Disruptor Information
No information available

13. DISPOSAL CONSIDERATIONS

Waste Treatment Methods

Waste Disposal Methods	Disposal should be in accordance with applicable regional, national and local laws and regulations. Do not discharge to sewer.
Local disposal regulations	Not available.
Hazardous waste code	Not regulated.
Contaminated Packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. TRANSPORT INFORMATION

DOT	Not regulated
TDG	Not regulated
MEX	Not regulated
ICAO	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated
RID	Not regulated
ADR	Not regulated
ADN	Not regulated

15. REGULATORY INFORMATION

European Union
Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work.

International Inventories

USINV	Component listed
CANINV	Component listed
EINECS/ELINCS	Component listed
IECSC	Component listed
AICS	Component listed

USINV/TSCA – United States Toxic Substances Control Act Section 8(b) Inventory
CANINV/DSL/NDSL – Canadian Domestic Substances List/Non-Domestic Substance List
EINECS/ELINCS – European Inventory of Existing Commercial Chemical Substance / EU List of Notified Chemical Substances
IECSC – Chinese Inventory of Existing Chemical Substances
AICS – Australian Inventory of Chemical Substances

U.S. Federal Regulations
This product is not known to be a “Hazardous Chemical” as defined by the OSHA Hazardous Communication Standard, 29 CFR 1910.1200.

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does contains a chemical which are subject to the reporting requirements of the Act and Title 40n of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazardous Categorization

Acute Health Hazard	No
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act
This material, as supplied, does contains a component regulated as a hazardous substance under the Clean Water Act (Section 112(r) (40 CFR 68.130).

CERCLA
This material, as supplied, does contains a component regulated as hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302.4) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional or state level pertaining to releases of this material.

U.S. State Regulations

California Proposition 65
This product is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

State Right-to-Know

Massachusetts Right-to-Know Act – Substance List	Not regulated
New Jersey Worker and Community Right-to-Know Act	Not regulated
Pennsylvania Right-to-Know Act – Hazardous Substance	Not regulated
Rhode Island Right-to-Know Act	Not regulated

U.S. EPA Label Information

No information available

16. OTHER INFORMATION

Revision Date: 12-June-2019

Disclaimer:
IMPORTANT: The information contained in this SDS is correct to the best of our knowledge as of the issue date (or subsequent revision date, if any), and is to be used only as a guide. This SDS does not constitute a guarantee (express or implied) of any kind and we make no warranties of any kind as to the accuracy or completeness of the information contained herein or the merchantability or fitness of the product or this information for a particular purpose. It is the responsibility of each individual buyer/user to determine the suitability of this information and the product for its intended purposes. Product sales are subject to Cole Parmer standard terms and conditions of sale. This information relates only to the designated product as shipped and may not be valid if the product is used in combination with any other materials or is not used in accordance with our instructions, or is altered in any way. It is the responsibility of the buyer/user to ensure that its activities comply with all applicable government requirements. Since conditions of use of the product are not under direct control of Cole Parmer, it is the duty of the buyer/user to determine the necessary conditions for the safe use of the product. Cole Parmer will not be liable for any injuries or damages resulting from handling, use, misuse or contact with the product.

SAFETY DATA SHEET

acc. To OSHA HCS (29CFR 1910.1200) and WHMIS 2015 Regulation

Revision Date: 13-June-2019

Revision 2

1. IDENTIFICATION

Product Identifier

Product Name	pH 10.01 Buffer, Blue
Product Number(s)	00654-08, 05942-10, 05942-61, 05942-62, 05942-64, 05942-65, 05942-15, 00653-10, 00653-14, 00651-10, 00651-40, 00651-80, 98767-79, 98767-80 This SDS applies to pH 10.01 buffers with Lot # starting with CC.
Pure Substance/mixture	Mixture

Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Use as laboratory reagent
Uses advised against	No information available

Supplier

Cole-Parmer™
North America
625 East Bunker Court
Vernon Hills, IL
60061 USA
Tel: 1-800-323-4340

E-mail address	info@coleparmer.com
Made In	USA

Emergency Telephone

888-358-4717
8:00 am – 6:00 pm CST

2. HAZARDS IDENTIFICATION

Classification

OSHA Regulatory Status

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Not a dangerous substance or mixture according to the Globally Harmonized System (GHS)

Label Elements

Emergency Overview

The product contains no substances which at their given concentration, are considered hazardous to health.

Appearance Light Blue **Physical State** Liquid **Odor** None

Safety data sheet available upon request.

Precautionary Statements

Do not handle until all safety information has been read and understood.

Hazards not otherwise classified (HNOC)

No information available

Other Information

No information available

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	Weight %	Trade Secret
Water	7732-18-5	90-100 %	*
Sodium Carbonate	497-19-8	0-10 %	*
Sodium Bicarbonate	144-55-8	0-10 %	*
Thymol Blue Solution 0.04%	62625-21-2	0-10 %	*

*The exact percentage (concentration) of composition has been withheld as a trade secret.

4. FIRST AID MEASURES

First Aid Measures

General Advice	Use first aid treatment according to the nature of the injury. Get medical attention immediately if symptoms occur. Show this safety data sheet to the doctor in attendance.
Eye Contact	Rinse thoroughly with plenty of water, also under the eyelids. Obtain medical attention.
Skin Contact	Wash off immediately with soap and plenty of water for at least 15 minutes while removing all contaminated clothing and shoes. If skin reactions occur, contact a physician.
Inhalation	Move to fresh air. If breathing is difficult, give oxygen. If symptoms persist, obtain medical attention.
Ingestion	Clean mouth with water and drink afterwards plenty of water. Do not include vomiting. Call a physician or Poison Control Center immediately.
Production of First-Aiders	Use personal protective equipment. See Section 8 for more detail. Do not use mouth to mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical devices.

Most important symptoms and effects, both acute and delayed
Most important symptoms/effects

Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable Extinguishing Media
No information available

Specific Hazards Arising from the Chemical
No information available

Explosion Data
Sensitivity to Mechanical Impact - None
Sensitivity to Static Discharge - None

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures

Personal Precautions	Use personal protective equipment. Refer to Section 8. Evacuate personnel to safe areas.

Environmental Precautions	Beware of vapors accumulating to form explosives concentrations. Vapors can accumulate in low areas.

Method and Material for Containment and Cleaning Up

Methods for Containment	Prevent further leakage or spillage if safe to do so.
Methods for Cleaning Up	Soak up with inert absorbent material. Pick up and transfer to properly labeled containers.

7. HANDLING AND STORAGE

Precautions for Safe Handling

Handling	To avoid risks to human health and the environment, comply with the instructions for use. Wear personal protective equipment. Avoid breathing dust/fume/gas/mist/vapors/spray Ensure adequate ventilation, especially in confined areas.

Conditions for Safe Storage, Including any Incompatibilities

Storage	Keep container tightly closed in a dry and well-ventilated place. Store at room temperature in the original container. Keep away from direct sunlight.
Incompatible Products	No information available.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Guidelines	This product does not contain any hazardous materials with occupational exposure limits established by the region-specific regulatory bodies.

Appropriate Engineering Controls

Engineering Measures	Showers Eyewash stations Ventilation systems

Individual protection measures, such as personal protective equipment

Eye/face Protection	Wear chemical splash goggles. If splashes are likely to occur, wear: Face-shield.
Skin and Body Protection	Wear protection gloves/clothing
Respiratory Protection	None required under normal usage. In case of inadequate ventilation wear respiratory protection.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties.

Physical State	Liquid
Appearance	Light blue
Odor	None
Odor Threshold	No information available
pH Range	8.51-11.51

Property	**Values**	**Remarks * Method**
Melting point/freezing point	No information available	
Boiling Point/Range	~ 100 °C / 212 °F	
Flash Point (High in °C)	N/A	
Evaporation Rate	No information available	
Flammability (solid, gas)	No information available	
Flammability Limit in Air		

Upper flammability limit:	No information available
Lower flammability limit:	No information available
Vapor pressure	No information available
Vapor Density	No information available
Specific Gravity	No information available
Water Solubility	soluble
Solubility in other solvents	No information available
Partition coefficient	No information available
Autoignition Temperature	
Decomposition Temperature	No information available
Kinematic Viscosity	No information available
Dynamic Viscosity	No information available
Explosive Properties	No information available
Oxidizing Properties	No information available

Other Information

Softening Point	No information available
Molecular Weight	No information available
VOC Content (%)	No information available
Density	No information available
Bulk Density	No information available

10. STABILITY AND REACTIVITY

Reactivity

No information available

Chemical Stability

Stable under normal conditions

Possibility of Hazardous Reactions

None under normal processing

Conditions to Avoid

Extremes of temperature and direct sunlight

Incompatible Materials

No information available

Hazardous Decomposition Products

Thermal decomposition can lead to release of irritating gases and vapors.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation	No information available
Eye Contact	No information available
Skin Contact	No information available
Ingestion	No information available

Component		LD50 Oral	LD50 Dermal	LC50 Inhalation
Water	7732-18-5	>90 mL/kg (Rat)	-	-
Sodium Carbonate	497-19-8	4090 mg/kg (Rat)	-	2300 mg/m^{3}
Sodium Bicarbonate	144-55-8	4220 mg/kg (Rat)	-	-

Information on Toxicological Effects

Symptoms	No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Sensitization	No information available

Mutagenic Effects	No information available
Carcinogenicity	No information available
Reproductive Effects	No information available
STOT – single exposure	No information available
STOT – repeated exposure	No information available
Aspiration hazard	No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity

Component	Freshwater Algae	Freshwater Fish	Water Flea
Sodium Carbonate 497-19-8	242 mg/L EC50 = 120 h	310 – 1220 mg/L LC50 96 h	265 mg/L EC50 = 48 h
Sodium Bicarbonate 144-55-8	650 mg/L EC50 = 120 h	8250 – 9000 mg/L LC50 96 h	2350 mg/L EC50 = 48 h

Persistence and Degradability
No information available

Bioaccumulation/Accumulation
No information available

Mobility
No information available

Other adverse effects
No information available

13. DISPOSAL CONSIDERATIONS

Waste Treatment Methods

Waste Disposal Methods	Disposal should be in accordance with applicable regional, national and local laws and regulations.
Contaminated Packaging	Improper disposal or reuse of this container may be dangerous and illegal.

Component	CAWAST
Sodium Carbonate 497-19-8	Corrosive

14. TRANSPORT INFORMATION

DOT	Not regulated
TDG	Not regulated
MEX	Not regulated
ICAO	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated
RID	Not regulated
ADR	Not regulated
ADN	Not regulated

15. REGULATORY INFORMATION

International Inventories

USINV	Complies
CANINV	Complies
EINECS/ELINCS	Complies
IECSC	Complies

USINV/TSCA – United States Toxic Substances Control Act Section 8(b) Inventory
CANINV/DSL/NDSL – Canadian Domestic Substances List/Non-Domestic Substance List
EINECS/ELINCS – European Inventory of Existing Commercial Chemical Substance / EU List of Notified Chemical Substances
IECSC – Chinese Inventory of Existing Chemical Substances

U.S. Federal Regulations

This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazardous Communication Standard, 29 CFR 1910.1200.

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40n of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazardous Categorization

Acute Health Hazard	No
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act

Not applicable

CERCLA

This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional or state level pertaining to releases of this material.

U.S. State Regulations

California Proposition 65

This product is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

State Right-to-Know

Massachusetts Right-to-Know Act – Substance List	Not regulated
New Jersey Worker and Community Right-to-Know Act	Not regulated
Pennsylvania Right-to-Know Act – Hazardous Substance	Not regulated
Rhode Island Right-to-Know Act	Not regulated

U.S. EPA Label Information

No information available

16. OTHER INFORMATION

Revision Date: 13-June-2019

Disclaimer:

IMPORTANT: The information contained in this SDS is correct to the best of our knowledge as of the issue date (or subsequent revision date, if any), and is to be used only as a guide. This SDS does not constitute a guarantee (express or implied) of any kind and we make no warranties of any kind as to the accuracy or completeness of the information contained herein or the merchantability or fitness of the product or this information for a particular purpose. It is the responsibility of each individual buyer/user to determine the suitability of this information and the product for its intended purposes. Product sales are subject to Cole Parmer standard terms and conditions of sale. This information relates only to the designated product as shipped and may not be valid if the product is used in combination with any other materials or is not used in accordance with our instructions, or is altered in any way. It is the responsibility of the buyer/user to ensure that its activities comply with all applicable government requirements. Since conditions of use of the product are not under direct control of Cole Parmer, it is the duty of the buyer/user to determine the necessary conditions for the safe use of the product. Cole Parmer will not be liable for any injuries or damages resulting from handling, use, misuse or contact with the product.

Section 1: IDENTIFICATION

Product Name: Simple Green® All-Purpose Cleaner (Ready-To-Use)
Additional Names:

Manufacturer's Part Number: **Please refer to Section 16*

Recommended Use: Cleaner for hard non-porous water resistant surfaces
Restrictions on Use: Do not use on non-rinseable surfaces.

Company: Sunshine Makers, Inc.
15922 Pacific Coast Highway
Huntington Beach, CA 92649 USA

Telephone: 800-228-0709 ● 562-795-6000 *Mon – Fri, 8am – 5pm PST*
Fax: 562-592-3830
Email: info@simplegreen.com

Emergency Phone: Chem-Tel 24-Hour Emergency Service: 800-255-3924

Section 2: HAZARDS IDENTIFICATION

This product is not considered hazardous under 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200).

OSHA HCS 2012
Label Elements
Signal Word: None
Hazard Symbol(s)/Pictogram(s): None required
Hazard Statements: None
Precautionary Statements: None
Hazards Not Otherwise Classified (HNOC): None
Other Information: None Known

Section 3: COMPOSITION/INFORMATION ON INGREDIENTS

Ingredient	CAS Number	Percent Range
Water	7732-18-5	> 96.588%*
C9-11 Alcohols Ethoxylated	68439-46-3	< 1.000%*
Surfactant	Proprietary Mixture	< 1.000%*
Sodium Citrate	68-04-2	< 1.000%*
Sodium Carbonate	497-19-8	< 0.100%*
Tetrasodium Glutamate Diacetate	51981-21-6	< 0.100%*
Citric Acid	77-92-9	< 0.100%*
Blend of Polyoxyalkylene Substituted Chromophores (Cyan and Yellow)**	Proprietary Mixture	< 0.010%*
Methylchloroisothiazolinone, Methylisothiazolinone	55965-84-9	< 0.002%*
Fragrances	Proprietary Mixture	< 0.100%*

**specific percentages of composition are being withheld as a trade secret*
***Colorant added to select UPCS*

Section 4: FIRST-AID MEASURES

Inhalation: Not expected to cause respiratory irritation. If adverse effect occurs, move to fresh air.
Skin Contact: Not expected to cause skin irritation. If adverse effect occurs, rinse skin with water.
Eye Contact: Not expected to cause eye irritation. If adverse effect occurs, flush eyes with water.
Ingestion: May cause upset stomach. Drink plenty of water to dilute. See section 11.

Most Important Symptoms/Effects, Acute and Delayed: None known.

Indication of Immediate Medical Attention and Special Treatment Needed, if necessary: Treat symptomatically

Section 5: FIRE-FIGHTING MEASURES

Suitable & Unsuitable Extinguishing Media: Use Dry chemical, CO2, water spray or “alcohol” foam. Avoid high volume jet water.
Specific Hazards Arising from Chemical: In event of fire, fire created carbon oxides may be formed.
Special Protective Actions for Fire-Fighters: Wear positive pressure self-contained breathing apparatus; Wear full protective clothing.

This product is non-flammable. See Section 9 for Physical Properties.

Section 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions, Protective Equipment and Emergency Procedures: *For non-emergency and emergency personnel:* See section 8 – personal protection. Avoid eye contact. Safety goggles suggested.

Environmental Precautions: Do not allow into open waterways and ground water systems.

Methods and Materials for Containment and Clean Up: Dike or soak up with inert absorbent material. See section 13 for disposal considerations.

Section 7: HANDLING AND STORAGE

Precautions for Safe Handling: Ensure adequate ventilation. Keep out of reach of children. Keep away from heat, sparks, open flame and direct sunlight. Do not pierce any part of the container. Do not mix or contaminate with any other chemical. Do not eat, drink or smoke while using this product.

Conditions for Safe Storage including Incompatibilities: Keep container tightly closed. Keep in cool dry area. Avoid prolonged exposure to sunlight. Do not store at temperatures above 109°F (42.7°C). If separation occurs, mix the product for reconstitution.

Section 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Limit Values: No components listed with TWA or STEL values under OSHA or ACGIH.

Appropriate Engineering Controls: Showers, eyewash stations, ventilation systems

Individual Protection Measures / Personal Protective Equipment (PPE)
Eye Contact: Use protective glasses or safety goggles if splashing or spray-back is likely.
Respiratory: Use in well ventilated areas or local exhaust ventilations when cleaning small spaces.
Skin Contact: Use protective gloves (any material) when used for prolonged periods or dermally sensitive.
General Hygiene Considerations: Wash thoroughly after handling and before eating or drinking.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Green Liquid	**Partition Coefficient: n-octanol/water:**	Not determined		
Odor:	Added sassafras odor	**Autoignition Temperature:**	Non-flammable		
Odor Threshold:	Not determined	**Decomposition Temperature:**	42.7°C (109°F)		
pH:	8.2 – 9.2	**Viscosity:**	Like water		
Freezing Point:	0°C (32°F)	**Specific Gravity :**	0.995 – 1.010		
Boiling Point & Range:	98°C (210°F)	**VOCs:**	_**Water & fragrance exemption in calculation_		
Flash Point:	> 212°F	SCAQMD 304-91 / EPA 24:	Not tested		
Evaporation Rate:	Not determined	CARB Method 310**:	0.3 g/L	0.003 lb/gal	0.03%
Flammability (solid, gas):	Not applicable	SCAQMD Method 313:	Not tested		
Upper/Lower Flammability or Explosive Limits:	Not applicable	**VOC Composite Partial Pressure:**	Not determined		

Section 9: PHYSICAL AND CHEMICAL PROPERTIES - continued

Vapor Pressure :	Not determined	**Relative Density:**	8.30 – 8.42 lb/gal
Vapor Density:	Not determined	**Solubility:**	100% in water

Section 10: STABILITY AND REACTIVITY

Reactivity:	Non-reactive.
Chemical Stability:	Stable under normal conditions 70°F (21°C) and 14.7 psig (760 mmHg).
Possibility of Hazardous Reactions:	None known.
Conditions to Avoid:	Excessive heat or cold.
Incompatible Materials:	Do not mix with oxidizers, acids, bathroom cleaners, or disinfecting agents.
Hazardous Decomposition Products:	Normal products of combustion - CO, CO2.

Section 11: TOXICOLOGICAL INFORMATION

Likely Routes of Exposure:	Inhalation -	Overexposure may cause headache.
	Skin Contact -	Not expected to cause irritation, repeated contact may cause dry skin.
	Eye Contact -	Not expected to cause irritation, may cause slight stinging sensation.
	Ingestion -	May cause upset stomach.

Symptoms related to the physical, chemical and toxicological characteristics: no symptoms expected under typical use conditions.
Delayed and immediate effects and or chronic effects from short term exposure: no symptoms expected under typical use conditions.
Delayed and immediate effects and or chronic effects from long term exposure: headache, dry skin, or skin irritation may occur.
Interactive effects: Not known.

Numerical Measures of Toxicity

Acute Toxicity:	Oral LD_{50} (rat)	> 5 g/kg body weight
	Dermal LD_{50} (rabbit)	> 5 g/kg body weight

Calculated via OSHA HCS 2012 / Globally Harmonized System of Classification and Labelling of Chemicals

Skin Corrosion/Irritation:	Based on similar formulations, does not classify under this category.
Eye Damage/Irritation:	Based on similar formulations, does not classify under this category.
Germ Cell Mutagenicity:	Mixture does not classify under this category.
Carcinogenicity:	Mixture does not classify under this category.
Reproductive Toxicity:	Mixture does not classify under this category.
STOT-Single Exposure:	Mixture does not classify under this category.
STOT-Repeated Exposure:	Mixture does not classify under this category.
Aspiration Hazard:	Mixture does not classify under this category.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity:	Volume of ingredients used does not trigger toxicity classifications under the Globally Harmonized System of Classification and Labelling of Chemicals.
Aquatic:	Based on similar formulations expected Aquatic Toxicity - Low, based on OECD 201, 202, 203 + Microtox: EC_{50} & IC_{50} ≥ 100 mg/L. Volume of ingredients used does not trigger toxicity classifications under the Globally Harmonized System of Classification and Labelling of Chemicals.
Terrestrial:	Not tested on finished formulation.

Persistence and Degradability:	Based on similar formulations, expected to be readily biodegradable under OECD 301D, and reach 100% biodegradation within 60 days.
Bioaccumulative Potential:	No data available.
Mobility in Soil:	No data available.
Other Adverse Effects:	No data available.

Section 13: DISPOSAL CONSIDERATIONS

Unused or Used Liquid: May be considered hazardous in your area depending on usage and tonnage of disposal – check with local, regional, and or national regulations for appropriate methods of disposal.

Empty Containers: May be offered for recycling.

Never dispose of used degreasing rinsates into lakes, streams, and open bodies of water or storm drains.

Section 14: TRANSPORT INFORMATION

U.N. Number:	Not applicable
U.N. Proper Shipping Name:	Cleaning Compound, Liquid NOI
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Marine Pollutant - NO
Transport in Bulk (according to Annex II of MARPOL 73/78 and IBC Code):	Unknown.
Special precautions which user needs to be aware of/comply with, in connection with transport or conveyance either within or outside their premises:	None known.

U.S. (DOT) / Canadian TDG:	Not Regulated for shipping.	**ICAO/ IATA:**	Not classified as Hazardous
IMO / IDMG:	Not classified as Hazardous	**ADR/RID:**	Not classified as Hazardous

Section 15: REGULATORY INFORMATION

All components are listed on: TSCA and DSL Inventory.

SARA Title III: Sections 311/312 Hazard Categories – Not applicable.
Sections 313 Superfunds Amendments and Reauthorizations Act of 1986 – Not applicable.
Sections 302 – Not applicable.

Clean Air Act (CAA): Not applicable
Clean Water Act (CWA): Not applicable

State Right To Know Lists: No ingredients listed
California Proposition 65: No ingredients listed

This product has been classified as "not classifiable as hazardous" in accordance with Consumer Product Safety Commission (16 CFR Chapter 2), and labelled and packaged accordingly.

US Consumer Product Safety Commission Regulations
This product is labeled in accordance with regulations administered by the Consumer Product Safety Commission (CPSC). However, the use pattern and exposure in the workplace are generally not consistent with those experienced by consumers. Therefore, the requirements of the Occupational Safety and Health Administration applicable to this SDS differ from the labeling requirements of the CPSC, and this SDS may contain additional health hazard information not pertinent to consumer use and not found on the product label.

Section 16: OTHER INFORMATION

Size	UPC		Size	UPC
32 fl. oz. trigger	043318000713		32 fl. oz. trigger	043318006401
32 fl. oz. trigger	043318002496	***Colorless*	32 fl. oz. trigger	043318160271

USA part numbers listed only. Not all part numbers listed. USA part numbers may not be valid for international sale.

Section 16: OTHER INFORMATION - continued

NFPA:

Health – None
Flammability – Non-flammable
Stability – Stable
Special - None

Acronyms

NTP	National Toxicology Program	IARC	International Agency for Research on Cancer
OSHA	Occupational Safety and Health Administration	CPSC	Consumer Product Safety Commission
TSCA	Toxic Substances Control Act	DSL	Domestic Substances List

Prepared / Revised By: Sunshine Makers, Inc., Regulatory Department.
This SDS has been revised in the following sections: Section 3 correction

DISCLAIMER: The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

YSI 3682 Zobell Solution

YSI Inc.

Chemwatch Hazard Alert Code: 2

Version No: **2.2**
Safety Data Sheet according to OSHA HazCom Standard (2012) requirements

Issue Date: **09/27/2018**
Print Date: **09/27/2018**
S.GHS.USA.EN

SECTION 1 IDENTIFICATION

Product Identifier

Product name	YSI 3682 Zobell Solution
Synonyms	061320, 061321, 061322
Other means of identification	Not Available

Recommended use of the chemical and restrictions on use

Relevant identified uses	Calibration of analytical instruments / Reagent.

Name, address, and telephone number of the chemical manufacturer, importer, or other responsible party

Registered company name	**YSI Inc.**
Address	1700/1725 Brannum Ln Yellow Springs OH 45387 United States
Telephone	(937) 767-7241
Fax	Not Available
Website	www.ysi.com
Email	MSDSinfo@ysi.com

Emergency phone number

Association / Organisation	**CHEMTREC**
Emergency telephone numbers	**(800) 424-9300**
Other emergency telephone numbers	**011 703-527-3887**

SECTION 2 HAZARD(S) IDENTIFICATION

Classification of the substance or mixture

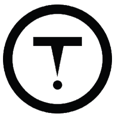
CHEMWATCH HAZARD RATINGS

		Min	Max
Flammability	0		
Toxicity	2	▨	
Body Contact	2	▨	
Reactivity	0		
Chronic	2	▨	

0 = Minimum
1 = Low
2 = Moderate
3 = High
4 = Extreme

Note: The hazard category numbers found in GHS classification in section 2 of this SDSs are NOT to be used to fill in the NFPA 704 diamond. Blue = Health Red = Fire Yellow = Reactivity White = Special (Oxidizer or water reactive substances)

CANADIAN WHMIS SYMBOLS



Classification	Skin Corrosion/Irritation Category 2, Eye Irritation Category 2A, Germ cell mutagenicity Category 2, Specific target organ toxicity - single exposure Category 3 (respiratory tract irritation), Acute Aquatic Hazard Category 2, Chronic Aquatic Hazard Category 3

Label elements

Hazard pictogram(s)	
SIGNAL WORD	**WARNING**

Hazard statement(s)

H315	Causes skin irritation.
H319	Causes serious eye irritation.
H341	Suspected of causing genetic defects.
H335	May cause respiratory irritation.
H401	Toxic to aquatic life.
H412	Harmful to aquatic life with long lasting effects.

Hazard(s) not otherwise specified

Not Applicable

Supplementary statement(s)

Not Applicable

CLP classification (additional)

Not Applicable

Precautionary statement(s) Prevention

P201	Obtain special instructions before use.
P271	Use only outdoors or in a well-ventilated area.
P281	Use personal protective equipment as required.
P261	Avoid breathing dust/fumes.
P273	Avoid release to the environment.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

Precautionary statement(s) Response

P308+P313	IF exposed or concerned: Get medical advice/attention.
P362	Take off contaminated clothing and wash before reuse.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P312	Call a POISON CENTER or doctor/physician if you feel unwell.
P337+P313	If eye irritation persists: Get medical advice/attention.
P302+P352	IF ON SKIN: Wash with plenty of soap and water.
P304+P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P332+P313	If skin irritation occurs: Get medical advice/attention.

Precautionary statement(s) Storage

P405	Store locked up.
P403+P233	Store in a well-ventilated place. Keep container tightly closed.

Precautionary statement(s) Disposal

P501	Dispose of contents/container in accordance with local regulations.

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Substances

See section below for composition of Mixtures

Mixtures

CAS No	%[weight]	Name
7447-40-7	72-78	potassium chloride
13746-66-2	10-15	potassium ferricyanide(III)
14459-95-1	10-15	potassium ferrocyanide trihydrate

SECTION 4 FIRST-AID MEASURES

Description of first aid measures

Eye Contact	If this product comes in contact with the eyes: - Wash out immediately with fresh running water. - Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids. - Seek medical attention without delay; if pain persists or recurs seek medical attention. - Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.
Skin Contact	If skin contact occurs: - Immediately remove all contaminated clothing, including footwear. - Flush skin and hair with running water (and soap if available). - Seek medical attention in event of irritation.
Inhalation	- If fumes or combustion products are inhaled remove from contaminated area. - Lay patient down. Keep warm and rested. - Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures. - Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary. - Transport to hospital, or doctor, without delay.
Ingestion	- If swallowed do **NOT** induce vomiting. - If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration. - Observe the patient carefully. - Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious. - Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink. - Seek medical advice.

Most important symptoms and effects, both acute and delayed

See Section 11

Indication of any immediate medical attention and special treatment needed

For potassium intoxications:

- Hyperkalaemia, in patients with abnormal renal function, results from reduced renal excretion following intoxication.
- The presence of electrocardiographic evidence of hyperkalemia or serum potassium levels exceeding 7.5 mE/L indicates a medical emergency requiring an intravenous line and constant cardiac monitoring.
- The intravenous ingestion of 5-10 ml of 10% calcium gluconate, in adults, over a 2 minute period antagonises the cardiac and neuromuscular effects. The duration of action is approximately 1 hour. [Ellenhorn and Barceloux: Medical Toxicology]

SECTION 5 FIRE-FIGHTING MEASURES

Extinguishing media

- Water spray or fog.
- Foam.
- Dry chemical powder.
- BCF (where regulations permit).
- Carbon dioxide.

Special hazards arising from the substrate or mixture

Fire Incompatibility	- Avoid contamination with oxidising agents i.e. nitrates, oxidising acids, chlorine bleaches, pool chlorine etc. as ignition may result

Special protective equipment and precautions for fire-fighters

Fire Fighting	- Alert Fire Brigade and tell them location and nature of hazard. - Wear breathing apparatus plus protective gloves. - Prevent, by any means available, spillage from entering drains or water courses. - Use water delivered as a fine spray to control fire and cool adjacent area. - **DO NOT** approach containers suspected to be hot. - Cool fire exposed containers with water spray from a protected location. - If safe to do so, remove containers from path of fire. - Equipment should be thoroughly decontaminated after use.
Fire/Explosion Hazard	- Combustible solid which burns but propagates flame with difficulty; it is estimated that most organic dusts are combustible (circa 70%) - according to the circumstances under which the combustion process occurs, such materials may cause fires and / or dust explosions. - Organic powders when finely divided over a range of concentrations regardless of particulate size or shape and suspended in air or some other oxidizing medium may form explosive dust-air mixtures and result in a fire or dust explosion (including secondary explosions). - Avoid generating dust, particularly clouds of dust in a confined or unventilated space as dusts may form an explosive mixture with air, and any source of ignition, i.e. flame or spark, will cause fire or explosion. Dust clouds generated by the fine grinding of the solid are a particular hazard; accumulations of fine dust (420 micron or less) may burn rapidly and fiercely if ignited - particles exceeding this limit will generally not form flammable dust clouds; once initiated, however, larger particles up to 1400 microns diameter will contribute to the propagation of an explosion. - In the same way as gases and vapours, dusts in the form of a cloud are only ignitable over a range of concentrations; in principle, the concepts of lower explosive limit (LEL) and upper explosive limit (UEL) are applicable to dust clouds but only the LEL is of practical use; - this is because of the inherent difficulty of achieving homogeneous dust clouds at high temperatures (for dusts the LEL is often called the "Minimum Explosible Concentration", MEC). - When processed with flammable liquids/vapors/mists,ignitable (hybrid) mixtures may be formed with combustible dusts. Ignitable mixtures will increase the rate of explosion pressure rise and the Minimum Ignition Energy (the minimum amount of energy required to ignite dust clouds - MIE) will be lower than the pure dust in air mixture. The Lower Explosive Limit (LEL) of the vapour/dust mixture will be lower than the individual LELs for the vapors/mists or dusts. - A dust explosion may release of large quantities of gaseous products; this in turn creates a subsequent pressure rise of explosive force capable of damaging plant and buildings and injuring people. - Usually the initial or primary explosion takes place in a confined space such as plant or machinery, and can be of sufficient force to damage or rupture the plant. If the shock wave from the primary explosion enters the surrounding area, it will disturb any settled dust layers, forming a second dust cloud, and often initiate a much larger secondary explosion. All large scale explosions have resulted from chain reactions of this type. - Dry dust can be charged electrostatically by turbulence, pneumatic transport, pouring, in exhaust ducts and during transport. - Build-up of electrostatic charge may be prevented by bonding and grounding. - Powder handling equipment such as dust collectors, dryers and mills may require additional protection measures such as explosion venting.

Continued...

	▸ All movable parts coming in contact with this material should have a speed of less than 1-meter/sec. ▸ A sudden release of statically charged materials from storage or process equipment, particularly at elevated temperatures and/ or pressure, may result in ignition especially in the absence of an apparent ignition source. ▸ One important effect of the particulate nature of powders is that the surface area and surface structure (and often moisture content) can vary widely from sample to sample, depending of how the powder was manufactured and handled; this means that it is virtually impossible to use flammability data published in the literature for dusts (in contrast to that published for gases and vapours). ▸ Autoignition temperatures are often quoted for dust clouds (minimum ignition temperature (MIT)) and dust layers (layer ignition temperature (LIT)); LIT generally falls as the thickness of the layer increases. Combustion products include: carbon monoxide (CO) carbon dioxide (CO2) hydrogen chloride phosgene nitrogen oxides (NOx) other pyrolysis products typical of burning organic material. May emit poisonous fumes. May emit corrosive fumes.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

See section 8

Environmental precautions

See section 12

Methods and material for containment and cleaning up

Minor Spills	▸ Remove all ignition sources. ▸ Clean up all spills immediately. ▸ Avoid contact with skin and eyes. ▸ Control personal contact with the substance, by using protective equipment. ▸ Use dry clean up procedures and avoid generating dust. ▸ Place in a suitable, labelled container for waste disposal. Environmental hazard - contain spillage.
Major Spills	Environmental hazard - contain spillage. Moderate hazard. ▸ **CAUTION**: Advise personnel in area. ▸ Alert Emergency Services and tell them location and nature of hazard. ▸ Control personal contact by wearing protective clothing. ▸ Prevent, by any means available, spillage from entering drains or water courses. ▸ Recover product wherever possible. ▸ **IF DRY:** Use dry clean up procedures and avoid generating dust. Collect residues and place in sealed plastic bags or other containers for disposal. **IF WET:** Vacuum/shovel up and place in labelled containers for disposal. ▸ **ALWAYS:** Wash area down with large amounts of water and prevent runoff into drains. ▸ If contamination of drains or waterways occurs, advise Emergency Services.

Personal Protective Equipment advice is contained in Section 8 of the SDS.

SECTION 7 HANDLING AND STORAGE

Precautions for safe handling

Safe handling	▸ Avoid all personal contact, including inhalation. ▸ Wear protective clothing when risk of exposure occurs. ▸ Use in a well-ventilated area. ▸ Prevent concentration in hollows and sumps. ▸ **DO NOT** enter confined spaces until atmosphere has been checked. ▸ **DO NOT** allow material to contact humans, exposed food or food utensils. ▸ Avoid contact with incompatible materials. ▸ When handling, **DO NOT** eat, drink or smoke. ▸ Keep containers securely sealed when not in use. ▸ Avoid physical damage to containers. ▸ Always wash hands with soap and water after handling. ▸ Work clothes should be laundered separately. Launder contaminated clothing before re-use. ▸ Use good occupational work practice. ▸ Observe manufacturer's storage and handling recommendations contained within this SDS. ▸ Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained. ▸ Organic powders when finely divided over a range of concentrations regardless of particulate size or shape and suspended in air or some other oxidizing medium may form explosive dust-air mixtures and result in a fire or dust explosion (including secondary explosions) ▸ Minimise airborne dust and eliminate all ignition sources. Keep away from heat, hot surfaces, sparks, and flame. ▸ Establish good housekeeping practices. ▸ Remove dust accumulations on a regular basis by vacuuming or gentle sweeping to avoid creating dust clouds. ▸ Use continuous suction at points of dust generation to capture and minimise the accumulation of dusts. Particular attention should be given to overhead and hidden horizontal surfaces to minimise the probability of a "secondary" explosion. According to NFPA Standard 654, dust layers 1/32 in.(0.8 mm) thick can be sufficient to warrant immediate cleaning of the area. ▸ Do not use air hoses for cleaning. ▸ Minimise dry sweeping to avoid generation of dust clouds. Vacuum dust-accumulating surfaces and remove to a chemical disposal area. Vacuums with explosion-proof motors should be used. ▸ Control sources of static electricity. Dusts or their packages may accumulate static charges, and static discharge can be a source of ignition. ▸ Solids handling systems must be designed in accordance with applicable standards (e.g. NFPA including 654 and 77) and other national guidance. ▸ Do not empty directly into flammable solvents or in the presence of flammable vapors. ▸ The operator, the packaging container and all equipment must be grounded with electrical bonding and grounding systems. Plastic bags and plastics cannot be grounded, and antistatic bags do not completely protect against development of static charges.

Continued...

	Empty containers may contain residual dust which has the potential to accumulate following settling. Such dusts may explode in the presence of an appropriate ignition source. ▸ Do NOT cut, drill, grind or weld such containers. ▸ In addition ensure such activity is not performed near full, partially empty or empty containers without appropriate workplace safety authorisation or permit.
Other information	▸ Store in original containers. ▸ Keep containers securely sealed. ▸ Store in a cool, dry area protected from environmental extremes. ▸ Store away from incompatible materials and foodstuff containers. ▸ Protect containers against physical damage and check regularly for leaks. ▸ Observe manufacturer's storage and handling recommendations contained within this SDS. For major quantities: ▸ Consider storage in bunded areas - ensure storage areas are isolated from sources of community water (including stormwater, ground water, lakes and streams}. ▸ Ensure that accidental discharge to air or water is the subject of a contingency disaster management plan; this may require consultation with local authorities.

Conditions for safe storage, including any incompatibilities

Suitable container	▸ Glass container is suitable for laboratory quantities ▸ Polyethylene or polypropylene container. ▸ Check all containers are clearly labelled and free from leaks.
Storage incompatibility	Several members of the family described as metal cyano complexes are endothermic and tend towards explosive instability; most are capable of violent oxidation under appropriate circumstances. BRETHERICKS HANDBOOK OF REACTIVE CHEMICAL HAZARDS, 4th Edition ferricyanide: ▸ mixtures with water, acids,or alcohols may slowly decompose producing hydrocyanic acid ▸ reacts explosively with strong oxidisers, ammonia chromium trioxide, chromic acid, chromic anhydride, sodium nitrite ▸ reacts violently with copper(II) nitrate, trihydrate. ▸ Contact with acids produces toxic fumes ▸ Avoid reaction with oxidising agents

X — Must not be stored together
0 — May be stored together with specific preventions
+ — May be stored together

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Control parameters

OCCUPATIONAL EXPOSURE LIMITS (OEL)

INGREDIENT DATA

Source	Ingredient	Material name	TWA	STEL	Peak	Notes
US ACGIH Threshold Limit Values (TLV)	potassium ferricyanide(III)	Iron salts, soluble, as Fe	1 mg/m3	Not Available	Not Available	TLV® Basis: URT & skin irr

EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
potassium chloride	Potassium chloride	7.8 mg/m3	86 mg/m3	510 mg/m3
potassium ferricyanide(III)	Potassium ferricyanide	13 mg/m3	18 mg/m3	110 mg/m3
potassium ferrocyanide trihydrate	Potassium ferrocyanide; (Tetrapotassium hexacyanoferrate)	14 mg/m3	20 mg/m3	120 mg/m3
potassium ferrocyanide trihydrate	Potassium hexacyanoferrate(II) trihydrate; (Potassium ferricyanide trihydrate)	16 mg/m3	23 mg/m3	140 mg/m3

Ingredient	Original IDLH	Revised IDLH
potassium chloride	Not Available	Not Available
potassium ferricyanide(III)	Not Available	Not Available
potassium ferrocyanide trihydrate	Not Available	Not Available

Exposure controls

Appropriate engineering controls	Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection. The basic types of engineering controls are: Process controls which involve changing the way a job activity or process is done to reduce the risk. Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment. Ventilation can remove or dilute an air contaminant if designed properly. The design of a ventilation system must match the particular process and chemical or contaminant in use. Employers may need to use multiple types of controls to prevent employee overexposure. ▸ Local exhaust ventilation is required where solids are handled as powders or crystals; even when particulates are relatively large, a certain proportion will be powdered by mutual friction. ▸ Exhaust ventilation should be designed to prevent accumulation and recirculation of particulates in the workplace. ▸ If in spite of local exhaust an adverse concentration of the substance in air could occur, respiratory protection should be considered. Such protection

- might consist of:

(a): particle dust respirators, if necessary, combined with an absorption cartridge;
(b): filter respirators with absorption cartridge or canister of the right type;
(c): fresh-air hoods or masks

- Build-up of electrostatic charge on the dust particle, may be prevented by bonding and grounding.
- Powder handling equipment such as dust collectors, dryers and mills may require additional protection measures such as explosion venting.

Air contaminants generated in the workplace possess varying "escape" velocities which, in turn, determine the "capture velocities" of fresh circulating air required to efficiently remove the contaminant.

Type of Contaminant:	Air Speed:
direct spray, spray painting in shallow booths, drum filling, conveyer loading, crusher dusts, gas discharge (active generation into zone of rapid air motion)	1-2.5 m/s (200-500 f/min.)
grinding, abrasive blasting, tumbling, high speed wheel generated dusts (released at high initial velocity into zone of very high rapid air motion).	2.5-10 m/s (500-2000 f/min.)

Within each range the appropriate value depends on:

Lower end of the range	Upper end of the range
1: Room air currents minimal or favourable to capture	1: Disturbing room air currents
2: Contaminants of low toxicity or of nuisance value only	2: Contaminants of high toxicity
3: Intermittent, low production.	3: High production, heavy use
4: Large hood or large air mass in motion	4: Small hood-local control only

Simple theory shows that air velocity falls rapidly with distance away from the opening of a simple extraction pipe. Velocity generally decreases with the square of distance from the extraction point (in simple cases). Therefore the air speed at the extraction point should be adjusted, accordingly, after reference to distance from the contaminating source. The air velocity at the extraction fan, for example, should be a minimum of 4-10 m/s (800-2000 f/min) for extraction of crusher dusts generated 2 metres distant from the extraction point. Other mechanical considerations, producing performance deficits within the extraction apparatus, make it essential that theoretical air velocities are multiplied by factors of 10 or more when extraction systems are installed or used.

Personal protection

Eye and face protection

- Safety glasses with side shields.
- Chemical goggles.
- Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task. This should include a review of lens absorption and adsorption for the class of chemicals in use and an account of injury experience. Medical and first-aid personnel should be trained in their removal and suitable equipment should be readily available. In the event of chemical exposure, begin eye irrigation immediately and remove contact lens as soon as practicable. Lens should be removed at the first signs of eye redness or irritation - lens should be removed in a clean environment only after workers have washed hands thoroughly. [CDC NIOSH Current Intelligence Bulletin 59], [AS/NZS 1336 or national equivalent]

Skin protection

See Hand protection below

Hands/feet protection

The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.
The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and.has to be observed when making a final choice.
Personal hygiene is a key element of effective hand care. Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturiser is recommended.
Suitability and durability of glove type is dependent on usage. Important factors in the selection of gloves include:

- frequency and duration of contact,
- chemical resistance of glove material,
- glove thickness and
- dexterity

Select gloves tested to a relevant standard (e.g. Europe EN 374, US F739, AS/NZS 2161.1 or national equivalent).

- When prolonged or frequently repeated contact may occur, a glove with a protection class of 5 or higher (breakthrough time greater than 240 minutes according to EN 374, AS/NZS 2161.10.1 or national equivalent) is recommended.
- When only brief contact is expected, a glove with a protection class of 3 or higher (breakthrough time greater than 60 minutes according to EN 374, AS/NZS 2161.10.1 or national equivalent) is recommended.
- Some glove polymer types are less affected by movement and this should be taken into account when considering gloves for long-term use.
- Contaminated gloves should be replaced.

As defined in ASTM F-739-96 in any application, gloves are rated as:

- Excellent when breakthrough time > 480 min
- Good when breakthrough time > 20 min
- Fair when breakthrough time < 20 min
- Poor when glove material degrades

For general applications, gloves with a thickness typically greater than 0.35 mm, are recommended.
It should be emphasised that glove thickness is not necessarily a good predictor of glove resistance to a specific chemical, as the permeation efficiency of the glove will be dependent on the exact composition of the glove material. Therefore, glove selection should also be based on consideration of the task requirements and knowledge of breakthrough times.
Glove thickness may also vary depending on the glove manufacturer, the glove type and the glove model. Therefore, the manufacturers' technical data should always be taken into account to ensure selection of the most appropriate glove for the task.
Note: Depending on the activity being conducted, gloves of varying thickness may be required for specific tasks. For example:

- Thinner gloves (down to 0.1 mm or less) may be required where a high degree of manual dexterity is needed. However, these gloves are only likely to give short duration protection and would normally be just for single use applications, then disposed of.
- Thicker gloves (up to 3 mm or more) may be required where there is a mechanical (as well as a chemical) risk i.e. where there is abrasion or puncture potential

Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturiser is recommended.

	Experience indicates that the following polymers are suitable as glove materials for protection against undissolved, dry solids, where abrasive particles are not present. ▸ polychloroprene. ▸ nitrile rubber. ▸ butyl rubber. ▸ fluorocaoutchouc. ▸ polyvinyl chloride. Gloves should be examined for wear and/ or degradation constantly.
Body protection	See Other protection below
Other protection	▸ Overalls. ▸ P.V.C. apron. ▸ Barrier cream. ▸ Skin cleansing cream. ▸ Eye wash unit.

Respiratory protection

Particulate. (AS/NZS 1716 & 1715, EN 143:2000 & 149:001, ANSI Z88 or national equivalent)

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	P1 Air-line*	- -	PAPR-P1 -
up to 50 x ES	Air-line**	P2	PAPR-P2
up to 100 x ES	-	P3 Air-line*	- -
100+ x ES	-	Air-line**	PAPR-P3

*** - Negative pressure demand ** - Continuous flow**
A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

- **Respirators may be necessary when engineering and administrative controls do not adequately prevent exposures.**
- **The decision to use respiratory protection should be based on professional judgment that takes into account toxicity information, exposure measurement data, and frequency and likelihood of the worker's exposure - ensure users are not subject to high thermal loads which may result in heat stress or distress due to personal protective equipment (powered, positive flow, full face apparatus may be an option).**
- **Published occupational exposure limits, where they exist, will assist in determining the adequacy of the selected respiratory protection. These may be government mandated or vendor recommended.**
- **Certified respirators will be useful for protecting workers from inhalation of particulates when properly selected and fit tested as part of a complete respiratory protection program.**
- **Use approved positive flow mask if significant quantities of dust becomes airborne.**
- **Try to avoid creating dust conditions.**

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	White

Physical state	Divided Solid|Powder	**Relative density (Water = 1)**	Not Available
Odour	Not Available	**Partition coefficient n-octanol / water**	Not Available
Odour threshold	Not Available	**Auto-ignition temperature (°C)**	Not Available
pH (as supplied)	Not Available	**Decomposition temperature**	Not Available
Melting point / freezing point (°C)	Not Available	**Viscosity (cSt)**	Not Available
Initial boiling point and boiling range (°C)	Not Available	**Molecular weight (g/mol)**	Not Available
Flash point (°C)	Not Available	**Taste**	Not Available
Evaporation rate	Not Available	**Explosive properties**	Not Available
Flammability	Not Available	**Oxidising properties**	Not Available
Upper Explosive Limit (%)	Not Available	**Surface Tension (dyn/cm or mN/m)**	Not Applicable
Lower Explosive Limit (%)	Not Available	**Volatile Component (%vol)**	Not Available
Vapour pressure (kPa)	Not Available	**Gas group**	Not Available
Solubility in water (g/L)	Miscible	**pH as a solution (1%)**	Not Available
Vapour density (Air = 1)	Not Available	**VOC g/L**	Not Available

SECTION 10 STABILITY AND REACTIVITY

Reactivity	See section 7
Chemical stability	▸ Unstable in the presence of incompatible materials. ▸ Product is considered stable. ▸ Hazardous polymerisation will not occur.
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7

Continued...

Incompatible materials	See section 7
Hazardous decomposition products	See section 5

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects

Inhaled	The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage. Persons with impaired respiratory function, airway diseases and conditions such as emphysema or chronic bronchitis, may incur further disability if excessive concentrations of particulate are inhaled. If prior damage to the circulatory or nervous systems has occurred or if kidney damage has been sustained, proper screenings should be conducted on individuals who may be exposed to further risk if handling and use of the material result in excessive exposures.
Ingestion	Accidental ingestion of the material may be damaging to the health of the individual. Use as a food additive indicates good tolerance of small amounts, but excessive amounts or overuse may bring irritant and/or harmful effects Acute potassium poisoning after swallowing is rare, because vomiting usually occurs and renal excretion is fast. Potassium causes a slow, weak pulse, irregularities in heart rhythm, heart block and an eventual fall in blood pressure. A number of materials such as cyanamide, calcium cyanamide, cyanates, isocyanates, isonitrile, thiocyanates, ferricyanide and ferrocyanide, and cyanoacetates do not exhibit the same toxic effects as cyanides and nitriles. The toxicity of complex cyanides depends on its stability in solution, ability to release cyanide ions on dissociation and alteration in pH of solutions. They are compounds in which the cyanide anion is incorporated into a complex or complexes and they are different in chemical and toxicologic properties from simple cyanides.
Skin Contact	This material can cause inflammation of the skin on contact in some persons. The material may accentuate any pre-existing dermatitis condition Skin contact is not thought to have harmful health effects (as classified under EC Directives); the material may still produce health damage following entry through wounds, lesions or abrasions. Irritation and skin reactions are possible with sensitive skin Open cuts, abraded or irritated skin should not be exposed to this material Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.
Eye	This material can cause eye irritation and damage in some persons.
Chronic	Long-term exposure to respiratory irritants may result in airways disease, involving difficulty breathing and related whole-body problems. Strong evidence exists that this substance may cause irreversible mutations (though not lethal) even following a single exposure. Laboratory (in vitro) and animal studies show, exposure to the material may result in a possible risk of irreversible effects, with the possibility of producing mutation. Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure. Long term exposure to high dust concentrations may cause changes in lung function i.e. pneumoconiosis, caused by particles less than 0.5 micron penetrating and remaining in the lung. Prolonged or repeated skin contact may cause drying with cracking, irritation and possible dermatitis following.

YSI 3682 Zobell Solution

TOXICITY	IRRITATION
Not Available	Not Available

potassium chloride

TOXICITY	IRRITATION
Oral (rat) LD50: 2600 mg/kg[2]	Eye (rabbit): 500 mg/24h - mild

potassium ferricyanide(III)

TOXICITY	IRRITATION
Oral (mouse) LD50: 2970 mg/kg[2]	Not Available

potassium ferrocyanide trihydrate

TOXICITY	IRRITATION
Oral (rat) LD50: 6400 mg/kg[2]	Not Available

Legend:	*1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2.* Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances*

POTASSIUM CHLORIDE	The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.
POTASSIUM FERROCYANIDE TRIHYDRATE	No significant acute toxicological data identified in literature search.
YSI 3682 Zobell Solution & POTASSIUM FERRICYANIDE(III) & POTASSIUM FERROCYANIDE TRIHYDRATE	Asthma-like symptoms may continue for months or even years after exposure to the material ends. This may be due to a non-allergic condition known as reactive airways dysfunction syndrome (RADS) which can occur after exposure to high levels of highly irritating compound. Main criteria for diagnosing RADS include the absence of previous airways disease in a non-atopic individual, with sudden onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. Other criteria for diagnosis of RADS include a reversible airflow pattern on lung function tests, moderate to severe bronchial hyperreactivity on methacholine challenge testing, and the lack of minimal lymphocytic inflammation, without eosinophilia. RADS (or asthma) following an irritating inhalation is an infrequent disorder with rates related to the concentration of and duration of exposure to the irritating substance. On the other hand, industrial bronchitis is a disorder that occurs as a result of exposure due to high concentrations of irritating substance (often particles) and is completely reversible after exposure ceases. The disorder is characterized by difficulty breathing, cough and mucus production.

Acute Toxicity	⊘	**Carcinogenicity**	⊘
Skin Irritation/Corrosion	✓	**Reproductivity**	⊘

Serious Eye Damage/Irritation	✓	**STOT - Single Exposure**	✓
Respiratory or Skin sensitisation	⊘	**STOT - Repeated Exposure**	⊘
Mutagenicity	✓	**Aspiration Hazard**	⊘

Legend:
✗ *– Data available but does not fill the criteria for classification*
✓ *– Data available to make classification*
⊘ *– Data Not Available to make classification*

SECTION 12 ECOLOGICAL INFORMATION

Toxicity

YSI 3682 Zobell Solution

ENDPOINT	TEST DURATION (HR)	SPECIES	VALUE	SOURCE
Not Available	Not Available	Not Available	Not Available	Not Available

potassium chloride

ENDPOINT	TEST DURATION (HR)	SPECIES	VALUE	SOURCE
LC50	96	Fish	29.8000mg/L	4
EC50	48	Crustacea	83mg/L	4
EC50	96	Algae or other aquatic plants	1337mg/L	4
NOEC	48	Crustacea	240.45mg/L	4

potassium ferricyanide(III)

ENDPOINT	TEST DURATION (HR)	SPECIES	VALUE	SOURCE
LC50	96	Fish	2.8mg/L	4
EC50	72	Algae or other aquatic plants	0.127mg/L	4
NOEC	72	Algae or other aquatic plants	0.031mg/L	4

potassium ferrocyanide trihydrate

ENDPOINT	TEST DURATION (HR)	SPECIES	VALUE	SOURCE
LC50	96	Fish	33.0mg/L	4
EC50	72	Algae or other aquatic plants	0.267mg/L	4
NOEC	72	Algae or other aquatic plants	0.031mg/L	4

Legend: *Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 (QSAR) - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data*

Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Do NOT allow product to come in contact with surface waters or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment wash-waters.
Wastes resulting from use of the product must be disposed of on site or at approved waste sites.
For Complex Metallocyanides:
Environmental Fate: Metallocyanide complexes have a wide range of stabilities. Cobaltocyanide is difficult to destroy with highly destructive acid distillation in the laboratory. Metallocyanide complexes must be regarded as a delayed source of free cyanide in natural aquatic systems which will be released under certain conditions (e.g., ultraviolet irradiation, decreased pH, increased temperature) regardless of stability.
Atmospheric Fate: The iron cyanides are very stable but exhibit photodecomposition. In the presence of sunlight they dissociate to release the cyanide ion, thus affecting toxicity; at night the reaction may reverse to produce a less toxic form or state. Cyanide complexes of iron dissociate very little, but they are subject to photolysis by natural light.
Aquatic Fate: Zinc [Zn(CN)4-2] and cadmium [Cd(CN)3 - and Cd(CN)4-2] complexes dissociate rapidly and nearly completely in dilute solutions. Moderately stable complexes include copper [Cu(CN)2 - and Cu(CN)3 -2], nickel [Ni(CN)4 -2], and silver [Ag (CN)2-2]. The most stable complexes include iron [Fe(CN)6-4] and cobalt [Co(CN)6-4]. Release of cyanide ion by photodecomposition might be important in relatively clean receiving waters. Complex metallocyanide ions in solution can be dissociated or decomposed to release free cyanide ion that forms hydrogen cyanide (HCN) through hydrolytic reactions in water. The concentration of HCN may change due to exposure to natural light, changes in pH or hardness, or because of increased dilution of the complex.
Ecotoxicity: The effect of pH on the toxicity of metallocyanides is complex. An increase in pH from 7.4 to 7.8 reduces the toxicity of cyanonickelate by ten- to 13-fold. The likelihood of predicting the toxicity of a complex effluent containing metallocyanides from its chemical analysis is remote. Toxicity tests on metallocyanides alone must be carried out with very precise pH control.
Ferrocyanide ion is toxic to fish. The US EPA recommends that ferrocyanide levels in water be maintained below 2 ppm. [OHMTADS]
DO NOT discharge into sewer or waterways.

Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
potassium chloride	HIGH	HIGH

Bioaccumulative potential

Ingredient	Bioaccumulation
potassium chloride	LOW (LogKOW = -0.4608)

Mobility in soil

Ingredient	Mobility
potassium chloride	LOW (KOC = 14.3)

Continued...

SECTION 13 DISPOSAL CONSIDERATIONS

Waste treatment methods

Product / Packaging disposal	‣ Containers may still present a chemical hazard/ danger when empty. ‣ Return to supplier for reuse/ recycling if possible. Otherwise: ‣ If container can not be cleaned sufficiently well to ensure that residuals do not remain or if the container cannot be used to store the same product, then puncture containers, to prevent re-use, and bury at an authorised landfill. ‣ Where possible retain label warnings and SDS and observe all notices pertaining to the product. Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked. A Hierarchy of Controls seems to be common - the user should investigate: ‣ Reduction ‣ Reuse ‣ Recycling ‣ Disposal (if all else fails) This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use. Shelf life considerations should also be applied in making decisions of this type. Note that properties of a material may change in use, and recycling or reuse may not always be appropriate. In most instances the supplier of the material should be consulted. ‣ **DO NOT** allow wash water from cleaning or process equipment to enter drains. ‣ It may be necessary to collect all wash water for treatment before disposal. ‣ In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first. ‣ Where in doubt contact the responsible authority.

SECTION 14 TRANSPORT INFORMATION

Labels Required

Marine Pollutant	NO

Land transport (DOT): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Air transport (ICAO-IATA / DGR): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Sea transport (IMDG-Code / GGVSee): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Transport in bulk according to Annex II of MARPOL and the IBC code

Not Applicable

SECTION 15 REGULATORY INFORMATION

Safety, health and environmental regulations / legislation specific for the substance or mixture

POTASSIUM CHLORIDE(7447-40-7) IS FOUND ON THE FOLLOWING REGULATORY LISTS

US Toxic Substances Control Act (TSCA) - Chemical Substance Inventory
US TSCA Chemical Substance Inventory - Interim List of Active Substances

POTASSIUM FERRICYANIDE(III)(13746-66-2) IS FOUND ON THE FOLLOWING REGULATORY LISTS

US - Alaska Limits for Air Contaminants
US - California Permissible Exposure Limits for Chemical Contaminants
US - Hawaii Air Contaminant Limits
US - Michigan Exposure Limits for Air Contaminants
US - Minnesota Permissible Exposure Limits (PELs)
US - Oregon Permissible Exposure Limits (Z-1)
US - Pennsylvania - Hazardous Substance List
US - Rhode Island Hazardous Substance List
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants
US - Washington Permissible exposure limits of air contaminants
US ACGIH Threshold Limit Values (TLV)
US List of Active Substances Exempt from the TSCA Inventory Notifications (Active-Inactive) Rule
US Toxic Substances Control Act (TSCA) - Chemical Substance Inventory

POTASSIUM FERROCYANIDE TRIHYDRATE(14459-95-1) IS FOUND ON THE FOLLOWING REGULATORY LISTS

US - Pennsylvania - Hazardous Substance List
US Toxic Substances Control Act (TSCA) - Chemical Substance Inventory
US TSCA Chemical Substance Inventory - Interim List of Active Substances

ECHA SUMMARY

Ingredient	CAS number	Index No	ECHA Dossier
potassium chloride	7447-40-7	Not Available	01-2119539416-36-XXXX|01-2120104951-64-XXXX

Harmonisation (C&L Inventory)	Hazard Class and Category Code(s)	Pictograms Signal Word Code(s)	Hazard Statement Code(s)
1	Not Classified	Not Available	Not Available

Harmonisation Code 1 = The most prevalent classification. Harmonisation Code 2 = The most severe classification.

Ingredient	CAS number	Index No	ECHA Dossier
potassium ferricyanide(III)	13746-66-2	Not Available	Not Available

Harmonisation (C&L Inventory)	Hazard Class and Category Code(s)	Pictograms Signal Word Code(s)	Hazard Statement Code(s)
1	Skin Irrit. 2; Eye Irrit. 2; STOT SE 3	GHS07; Wng	H315; H319; H335

Continued...

Harmonisation Code 1 = The most prevalent classification. Harmonisation Code 2 = The most severe classification.

Ingredient	CAS number	Index No	ECHA Dossier
potassium ferrocyanide trihydrate	14459-95-1	Not Available	Not Available

Harmonisation (C&L Inventory)	Hazard Class and Category Code(s)	Pictograms Signal Word Code(s)	Hazard Statement Code(s)
1	Aquatic Chronic 2	GHS09	H411
1	Aquatic Chronic 3		H412
1	Aquatic Chronic 3		H412

Harmonisation Code 1 = The most prevalent classification. Harmonisation Code 2 = The most severe classification.

Federal Regulations

Superfund Amendments and Reauthorization Act of 1986 (SARA)

SECTION 311/312 HAZARD CATEGORIES

Flammable (Gases, Aerosols, Liquids, or Solids)	No
Gas under pressure	No
Explosive	No
Self-heating	No
Pyrophoric (Liquid or Solid)	No
Pyrophoric Gas	No
Corrosive to metal	No
Oxidizer (Liquid, Solid or Gas)	No
Organic Peroxide	No
Self-reactive	No
In contact with water emits flammable gas	No
Combustible Dust	No
Carcinogenicity	No
Acute toxicity (any route of exposure)	No
Reproductive toxicity	No
Skin Corrosion or Irritation	Yes
Respiratory or Skin Sensitization	No
Serious eye damage or eye irritation	Yes
Specific target organ toxicity (single or repeated exposure)	No
Aspiration Hazard	No
Germ cell mutagenicity	Yes
Simple Asphyxiant	No

US. EPA CERCLA HAZARDOUS SUBSTANCES AND REPORTABLE QUANTITIES (40 CFR 302.4)

None Reported

State Regulations

US. CALIFORNIA PROPOSITION 65

None Reported

National Inventory Status

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (potassium chloride; potassium ferricyanide(III); potassium ferrocyanide trihydrate)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	Y
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
Legend:	*Y = All ingredients are on the inventory* *N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)*

SECTION 16 OTHER INFORMATION

Revision Date	09/27/2018
Initial Date	09/21/2018

Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

Definitions and abbreviations

PC－TWA: Permissible Concentration-Time Weighted Average
PC－STEL: Permissible Concentration-Short Term Exposure Limit
IARC: International Agency for Research on Cancer
ACGIH: American Conference of Governmental Industrial Hygienists
STEL: Short Term Exposure Limit
TEEL: Temporary Emergency Exposure Limit。
IDLH: Immediately Dangerous to Life or Health Concentrations
OSF: Odour Safety Factor
NOAEL :No Observed Adverse Effect Level
LOAEL: Lowest Observed Adverse Effect Level
TLV: Threshold Limit Value
LOD: Limit Of Detection
OTV: Odour Threshold Value
BCF: BioConcentration Factors
BEI: Biological Exposure Index

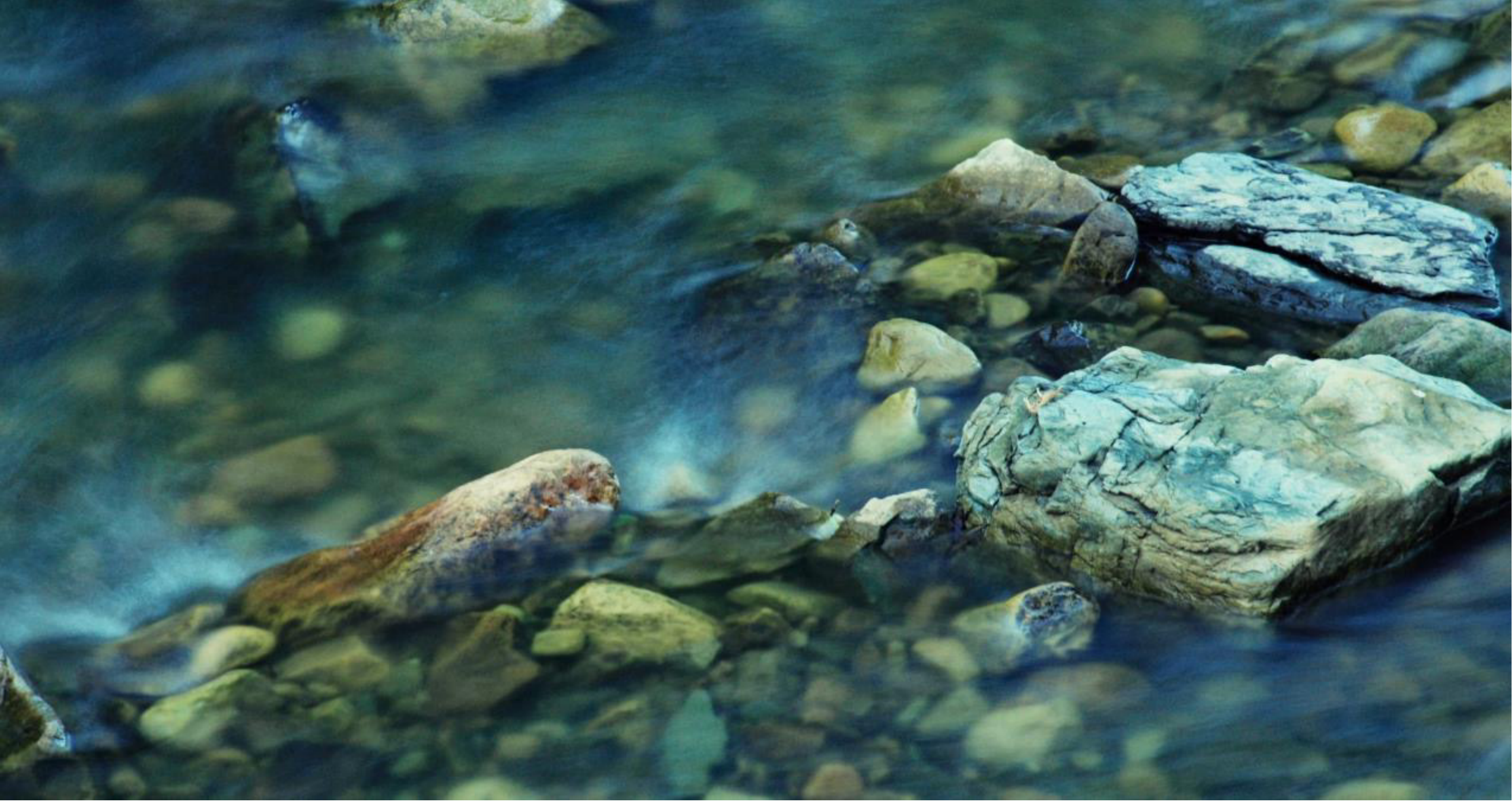
YSI, a Xylem brand cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.
Powered by AuthorITe, from Chemwatch.

Attachment D
Certifications

Certifications for applicable staff to be added prior to commencement of field activities.

Attachment E

Pandemic and Epidemic Safety Plan



November 2022

Pandemic and Epidemic Safety Plan

PLAYING IT SAFE

Stop Play Record Rewind

November 2022

Pandemic and Epidemic Safety Plan

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TABLES

ABBREVIATIONS

CDC	U.S. Centers for Disease Control and Prevention
EPA	U.S. Environmental Protection Agency
H&S	Health and Safety
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment

1 Introduction and Background

Anchor QEA, LLC, and all subsidiaries (Anchor QEA) has developed this Pandemic and Epidemic Safety Plan, which applies to both office and field work. The objective of this Safety Plan is to provide operational guidelines that address the challenges presented by a pandemic or epidemic and ensure consistency in Anchor QEA's response actions across the firm. We have developed this Safety Plan to support operational efforts. There are a lot of issues to consider, but the underlying priority is protecting employees, coworkers, and families. This plan will be applied pre- and post-pandemic in addition to during a designated pandemic or epidemic at the discretion of the Health and Safety (H&S) Program Lead, Director of Health and Safety, Chief Executive Officer, and/or Managing Committee. This plan may require periodic updates as conditions change.

These guidelines take the recommendations from the U.S. Centers for Disease Control and Prevention (CDC) into account, in addition to local and state laws and requirements. The following principles are the basis of the operational guidelines presented in this Safety Plan:

- Apply operational decisions consistent with applicable orders, requirements, and regulations.
- Require anyone who is sick to stay home.
- Focus on efforts to protect all employees.
- Require employees and visitors to self-check prior to entry.
- Evaluate guidelines and communication protocols for those buildings with common areas not in Anchor QEA's control.
- Clean, disinfect, and evaluate ventilation systems.
- Provide sustainable supplies of hand sanitizer, disinfectant wipes, and other personal cleaning supplies.
- Communicate immediately to office staff, visitors, and building management of a primary exposure situation as appropriate.
- Implement contact tracing of employees who have been confirmed or presumptive confirmed.
- Continue field work in accordance with this Safety Plan.
- Field programs will follow this Safety Plan unless the client, prime contractor, federal, state, or local government establish more restrictive measures, in which case the more restrictive measures will be followed.
- Updated information can be found at the CDC website (https://www.cdc.gov/), as well as state and local health agency websites.
- Field project schedules, modifications, and regulatory requirements will be discussed with the client representatives.
- All personnel have Stop Work Authority.

2 Plan Requirements

The objective of this Safety Plan is to provide operational guidelines that address pandemics and epidemics in addition to maintaining consistency in Anchor QEA's response actions across the organization.

If you have questions or concerns, please direct those to your Office Lead, Staff Manager, Project Manager, or H&S Program Lead.

Some site owners or prime contractors may conduct temperature readings or screening prior to entering an office or site, which is in accordance with some current guidance. Some site owners or prime contractors may want to record actual temperature readings, test results, or information other than general "yes" or "no" questions related to travel, symptoms, vaccination status, or other items. If you choose not to participate in the recording of screening information, the site owner or prime contractor may not allow you to access the site. You should immediately contact your Field Lead, Staff Manager, or Project Manager to discuss alternative work and available options.

Prior to Coming to Work

If an employee has had close contact with a confirmed case within the prior 10 days, we require that they be cleared by WorkCare through the screening process:

- **Regardless of vaccination status, if employees feel that they are sick or showing symptoms, they are required to stay home and not report to work (office or field).**
  - If employees are showing symptoms, they are to contact WorkCare and/or their healthcare provider for medical advice. If employees feel the need to visit a medical professional, it is recommended that the medical office be contacted first to determine when it is appropriate to visit.
  - They should call their Staff Manager immediately and notify them that they are sick. Showing up to work with symptoms will result in the employee being asked to leave to avoid potentially exposing others to an infectious disease.
- If employees show any symptoms while at work, they will be asked to leave and not return until they have been cleared by WorkCare.
- Exposure to, or close contact with, means being within 6 feet of an individual for 15 minutes or greater in a 24-hour period or being exposed to their cough or sneeze.
- If you meet the criteria listed for Primary or Secondary exposure listed in the Case Response section, you should take the following measures:
  - Do not report to work until cleared by WorkCare.
  - Contact your Staff Manager and Health and Safety.

- If masks (i.e., N95 or KN95) are used, they should be used in accordance with the Occupational Safety and Health Administration (OSHA) standard 1910.120, stating, in part, that the user must be fit-tested and in a surveillance program. However, if employees wish to provide their own N95 or KN95 mask, they must complete appropriate acknowledgements with Health and Safety prior to use.

Vaccination Policy

People are considered fully vaccinated 2 weeks after they have received the second dose in a two-dose series, or 2 weeks after they have received a single-dose vaccine. People are asked to maintain current vaccination by receiving a booster dose when eligible.

At this time, Anchor QEA does not require employees to be vaccinated except where required by law or regulation. However, there are locations and projects that may require additional vaccinations or an approved accommodation. In those cases, Anchor QEA will follow those requirements and only assign employees who meet the necessary requirements. For employees to be considered fully vaccinated against an infectious disease, their information must be uploaded to the WorkCare screening portal or recorded in other designated locations.

Screening

A daily self-check protocol is being instituted to replace the daily screening through WorkCare in an attempt to prevent sick or symptomatic employees from coming to work and spreading infection. Employees will self-check themselves for any symptoms that could be consistent with an infectious disease as listed in this plan or by CDC. If an employee has symptoms that could be consistent with disease, they are not to report to work, and if already at work, they should notify their Staff Manager and Health and Safety or Human Resources and return home. They should complete a Risk Stratification Survey through WorkCare and not return until cleared. Employees who report for work are stating that they do not have symptoms that could be consistent with an infectious disease, or they have been cleared by a healthcare professional.

Visitors

- Visitors are allowed; however, if they have any symptoms that could be consistent with an infectious disease they should not visit.
- Meetings with outside parties should take place virtually, when possible.
- Delivery personnel must follow all current protocols.

Case Response

According to the CDC, symptoms can appear 2 to 14 days after exposure. Symptoms or combinations of symptoms that may be consistent with an infectious disease include the following:

- Fever (100.4°F [37.8°C] or greater) or chills
- Cough
- Shortness of breath or difficulty breathing
- Fatigue
- Muscle or body aches (longer than 48 hours)
- Headache
- Sore throat
- Congestion or runny nose
- Nausea or vomiting
- Diarrhea
- New loss of taste or smell
- Positive test

If you have symptoms that are consistent with the above or others designated by CDC but have not tested positive, regardless of vaccination status, you are to not go into work until you have been cleared to return by WorkCare. Immediately contact your Staff Manager and Health and Safety or Human Resources. You should additionally contact the Project Manager if working in the field for a project.

Regarding exposures, there are two general scenarios that now apply, as follows:

1. **Primary Exposure:** These are employees who have tested positive for or have symptoms consistent with an infectious disease. If you have tested positive for an infectious disease, you must be in self-isolation and those with whom you have had close contact in the work environment within the time specified by the CDC and/or WorkCare will be notified. Health and Safety will work with the Office Lead and Human Resources to notify the Anchor QEA employees (and building management if applicable) who were identified. Project Managers will be responsible for notification of clients and other contractors with whom you were in close contact. You must not return to work until you have been cleared by WorkCare. The exception to this would be if your primary physician recommends more restrictive measures.
2. **Secondary Exposure:** These are employees who, within the time specified by the CDC and/or WorkCare, have had close contact with someone who has tested positive for an infectious disease or has symptoms consistent with an infectious disease. You must follow the direction of WorkCare and may not return to work until cleared by WorkCare. If you start to have symptoms or test positive, follow the appropriate guidance for Primary Exposure noted above.

In the event there is a documented case of an employee becoming infected with an infectious disease or symptoms consistent with an infectious disease (Primary Exposure), management will take immediate action as follows:

- The employee should be immediately self-isolated until they have been cleared by WorkCare.
- Notify the Staff Manager, Health and Safety, and Project Manager (if in the field) immediately.
- The employee will identify those with whom they have had close contact in the work environment within the time specified by CDC and/or WorkCare.
- Employees who came in close contact with the individual will be notified. Health and Safety will work with the Office Lead and Human Resources to notify the Anchor QEA employees who were identified. Project Managers will be responsible for notification of clients and other contractors with whom the individual was in close contact.
- Confidentiality for the employee should be maintained.

If an employee has had close contact with someone diagnosed with an infectious disease (Secondary Exposure) within the current time specified by the CDC and/or WorkCare, the Staff Manager, Office Lead, and/or Health and Safety will take immediate action as follows:

- If the employee is asymptomatic, have them wear a well-fitting face covering until 10 days have passed since the exposure.
- If the employee tests positive or develops symptoms, this becomes a Primary Exposure scenario, and that guidance should then be followed.

Workplace Requirements

All work locations are to follow the guidance in this document at a minimum. In locations where state or local requirements require specific plans, forms, risk evaluations, or other documents, those documents will be prepared for those specific instances. For field projects, follow the site-specific Health and Safety Plan personal protective equipment (PPE) requirements in addition to this document.

Travel Considerations

Travel will be considered based upon the current levels of transmission, restrictions, and overall risk to the employees at the time. They may range from no restrictions to stopping all travel.

- Employees must follow the same prevention guidelines off site, which includes travel, hotel, and other activities, to address potential exposures outside the workplace.
- When at hotels, consider disinfecting your own room with U.S. Environmental Protection Agency (EPA)-registered cleaners or alternatives, and consider using the "No Housekeeping" sign to minimize the people coming into your room.
- When traveling, follow all requirements in place for the location(s) that you visit, including any requirements for transportation to include air travel.

Face Covering and Physical Distancing Requirements

- As always, regardless of whether required at the time, individuals are permitted to wear a face covering if they desire as long as there is no safety risk.
- In some instances, a location, local area, or state may have more restrictive requirements in place. All individuals must follow the more restrictive requirements in those cases.
- Those who are at high or increased risk should consult with their healthcare provider about whether they need to wear a mask/face covering or take other precautions.
- Physical distancing, 6 feet or greater, is also an effective method to reduce the risk associated with contracting an infectious disease.
- All employees should have a face covering available in case they are requested to wear one when in close contact or enclosed situations.

Designated Coordinators

Anchor QEA will designate the following Coordinators in the workplace:

- For office locations, the Office Lead will be the Coordinator with support from the H&S Office Representative(s).
- For field sites, the Field Lead or Senior Person will be the Coordinator with support from the Project Manager.
- The H&S Program Lead and H&S Coordinator(s) will be the Corporate Coordinators with support from the Task Force and Managing Committee.

The responsibilities of the Coordinators are as follows:

- Ensure that information on required workplace safety protocols is provided to employees and all other individuals likely to be present at workplaces.
  - Communicate the required workplace safety protocols and related policies by email, websites, memoranda, flyers, or other means, and post signage at covered workplaces that sets forth the requirements and workplace safety protocols in a readily understandable manner as necessary.
  - This includes communicating the workplace safety protocols and requirements related to face coverings and physical distancing to visitors and all other individuals present at workplaces.
- If the designated Coordinator (or support person) becomes aware of individuals failing to comply with the requirements established at that time, do the following:
  - Ask the individual to comply.
  - If they still do not wish to comply, ask them to leave the workplace.
    - If they are a visitor ensure their company is notified.
    - If they are an employee notify Human Resources.

- If a location has more restrictive requirements, individuals will follow the more restrictive requirements.

The Corporate Coordinators will also be responsible for the following:

- Work with WorkCare and/or others to maintain proper vaccination documentation as appropriate.
- Provide support to the office and field Coordinators.

Prevention and Cleaning Requirements

An important step to control spread of the virus in the workplace focuses on hygiene and cleaning:

- All employees and management staff will follow CDC guidance regarding hand washing: https://www.cdc.gov/handwashing/index.html. Sanitizing wipes or gel will be made readily available around the office.
- All employees will be responsible for multiple daily cleaning of high-touch surfaces.
- Employees should follow published guidance to limit transmission outside of and at work: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html.
- The following link provides a list of EPA-recommended cleaning products able to kill the virus, as well as some initial guidance with alternatives if supplies run out: https://cfpub.epa.gov/wizards/disinfectants/. If these products are not available, then either a diluted bleach solution or 70% alcohol solution will work. The following link provides general recommendations for routine cleaning and disinfection: https://www.cdc.gov/coronavirus/2019-ncov/community/disinfecting-building-facility.html#anchor_1617548446719.
- Catch coughs and sneezes with a disposable tissue, etc. and throw away, then wash hands. If tissues are not available, direct coughs and sneezes into elbow.
- Avoid touching your own mouth, nose, or eyes.
- All employees will have their own PPE and will not share with others. Respirators and PPE will be cleaned/disinfected when doffing, along with a thorough arm, hand, and face washing when exiting.

Disinfection

- A sustainable supply of disinfectant wipes will be available for employees to wipe down surfaces that are touched in restrooms and other common areas when they leave the area.
- Staff Managers should still maintain regular contact with personnel even when they return to the office.

Table 1
Supply Recommendations

Item	Specifications	Required On-Hand Quantity*
Face coverings	Face coverings meeting CDC guidelines. Employees are responsible for their own face coverings and cleaning because use outside the office (on the bus, at the store, getting coffee, on the elevator) is important to avoid bringing the virus to the office.	Anchor QEA will provide face coverings as necessary.
Gloves	Disposable gloves of sufficient material to be used when cleaning common touch surfaces	Sustainable supply
Disinfectant spray or wipes	Wipes or manufactured disinfecting material. If using a solution, it must meet EPA guidance and be made fresh daily.	Sustainable supply
Hand sanitizer and motion sensor-activated dispensers	Hand sanitizer meeting CDC guidelines	Sustainable supply
Hand soap	Premanufactured soap available at various sink locations	Sustainable supply
Paper towels	Rolls or refills for hand towel machines that are already in place or are installed prior to opening	Sustainable supply
Spray bottles	Spray containers for use with disinfectant solutions that are mixed on site	As needed; sustainable supply

Note:
*Required On-Hand Quantity must be maintained in a sustainable supply. When quantities drop to a critical level and quantities cannot be immediately increased, appropriate actions should be taken.

Table 2
Office Responsibilities

Responsibility	Responsible Person(s)	Comments
Tracking State Requirements	Office Lead or Project Manager	
Office Reclosure	Office Lead, Anchor QEA Managing Committee, and/or H&S Program Lead	"Stop Work" can be applied as necessary
Office Access	Office Lead	
Workspace Configurations	Office Lead or Project Manager	
Shared Areas	Office Lead or Project Manager	
Staff Office Rotations	Office Lead or Project Manager	If needed
Screening (Staff/Visitors) – Oversight	Office Lead or Project Manager	
Local Field Project Staffing	Regional Leads, Project Managers, and Health and Safety	
Cleaning – Oversight	All	
Exposure Response (Source Tracing)	Health and Safety or Human Resources and Office Lead or Project Manager	
Office Procedures – Review and Modification	H&S Program Lead or Human Resources and Office Lead or Project Manager	If needed

3 Source Materials

CDC (Centers for Disease Control and Prevention), 2021. CDC website: cdc.gov.

Lear Corporation, 2020. *Safe Work Playbook: An interactive guide for COVID-19 Pandemic Preparedness and Response Second Edition*. June 26, 2020.

Lotito, M.J., M.J. Ackie, and B.J. Sarchet, 2020. *Back to Work? Assessing Whether, When and How to Re-Open for Business*. Littler Workplace Policy Institute. Webinar. April 27, 2020.

Safer Federal Workforce Task Force, 2021. *COVID-19 Workplace Safety: Guidance for Federal Contractors and Subcontractors*. September 24, 2021. Available at: https://www.saferfederalworkforce.gov/downloads/Draft%20contractor%20guidance%20doc_20210922.pdf

Attachment F

Field Program Wildfire Management Plan

Field Program Wildfire Management Plan

Date: ________________________________
Project No: ________________________________
Project Name: ________________________________

Wildfires can be a common threat in many areas of the country and we need to recognize this threat. If a local wildfire could endanger the field team, the non-essential work should be rescheduled. This Management Plan is intended to provide information needed to prepare and respond to a situation where wildfire smoke has inundated the area and the safety of outdoor activities needs to be evaluated. According to *Wildfire Smoke: A Guide For Public Health Officials* (California Air Resources Board et al. 2019), wildfire smoke is a mixture of air pollutants where particulate matter is the main concern. A large population can be exposed to smoke from a wildfire event; however, most healthy adults and children will recover quickly from wildfire smoke exposure. Certain portions of the population may be at greater risk of experiencing health effects.

"Wildfire behavior will vary depending on natural fuel type; fires in forest fuels can range from mild to severe and can spread very slowly or extremely rapidly depending on weather and fuel conditions. Wildfires in forests can last for weeks or months and are often the type that results in the most severe and longest duration air quality impacts. Smoke levels in populated areas can be difficult to predict" (California Air Resources Board et al. 2019).

Determining Potential for Harmful Exposure

When there are wildfires and/or smoke in the area where outdoor work is to be performed, the Field Lead, or designee, will access air quality conditions at the beginning of each shift at a minimum. This will occur more frequently depending on conditions.

The current and forecasted Air Quality Index (AQI) can be found at https://www.airnow.gov/. The AQI is a metric that ranges from 0 to 500. The AQI value increases as the amount of particulate matter in the air increases (Air Now 2020).

Anchor QEA's policy will be to avoid non-essential field work when the AQI is 101 or greater. The use of controls (N95 masks) during smoky conditions in order to continue with field work will not be implemented when the AQI is greater than 150. For work to continue with an AQI between 101 and 150, justification must be established as to why the work cannot be delayed until conditions improve.

Responsibility is taken, not given. Take responsibility for safety.

Recommended Response Based on AQI Values

QI Category (AQI Values)	Anchor QEA Recommended Response *
Good (0-50)	None
Moderate (51-100)	For most employees, no action. Employees who are aggravated by conditions should take appropriate actions. Continue to monitor situations.
Unhealthy for Sensitive Groups (101-150)	For most employees, no action. Employees who are part of sensitive groups should take appropriate actions. Continue to closely monitor situations.
Unhealthy (151-200)	Outdoor work in these locations should be discontinued without the use of additional controls. ** Closely monitor situations.
Very Unhealthy (201-300)	Outdoor work in these locations should be discontinued without the use of additional controls. ** Closely monitor situations.
Hazardous (> 300)	Outdoor work in these locations should be discontinued without the use of additional controls. ** Closely monitor situations.

NO outdoor work or activities should continue

Source: Air Now 2020

* For any conditions where smoke and ash are present in the air, tight-fitting dust-resistant safety glasses or chemical goggles should be used as necessary to prevent or minimize eye irritation.

** N95 or P100 respirators can help protect your lungs from smoke or ash (if fit tested and properly worn) (California Department of Public Health et al., not dated, *Wildfire Smoke Factsheet*).
If it is believed a respirator is needed for this purpose, work must be stopped and re-evaluated.
Additionally, the Project Manager and Health and Safety should be consulted prior to proceeding.

Evacuation Levels and Response

LEVEL I (1)

"EVACUATION or PROTECTION ALERT: A wildfire threat is in your area. It would be wise to consider planning and/or packing, in the event an evacuation becomes necessary" (U.S. Forest Service 2020).

LEVEL II (2)

"EVACUATION WARNING or NOTICE: High probability of a need to evacuate. You should prepare now by packing necessary items and preparing your family, pets, and vehicle for potential departure" (U.S. Forest Service 2020).

LEVEL III (3)

"EVACUATION REQUEST or ORDER: Occupants of the affected area(s) are asked to leave within a specified time period, by pre-designated route(s). Perimeter roadblocks are typically established" (U.S. Forest Service 2020).

When a Level I (1) is issued, work should be evaluated. Only essential necessary work should be performed with a pre-evacuation plan in place. If work is continued, conditions are to be re-evaluated at least every hour. No work is to be performed under a Level II (2) or III (3). Staff should not enter or evacuate areas designated as a Level II (2) or III (3).

General Measures / Guidance

- Conditions should be monitored for wildfires in the area where work is to be performed.
- Wildfire discussions are to be part of the daily safety briefing when conditions are present.
- Evacuation plans should be in place prior to needing to evacuate.
- If planning to use respirators, fit testing must be accomplished prior to needing to use them.
- When unsure about conditions, pause work and evacuate, as necessary.
- Pre-evacuation plans must include a primary and alternate route in addition to items that must be taken with the team.
- Everyone has "Stop Work Authority."

References

Air Now, 2020. AQI Basics. Accessed July 2020. Available at: https://www.airnow.gov/aqi/aqi-basics/.

California Department of Public Health, Department of Health & Human Services, Centers for Disease Control and Prevention, U.S. Forest Service, California Air Resources Board, Office of Environmental Health Hazard Assessment, U.S. Environmental Protection Agency. (n.d.). *Wildfire Smoke Factsheet: Protect Your Lungs from Wildfire Smoke or Ash*. EPA-452/F-18-002. Available at: https://www3.epa.gov/airnow/smoke_fires/respiratory-protection-508.pdf.

California Air Resources Board, California Office of Environmental Health Hazard Assessment, U.S. Centers for Disease Control and Prevention, U.S. Forest Service, and U.S. Environmental Protection Agency, 2019. *Wildfire Smoke: A Guide for Public Health Officials*. Research Triangle Park, North Carolina: United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Health and Environmental Impacts Division. EPA-452/R-19-901. Revised August 2019. Available at: https://www3.epa.gov/airnow/wildfire-smoke/wildfire-smoke-guide-revised-2019.pdf.

U.S. Forest Service, 2020. *General Descriptions for the Three Evacuation Levels*. Accessed July 2020. Available at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3852749.pdf.

Wildfire Management Plan Acknowledgement

Project Number: ____________________________________

Project Name: ____________________________________

My signature below certifies that I have read and understand the policies and procedures specified in this Field Program Wildfire Management Plan.

Date	Name (print)	Signature	Company

Responsibility is taken, not given. Take responsibility for safety.

Appendix D
Supporting Information for Proposed Sample Locations

Riverbank Boring Log

Sheet 1 of 2

PDI-134

Project: **Gasco Sediments**	Ground Surface Elevation (ft): **31.7 feet**	Logged By: **James Melton**
Project #: **000029-02.59**	Method/Borehole Diameter: **Rotosonic / 6 inches**	Northing: **705957.8668** Easting: **7623179.276**
Client: **Northwest Natural Gas Co.**	Drilling Orientation: **45 degree angle, W 32 E orientation**	Vertical Datum: **City of Portland (C.O.P.)**
Location: **Portland, Oregon**	Total Vertical Depth: **25.5 feet**	Horizontal Datum: **Oregon State Plane, NAD83, Int. Feet**
Contractor: **Holt Drilling, Inc.**	Total Length **36**	Completion Date: **11/20/2019**

In-situ Depth (feet)	Elevation (feet COP)	Vertical Sample Depth (Method)	Sample Interval at 45 degree angle (feet)	Recovery (Percent)	Sample ID (Time)	Lithology	**Sediment Description** (Density, Moisture, Color, Minor Consttuent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	% Gravel	% Sand	% Fines
0 1 2 3	31 30 29	0.0 to 3.5 (CB)	0.0 to 5.0	5.0/5.0 (100%)	PDI-134RAB-0-10-191120 (@ 1445)		0 to 9.1 feet: Gravelly SILT with sand (ML): Dry, stiff, reddish brown, gravelly, SILT with sand (ML), light sheen, slight odor. Low plasticity silt, well graded sand, angular and rounded gravels. Brown to light brown impacted wood debris present. (FILL)	45	5	50
4 5 6	28 27 26 25	3.5 to 7.0 (CB)	5.0 to 10.0	5.0/5.0 (100%)						
7 8 9 10	24 23 22	7.0 to 10.5 (CB)	10.0 to 15.0	4.0/5.0 (80%)	VOC @ 9.6'		9.1 to 20.2 feet: Gravelly SILT (ML): Moist, stiff, black, gravelly, SILT (ML) with lampblack, strong hydrocarbon-like-like odor. Low plasticity. 15% lampblack. (FILL)	35	-	65
11 12 13	21 20 19 18	10.5 to 14.0 (CB)	15.0 to 20.0	5.0/5.0 (100%)						
14 15 16 17	17 16 15	14.0 to 17.5 (CB)	20.0 to 25.0	5.0/5.0 (100%)	PDI-134RAB-10-20-191120 (@ 1530) VOC @ 15.0'					
18 19 20	14 13 12	17.5 to 21.0 (CB)	25.0 to 30.0	5.0/5.0 (100%)						

ANCHOR QEA

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206-287-9130

Notes:
1. Angled borings performed for collection of samples for chemical testing.
2. Sample depth measured as depth below ground surface, calculated as sample interval times sin(45°).
3. Sample interval measured along length of core barrel drilled at angle.
4. CB = Core Barrel, VOC = Volitile Oranic Compounds Sample, DUP = Duplicate sample, WC = Waste Characterization Sample. (Waste characterization samples taken over entire interval of core)

Riverbank Boring Log

PDI-134

Sheet 2 of 2

Project: **Gasco Sediments**	Ground Surface Elevation (ft): **31.7 feet**	Logged By: **James Melton**
Project #: **000029-02.59**	Method/Borehole Diameter: **Rotosonic / 6 inches**	Northing: **705957.8668** Easting: **7623179.276**
Client: **Northwest Natural Gas Co.**	Drilling Orientation: **45 degree angle, W 32 E orientation**	Vertical Datum: **City of Portland (C.O.P.)**
Location: **Portland, Oregon**	Total Vertical Depth: **25.5 feet**	Horizontal Datum: **Oregon State Plane, NAD83, Int. Feet**
Contractor: **Holt Drilling, Inc.**	Total Length **36**	Completion Date: **11/20/2019**

In-situ Depth (feet)	Elevation (feet COP)	Vertical Sample Depth (Method)	Sample Interval at 45 degree angle (feet)	Recovery (Percent)	Sample ID (Time)	Lithology	**Sediment Description** (Density, Moisture, Color, Minor Consttuent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	% Gravel	% Sand	% Fines
20 21 22	11 10	21.0 to 21.7(CB)	30.0 to 31.0	1.0/1.0 (100%)	PDI-134RAB-20-25.5-191120 (@ 1555)	▨	20.2 to 22.4 feet: CONCRETE: damp, very stiff to hard, grey CONCRETE debris with silt and lampblack, no sheen, hydrocarbon-like odor. (FILL)			
23	9	21.7 to 25.5 (CB)	31.0 to 36.0	5.0/5.0 (100%)		■	22.4 to 23.8 feet: LAMPBLACK (~65%) with gravelly sand: loose, wood debris, tar-like gummy material, trace blebs, no sheen when wet. (FILL)	15	20	65
24 25	8 7				VOC @ 24.8' WC @ 1615	⁘	23.8 to 25.5 feet: SAND (SP): Moist, loose, black, poorly graded SAND (SP) with 15% lampblack, no sheen, hydrocarbon-like odor. Medium grained sand, tar-like gummy material, trace small gravels and woody debris. (FILL)	5	80	15
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40	6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6 -7 -8						End of Boring at 25.5 feet.			

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Notes:
1. Angled borings performed for collection of samples for chemical testing.
2. Sample depth measured as depth below ground surface, calculated as sample interval times sin(45°).
3. Sample interval measured along length of core barrel drilled at angle.
4. CB = Core Barrel, VOC = Volitile Oranic Compounds Sample, DUP = Duplicate sample, WC = Waste Characterization Sample. (Waste characterization samples taken over entire interval of core)

Riverbank Boring Log

PDI-142

Sheet 1 of 2

Project: **Gasco Sediments**	Ground Surface Elevation (ft): **32.9 feet**	Logged By: **James Melton**
Project #: **000029-02.59**	Method/Borehole Diameter: **Rotosonic / 6 inches**	Northing: **705152.3823** Easting: **7624637.472**
Client: **Northwest Natural Gas Co.**	Drilling Orientation: **45 degree angle, N 11 E orientation**	Vertical Datum: **City of Portland (C.O.P.)**
Location: **Portland, Oregon**	Total Vertical Depth: **30.4 feet**	Horizontal Datum: **Oregon State Plane, NAD83, Int. Feet**
Contractor: **Holt Drilling, Inc.**	Total Length **43.0**	Completion Date: **11/12/2019**

In-situ Depth (feet)	Elevation (feet COP)	Vertical Sample Depth (Method)	Sample Interval at 45 degree angle (feet)	Recovery (Percent)	Sample ID (Time)	Lithology	**Sediment Description** (Density, Moisture, Color, Minor Consttuent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	% Gravel	% Sand	% Fines
0 1 2 3	32 31 30	0.0 to 3.5 (CB)	0.0 to 5.0	4.5/5.0 (90%)	PDI-142RAB-0-10-191112 (@ 1120) VOC @ 5.0'	▨	0 to 30.4 feet: SAND (SW). Dry, loose, brown, gravelly, well graded SAND (SW), no sheen, no odor. Fine to coarse, subangular gravel. (FILL) @0 to 1.0 ft: Fine rounded gravels. @1.0 ft: Grades to subrounded gravel.	5	95	-
4 5 6 7	29 28 27 26	3.5 to 7.0 (CB)	5.0 to 10.0	4.7/5.0 (94%)		▨				
8 9 10	25 24 23	7.0 to 10.5 (CB)	10.0 to 15.0	5.0/5.0 (100%)		▨	@8.4 ft: Grades to more gravel. @9.7 ft: Grades to reddish gray mottling. @10.1 ft: Grades to trace gravels.	15 5	85 95	- -
11 12 13 14	22 21 20 19	10.5 to 14.0 (CB)	15.0 to 20.0	5.0/5.0 (100%)	PDI-142RAB-10-20-191112 (@ 1200)	▨	@13.0 to 16.1 ft: Grades to light grayish brown. @13.6 ft: Black laminations, very slight hydrocarbon-like odor			
15 16 17	18 17 16	14.0 to 17.5 (CB)	20.0 to 25.0	5.0/5.0 (100%)	VOC @ 17.1'	▨	@16.1 to 17.3 ft: Grades to reddish orange and black sands.			
18 19 20	15 14 13	17.5 to 21.0 (CB)	25.0 to 30.0	5.0/5.0 (100%)		▨	@17.3 to 17.6 ft: Grades to damp. @17.6 to 24.9 ft: Dry, brown, medium to coarse sand, mixed with black sand, trace subangular gravels.	5	95	-

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Notes:
1. Angled borings performed for collection of samples for chemical testing.
2.Sample depth measured as depth below ground surface, calculated as sample interval times sin(45°).
3.Sample interval measured along length of core barrel drilled at angle.
4. CB = Core Barrel, VOC = Volitile Oranic Compounds Sample, DUP = Duplicate sample, WC = Waste Characterization Sample. (Waste characterization samples taken over entire interval of core)

Riverbank Boring Log

Sheet 2 of 2

PDI-142

Project: **Gasco Sediments**	Ground Surface Elevation (ft): **32.9 feet**	Logged By: **James Melton**
Project #: **000029-02.59**	Method/Borehole Diameter: **Rotosonic / 6 inches**	Northing: **705152.3823** Easting: **7624637.472**
Client: **Northwest Natural Gas Co.**	Drilling Orientation: **45 degree angle, N 11 E orientation**	Vertical Datum: **City of Portland (C.O.P.)**
Location: **Portland, Oregon**	Total Vertical Depth: **30.4 feet**	Horizontal Datum: **Oregon State Plane, NAD83, Int. Feet**
Contractor: **Holt Drilling, Inc.**	Total Length **43.0**	Completion Date: **11/12/2019**

In-situ Depth (feet)	Elevation (feet COP)	Vertical Sample Depth (Method)	Sample Interval at 45 degree angle (feet)	Recovery (Percent)	Sample ID (Time)	Lithology	**Sediment Description** (Density, Moisture, Color, Minor Consttuent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	% Gravel	% Sand	% Fines
20	13						0 to 30.4 feet: SAND (SW). Dry, loose, brown, well-graded SAND (SW), no sheen, no odor. Trace fine to medium, rounded gravel. (FILL)	5	95	-
21	12	21.0 to 24.5 (CB)	30.0 to 35.0	5.0/5.0 (100%)						
22	11									
23	10									
24	9									
25	8	24.5 to 28 (CB)	35.0 to 40.0	3.8/5.0 (76%)	PDI-142RAB-20-30.4-191112 (@ 1435)					
26	7									
27	6									
28	5	28 to 30.4 (CB)	40.0 to 43.0	3.0/3.0 (100%)			@28.0 to 30.4 ft: Grades to damp, gray to dark gray sand with tar-like material, strong hydrocarbon-like odor.	1	99	-
29	4						@28.6 to 28.9 ft: Lense of silty sand (4 inches), hydrocarbon-like odor, no sheen when wet.	5	65	30
30	3				VOC @ 30.2' DUP @ 30.2'		@30.2 ft: Rainbow sheen when wet.			
31	2						End of Boring at 30.4 feet.			
32	1									
33	0									
34	-1									
35	-2									
36	-3									
37	-4									
38	-5									
39	-6									
40	-7									

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Notes:
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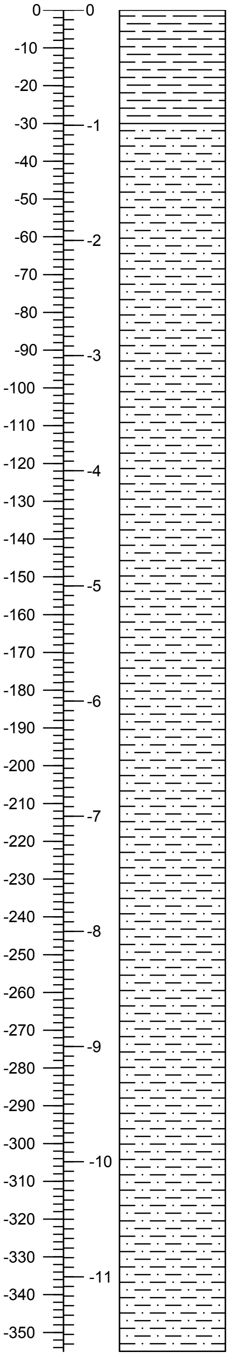
2. Sample depth measured as depth below ground surface, calculated as sample interval times sin(45°).
3. Sample interval measured along length of core barrel drilled at angle.
4. CB = Core Barrel, VOC = Volitile Oranic Compounds Sample, DUP = Duplicate sample, WC = Waste Characterization Sample. (Waste characterization samples taken over entire interval of core)

SEDIMENT CORE LOG

PROJECT: Portland Harbor RI/FS **CORE ID:** LW2-C273 **Page 1 of 1**

Collection Date:	10/20/2004	**Logged By:**	S.FitzGerald/J.Moore
Core Processing Date:	10/20/2004	**Mudline Elevation (NAVD88 ft):**	-9999.00
Core Tube Length (ft):	14	**Easting:**	7623605.42
Core Drive Length (ft):	13	**Northing:**	705868.79
Core Recovered Length (ft):	11.6	**Coordinate System:**	NAD83/91 Oregon State Plane North, International Feet

Core Depth (cm/ft) **Lithology**



Core Description	Grain Size % (G / S / Fines)	Sample ID		FID (ppm)	PID (ppm)
SILT: silt w/tr fine sand; stained black; strong odor; heavy sheen; wood debris @ 22cm, tr rootlets	0/<5/100	archived	LW2-C273-A	495	280
SILT w/sand: silt w/tr sand (v.fine-fine) in beds (up to 3cm thick) and laminae, sands decrease w/depth particularly below 200cm; med-high plasticity; med grayish brown; strong odor; heavy black staining in bands with heavy sheen and free product blebs, staining most pronounced to 81cm depth but is evident to 308cm, tar ball (2cm) @ 114cm; tr woody and plant debris, rootlets; sand est. @ 5-10% of unit overall	0/<25/>75	ANALYZED	LW2-C273-B	440	180
		ANALYZED	LW2-C273-C	1005	180
		archived	LW2-C273-D	866	189

SEDIMENT CORE LOG

PROJECT: Portland Harbor RI/FS
CORE ID: LW2-C278
Page 1 of 1

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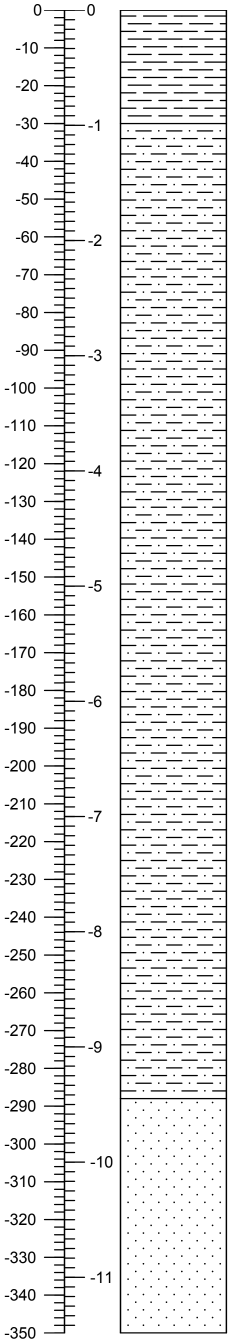
LWG Lower Willamette Group

Collection Date:	10/19/2004	**Logged By:**	S.FitzGerald/J.Moore
Core Processing Date:	10/19/2004	**Mudline Elevation (NAVD88 ft):**	-28.29
Core Tube Length (ft):	14	**Easting:**	7623909.4
Core Drive Length (ft):	13	**Northing:**	705763.02
Core Recovered Length (ft):	11.5	**Coordinate System:**	NAD83/91 Oregon State Plane North, International Feet

Core Depth (cm/ft) | **Lithology**



Core Description	Grain Size % (G / S / Fines)	Sample ID		FID (ppm)	PID (ppm)
SILT: silt w/tr fine sand, tr methane vesicles; soft; med grayish brown; tr rootlets	0/<5/100	archived	LW2-C278-A	2700	40
SILT w/sand: silt as above, w/thin sand (fine) laminae, sand bodies increase w/depth to ~0/50/50; mod stiff, med plast; med grayish brown; strong odor; black stain w/mod sheen associated w/sands, black lens @ 124cm (tarry or silty), free product lenses between 174-185cm; sand est. @ 10% of unit, abrupt basal contact	0/<25/>75	ANALYZED	LW2-C278-B	1680	42
		ANALYZED	LW2-C278-C	830	75+
SAND: fine sand, well sorted, tr silt lenses and silt bed in bottom 3cm; mod dense; v.dk gray; tr sheen florets	0/100/<5	ANALYZED	LW2-C278-D	1170	60+

SEDIMENT CORE LOG

PROJECT: Portland Harbor RI/FS **CORE ID:** LW2-C301 **Page 1 of 2**

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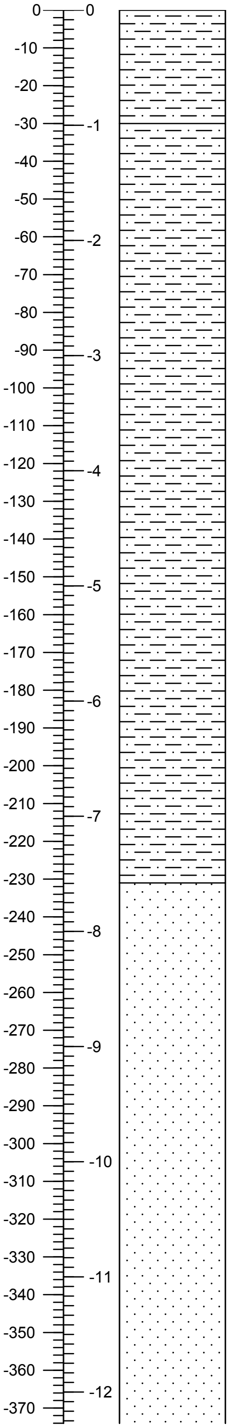
LWG LOWER WILLAMETTE GROUP

Collection Date:	11/08/2004	**Logged By:**	S.FitzGerald/J.Moore
Core Processing Date:	11/08/2004	**Mudline Elevation (NAVD88 ft):**	-4.90
Core Tube Length (ft):	20	**Easting:**	7624555.66
Core Drive Length (ft):	19	**Northing:**	705332.78
Core Recovered Length (ft):	16.9	**Coordinate System:**	NAD83/91 Oregon State Plane North, International Feet

Core Depth (cm/ft) · **Lithology**



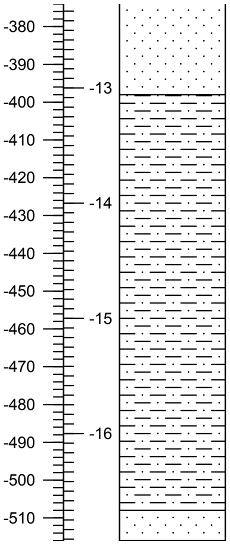
Core Description	Grain Size % (G / S / Fines)	Sample ID		FID (ppm)	PID (ppm)
SILT w/sand: silt, tr fine sand, w/sand bed from 21-22cm, tr methane vesicles; soft; med grn brn (olive); strong odor (naphth); sand bed stained black, heavy sheen	0/<25/>75	archived	LW2-C301-A	NA	71
SILT w/sand: silt as above, w/sand laminae and lenses, sand bed w/silt from 175-198cm; soft; med grn brn (olive); strong odor; bands of black stain, heavy sheen, sand bed is heavily stained w/ heavy sheen, free product occurs in lenses @ 45cm,57cm, 81-92cm, 140-144cm, 194-198cm, 220cm; a zone of highly plastic material (black with glossy sfc) occurs from 151-161cm; woody plant debris and lumber debris occurs in laminae; sand est @ 10-15% overall	0/<25/>75	ANALYZED	LW2-C301-B	NA	215
		ANALYZED	LW2-C301-C	NA	579
SAND: fine sand, tr silt lenses; sticky,dense; dk-v.dk gray; heavy stain and sheen, tarry lens from 303-306cm, free product from 378-390cm; abrupt, inclined basal contact from 394-398cm	0/100/<5	ANALYZED	LW2-C301-D	NA	1249
		ANA	LW2-C301-E	NA	1128

SEDIMENT CORE LOG

PROJECT:	Portland Harbor RI/FS	**CORE ID:**	LW2-C301	**Page 2 of 2**
Collection Date:	**11/08/2004**	**Logged By:**	**S.FitzGerald/J.Moore**	
Core Processing Date:	**11/08/2004**	**Mudline Elevation (NAVD88 ft):**	**-4.90**	
Core Tube Length (ft):	**20**	**Easting:**	**7624555.66**	
Core Drive Length (ft):	**19**	**Northing:**	**705332.78**	
Core Recovered Length (ft):	**16.9**	**Coordinate System:**	**NAD83/91 Oregon State Plane North, International Feet**	

integral consulting inc

LWG LOWER WILLAMETTE GROUP

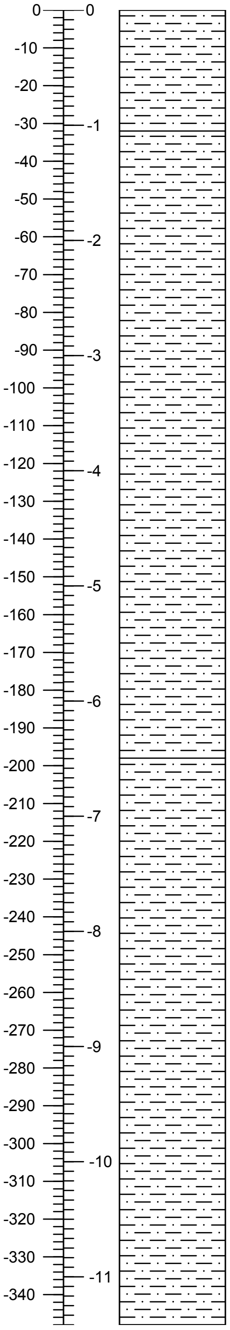


Core Depth (cm/ft)	**Lithology**	**Core Description**	**Grain Size % (G / S / Fines)**		**Sample ID**	**FID (ppm)**	**PID (ppm)**
				LYZED			
		SILT w/sand: silt w/fine sand laminae; med gr brn; thin (<0.5cm) bands of black stain and heavy sheen from 391-397cm, and @ 465cm, 491cm, 497cm and 508cm, free product @ 411cm; large piece of wood (stick) @ 411cm; sand (fine) est. @ 10%, light tan silt lenses @ 425cm	0/<25/>75	archived	LW2-C301-F	NA	150
				ANALYZED	LW2-C301-G	NA	375
		SAND: fine sand, tr silt; (color not noted); light sheen lenses	0/100/<5				

SEDIMENT CORE LOG

PROJECT:	Portland Harbor RI/FS	**CORE ID:**	LW2-C302
			Page 1 of 1
Collection Date:	**09/21/2004**	**Logged By:**	**S.FitzGerald/J.Moore**
Core Processing Date:	**09/22/2004**	**Mudline Elevation (NAVD88 ft):**	**-5.83**
Core Tube Length (ft):	**14**	**Easting:**	**7624629.05**
Core Drive Length (ft):	**13**	**Northing:**	**705300.94**
Core Recovered Length (ft):	**11.4**	**Coordinate System:**	**NAD83/91 Oregon State Plane North, International Feet**

Core Depth (cm/ft) | **Lithology**



Core Description	Grain Size % (G / S / Fines)	Sample ID		FID (ppm)	PID (ppm)
SILT w/sand: silt w/sand and clay, bed of med sand tr silt from 26-32cm; soft-stiff; med brownish gray; naphth odor; abrupt basal contact	0/10/90	archived	LW2-C302-A	410	12
SILT w/sand: silt as above w/sand (med) in thin beds, laminae, and lenses, becoming less common below 100cm; med brownish gray; strong odor; heavy sheen to free product in sands below 100cm; tr fine rootlets throughouot	0/10/90	ANALYZED	LW2-C302-B	580	23
SILT w/sand: as above, w/fine sand in thin beds, bed of sand up to 24cm thick betw 263-288cm, sand becomes less common below 288cm, predominately in thin laminae between 288-348cm; silt is med brn gray; strong odor; black staining in bands (up to ~1ft); tr rootlets	0/10/90	ANALYZED	LW2-C302-C	1320	247
		archived	LW2-C302-D	1690	211

Appendix E-1

Response to EPA and DEQ January 18, 2023 Comments on the In Situ Stabilization and Solidification Laboratory Pilot Study Work Plan

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Portland, Oregon 97219
503.670.1108

ANCHOR QEA

Memorandum

February 16, 2023

To: Hunter Young, U.S. Environmental Protection Agency
Wes Thomas, Oregon Department of Environmental Quality

From: Ryan Barth, Anchor QEA

cc: Bob Wyatt, NW Natural; Patty Dost, Pearl Legal Group; Lance Peterson, CDM Smith;
Rob Ede, Hahn and Associates; Billie-Jo Gauley and Jen Mott, Anchor QEA

Re: NW Natural Response to EPA and DEQ's January 18, 2023 Comments on the *In Situ Stabilization and Solidification Laboratory Pilot Study Work Plan* for the Gasco Sediments Site

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This memorandum was prepared by Anchor QEA on behalf of NW Natural and provides responses to the U.S. Environmental Protection Agency's (EPA's) and Oregon Department of Environmental Quality (DEQ's) comments dated January 18, 2023, on the *In Situ Stabilization and Solidification Laboratory Pilot Study Work Plan* for the Gasco Sediments Site Project Area (Project Area). This memorandum has been formatted to respond to EPA's comments first followed by responses to DEQ's comments. In accordance with the comments, the document title has been changed to *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (Work Plan). NW Natural performed numerous substantive revisions to the Work Plan to address the comments, including the following:

- Increasing the number of upland soil sampling locations and contaminant analytical list
- Revising the nomenclature of the phased testing approach (i.e., now described as Phases I through V) and providing additional rationale for the chemical analyte list for each phase of testing and the decision criteria for progressing from phase to phase
- Updating the design concept for the ISS deep treatment barrier wall to the DeWind OnePass technology, as detailed in response to EPA To Be Considered (TBC) Comment 3
- Providing additional rationale regarding the physical property and leachability testing objectives and evaluation criteria, as well as the in-water sediment and upland soil sampling locations and depths

As previously discussed with EPA and DEQ and detailed in Section 7 of the Work Plan, NW Natural is committed to performing an in-water field pilot test at the Project Area during the 2023 in-water construction window from July 1 through October 31 to further inform the in situ stabilization and solidification (ISS) remedy. To achieve this commitment, agreement is needed from EPA and DEQ that the comprehensive ISS remedial approach can be designed. The upland ISS barrier wall will only be designed if ISS is used to address all riverbank, shallow, and intermediate region sediment contamination. It would not be designed as a component of any other sediment remedy configuration. In addition, the Phase I through Phase III sediment and soil treatability testing results need to be available to inform the field pilot test design (see response to EPA General Comment 8 for more details on testing phases). As detailed in Section 4 of the Work Plan, these testing phases take many months to complete. Based on detailed, long-term schedule evaluations that account for the need to incorporate the treatability testing results findings into the forthcoming ISS Field Pilot Test Work Plan and subsequent EPA review and approval, along with coordination with the selected marine contractor whose near-term availability is limited between March 20 through 31, NW Natural needs EPA approval on the Work Plan by March 15 (30 calendar days from this Work Plan submittal date). Please inform NW Natural if EPA will achieve this turnaround time so it can initiate contracting with the various laboratories and marine contractor.

EPA General Comments on ISSLPS Work Plan

EPA General Comment 1

ISS as a Record of Decision (ROD) technology: While EPA agrees that ISS is a remedial technology that is included in the ROD's selected remedy, the work plan and/or future design deliverables should clearly discuss the conditions under which ISS was retained in the Feasibility Study (FS) and included in the selected remedy (e.g., for areas where access and slope stability issues exist, and for principal threat waste (PTW) underneath and around pilings, docks, berthing or mooring dolphins, and other structures servicing active wharfs or shore-based facilities that remain intact). ISS was specifically retained as a technology for use in areas with PTW and where groundwater is affecting porewater, which EPA recognizes are significant issues at the Gasco Project Area.

NW Natural Response

Future design deliverables will discuss the conditions under which ISS was retained in the FS and included in the selected remedy.

EPA General Comment 2

Consistency of the ISSLPS Work Plan with the Preferred Alternatives Report (PAR): Any EPA comments (dated December 5, 2022) on the October 31, 2022 PAR relevant to the ISSLPS Work Plan should also be addressed in the ISSLPS Work Plan.

NW Natural Response

The EPA comments on the PAR relevant to the Work Plan are addressed in the Work Plan.

EPA General Comment 3

Considerations for Sample Location Selection: NW Natural should consider the following and reassess whether the number and location of proposed sediment sample locations are adequate:

a. Sampling of sediment containing higher concentrations of benzene and chlorinated volatile organic compounds should be considered in order to evaluate long-term leachability of these contaminants from treated sediments and potentially inform design of a cap, if needed. Sediment known to contain higher concentrations of metals which are expected to be impacted by changes in pH should also be sampled to evaluate construction-related impacts to surface water and porewater quality.

b. Sampling of sediment containing concentrations of naphthalene above PTW-not reliably contained (PTW-NRC) thresholds should be considered to evaluate long-term leachability of these contaminants from treated sediments and potentially inform cap design, if needed.

c. Sampling of sediment containing non-mobile tar deposits since other forms of substantial product (i.e., residual dense nonaqueous phase liquid (DNAPL) and tar) also represent sources of highly concentrated contamination with the potential to contribute to long-term leaching.

NW Natural Response

NW Natural agrees that collection of the information EPA identifies in this comment is among the objectives for the treatability study. The Work Plan has been revised to provide further rationale for sample locations relative to the various considerations identified in the comment.

EPA General Comment 4

ISS performance in the field: In addition to the performance targets discussed in the ISSLPS Work Plan, the scope of the ISSLPS or the field pilot study work plan should include consideration of other testing criteria based on the implementability of ISS at full-scale. EPA recommends including additional discussion in the ISSLPS Work Plan or a future design deliverable regarding parameters that represent technology-specific or site-specific implementation limitations, such as ability of grout to flow through injector heads of an auger, application of ISS in limited access areas (i.e., underneath the dock), the effect of study parameters (including unconfined compressive strength, swell, etc.) on the use, maintenance, or function of functional structures (e.g., the dock), and the ability to vary grout mixes through sediments with different physical and chemical characteristics.

NW Natural Response

The requested additional discussion will be included in future design deliverables. As discussed in Section 3.4 of the Work Plan, the grout mix selection criteria directly account for a mix consistency that meets constructability requirements (e.g., ability of the grout to flow through the injector heads of an auger) and is suitable for efficient blending of sediment or soil with the grout. In general, it is infeasible to vary the grout mixture to meet localized differences in sediment/soil characteristics. An overarching objective of the grout design mix program is to evaluate whether one or a small number of grout mixes can achieve all the performance criteria for the range of empirically measured sediment and soil conditions. The program specifically acknowledges that the grout design mix may be different in the sediments versus along the top of riverbank given the differences in physical and chemical characteristics. Please also see response to DEQ General Comment 5e.

EPA General Comment 5

Advective Flux: In multiple sections of the ISSLPS Work Plan, it is suggested that the target permeability performance criteria of 10^{-6} centimeters per second (cm/s) will eliminate advective flux through the ISS treatment area. EPA expects that the testing results and subsequent remedial design (RD) evaluations will be used to verify that the permeability performance criteria of 10^{-6} cm/s will be sufficient to minimize or eliminate advective flux. Revise the ISSLPS Work Plan text as needed to address this expectation.

NW Natural Response

Section 1.3.1 of the Work Plan has been revised consistent with the comment.

EPA General Comment 6

Stabilizer/Binding Agent effects on Geochemistry: The ISSLPS Work Plan should consider how the various stabilizers/binding agents may affect the geochemistry of the sediment and porewater, and how those geochemical changes may affect mobilization of contamination. The ISSLPS Work Plan should also acknowledge that the water used during leachability tests may not be representative of the groundwater and porewater at the site and discuss how actual field conditions may differ from laboratory conditions.

NW Natural Response

Sections 2.1 and 3.6.1 of the Work Plan has been revised to address how the cementitious materials may affect the sediment and porewater geochemistry, and how those geochemical changes may affect contaminant mobility. The main effect is anticipated to be due to elevated pH imposed by the grout mix components, which could affect leachability of some inorganics. However, most cationic metals (e.g., zinc and lead) would be expected to be less leachable at high pH due to the insolubility of their hydroxides, and arsenic leachability generally decreases due to reaction with calcium and magnesium in the grout mix components to form relatively insoluble solid phases. The basic pH may also enhance dissolved organic carbon (DOC) leaching from sediment, and some studies suggest that polycyclic aromatic hydrocarbons (PAHs) can be mobilized with DOC (ITRC 2011).

Section 3.6.1 of the Work Plan has been revised to address representativeness of the leaching solutions. Specifically, the Design Team evaluated the river near-bottom surface water and upland groundwater concentrations to determine whether elevated concentrations exist above the ROD Table 17 groundwater cleanup levels (CULs). NW Natural collected near-bottom surface water multiple times over several years as part of the Gasco Early Action Removal Action long-term monitoring program and identified multiple contaminants of concern (COCs) that exceeded their respective CULs (Anchor QEA 2010). Similarly, elevated groundwater concentrations have been identified at the Gasco Operable Unit (OU) that exceed the ROD Table 17 groundwater CULs for multiple COCs (Anchor QEA 2018). The presence of these elevated concentrations would interfere with and obfuscate interpretation of COC leaching from the untreated and treated sediment and soil cylinders. Therefore, reagent water (composed of deionized water) will be used as the leachant for the modified EPA Methods 1312 and 1315 leach tests for both the in-water sediment and upland soils. Prior to use, the reagent water will be analyzed for the same COCs as the leachate testing. Although reagent water will be used in the leach test vessels, it is anticipated that redox conditions within the leach test vessels will be governed by the solid phases due to the reducing nature of the contaminated sediments and soils. The oxidation reduction potential will be measured for confirmation.

EPA General Comment 7

Grout Blend Design: The grout blend designs tested as part of the ISSLPS should consider amendments and/or additives (e.g., organophilic clays, activated carbon, etc.) to evaluate the potential to further improve reduction of contaminant leachability.

NW Natural Response

Additives such as organophilic clay (OC) and activated carbon (AC) were considered in developing the proposed testing approach but were excluded because prior experience indicated they would be unlikely to significantly reduce leaching. For the Gowanus Canal site ISS design, 15 different ISS mixes were tested and included multiple percentages of OC. All tested mixes had similar naphthalene leaching results. As stated by Grubb et al. 2020: "[T]he most expensive reagent OC was eliminated from further consideration after the bench scale study showed the nominal enhancement did not justify the significant additional cost." Similarly, during ISS treatability testing for the Quanta site with PAH-rich dense nonaqueous phase liquid (DNAPL) in sediment, OC and powdered AC were tested as additives in ISS mix formulas, and neither were found to reduce leaching for volatile organic compounds (VOCs) or PAHs (Ramboll et al. 2019). The ineffectiveness of sorptive amendments in reducing leachability is because leaching from nonaqueous phase liquid (NAPL)-impacted sediments is ultimately controlled by the effective solubilities of the NAPL constituents.

In addition, NW Natural had extended conversations with a manufacturer of sodium persulfate and eliminated this additive from consideration based on the manufacturer's recommendation given the Project Area conditions.

EPA General Comment 8

Supporting Criteria for Proceeding at Each Step: The ISSLPS Work Plan should specifically identify the quantitative criteria for determining next steps at every relevant decision-making point. Examples where such criteria should be developed include the following (NW Natural should review the document for other areas that could also benefit from criteria development):

a. Justify the specific physical testing results that will be considered to constitute "perform[ing] well" enough to warrant continuing to the Phase I leachability testing (e.g., as stated in Appendix A, Section 5.4.1). ISSLPS Work Plan Section 1.3.1 presently provides a justification for the permeability target but not for the proposed strength target;

b. Identify the Phase I leachability testing criteria (if any) that must be met to justify conducting the Phase II testing;

c. Identify quantitative criteria on which the decision will be made about whether to pursue Phase III testing; and

d. Identify clear, specific, quantitative criteria for determining whether it is appropriate to proceed with work plan development for a pilot-scale field investigation of ISS, based on the results of this laboratory pilot study. It is important that such criteria be developed prior to implementation of work described in the ISSLPS Work Plan, not thereafter.

NW Natural Response

A new Section 3.3 has been added to the Work Plan that describes the four phases of analyses for samples undergoing ISS treatment (previously identified as two phases). Phase I is to determine the most efficient composition of the two components, Blast Furnace Slag Cement (BFSC) and Portland cement (PC). It evaluates the impacts to treated sediment and soil strength and permeability due to changes in the ratio of BFSC and PC under a constant grout dosage and variable water/cement ratios, as illustrated in the revised Figure 3-1. This phase is completed using a single sediment and soil sample that contains the greatest percent fines in each respective media. This is because sediments/soils with higher fines will have a lower pre-treatment permeability, and ISS may not provide much additional reduction. Therefore, the higher fines samples provide the greatest challenge for ISS to increase strength while also reducing permeability. As noted on Figure 3-1, existing sediment sampling location C273 contains the highest percent fines so the proposed co-located sediment sampling location ISSTS-01 will be used for the Phase 1 testing. Alternatively, as discussed in response to EPA Comment TBC 3, the Dewind OnePass technology will result in compositing the full depth of soil column to the bottom of the ISS treatment barrier wall and no existing percent fines data exists over this depth horizon. Therefore, untreated bulk soil samples will be initially analyzed for grainsize at each of the five upland sampling locations and the location with the highest percent fines will be used for the Phase 1 testing.

Phase II uses the grout composition selected from the Phase I testing to evaluate the impacts to treated sediment and soil strength and permeability due to changes in the grout dosage (i.e., dry weight of cementitious admixture to wet weight of sediment) in sediments and soils, as illustrated in the revised Figure 3-2. This phase is completed using individual samples collected from four in-water sediment and five upland soil sampling locations.

Phase III testing will be performed on duplicate samples from the Phase II testing that optimally achieve the Phases I and II selection criteria for grout identified in Section 3.4. Phase III testing includes sediment and soil leachability testing via synthetic precipitation leaching procedure [SPLP] modified EPA Method 1312 analysis on both untreated sediment and soil and treated sediment and soil using the single BFSC to PC ratio and single grout dosage (or more if multiple grout dosages are selected based on the results of the Phase II testing) that optimally achieves the grout composition selection criteria identified in Sections 3.4 and 3.5.

Phase IV will be performed on additional duplicate samples from the Phase II testing. It will consist of additional sediment and soil leachability testing via Leaching Environmental Assessment Framework Method 1315M (modified for organic COCs) analysis on both untreated sediment and soil and treated sediment and soil using the single selected Phase I BFSC to PC ratio and Phase II grout dosage that generally achieves the lowest leachability during the Phase III leachability testing. However, consideration will also be given to the strength, cost considerations associated with adding increased dosage amounts (i.e., a lower dosage with a slightly higher leachability would be much more cost effective and may be selected for Phase IV testing), amount of swell, and workability of the grout to determine if the lowest leaching grout should be advanced to Phase IV leachability testing.

NW Natural will determine whether Phase V testing is warranted in coordination with EPA and DEQ based on the Phase IV testing results and associated remedial design evaluations. This revised four-phased approach nomenclature is used throughout the remainder of this memorandum and the Work Plan.

a. As stated in in Section 1.3.1, the target strength is intended to “structurally support the minimal post-construction loading on top of the ISS-treated materials.” The Phase III leachability testing (previously Phase I) will be performed if the strength target (50 pounds per square inch [psi]) and permeability target (10^{-6} cm/s or less) is achieved during the Phase II testing. Section 3.6 of the Work Plan has been revised to provide the requested justification.

b. There are no Phase III leachability criteria that must be met to justify conducting Phase IV leachability testing. As stated in Section 3.6.2, it is anticipated that the grout composition and dosage that identified the generally lowest leaching (if more than one dosage is tested) during the Phase III leachability testing will advance to Phase IV leachability testing. However, consideration will also be given to the strength, amount of swell, and workability of the grout to determine if the lowest leaching grout should be advanced to Phase IV leachability testing.

c. As stated in Section 3.6.3, the need for Phase V testing will be determined in coordination with EPA and DEQ after reviewing the Phase IV leachability testing results, including the more advanced physical microscale characterization, porosity, and DNAPL saturation results.

d. The ISS field pilot study will be performed if the strength target (50 psi) and permeability target (10^{-6} cm/s or less) is achieved at all or some portion of the four sediment sampling locations and five upland soil sampling locations.

EPA General Comment 9

Pilot Study Schedule: NW Natural should consider the following concerning the pilot study schedule:

a. EPA understands that NW Natural plan is to implement a field pilot study during the 2023 work window. The feasibility of a 2023 field pilot should be explained given that all laboratory testing results will not be available by Fall 2023.

b. The proposed reporting schedule indicates that the ISSLPS may not be completed until after the Interim Design (EPA assumes that the "Interim Design" is equivalent to the "50% Design"). EPA believes it is critical for NW Natural to complete the ISSLPS and report all testing results, including a recommended final grout blend design, in the Interim Design.

NW Natural Response

Section 4 of the Work Plan was revised to clarify how the treatability study results will be incorporated into forthcoming remedial design deliverables. Specifically, different treatability study elements will be completed sequentially over more than a year. This schedule, however, does not affect the Project Area remedial design process already underway. That is because the treatability study data are not needed to determine if ISS will be effective. The data will be used to ensure the means and methods for ISS technology used in the Project Area are optimally designed for site-specific conditions. For that reason, a separate *Revised Basis of Design Report* and *Preliminary Design* will be resubmitted as soon as possible. Due to the significant level of remedial design evaluations performed to support submittal of the *Combined Sediment Remedy Basis of Design and Preliminary Design Report* (Anchor QEA

2021) and subsequent evaluations of the revised ISS and Full Dredge Design presented to EPA, DEQ, and the Technical Coordination Team in 2022, the Preliminary Design is expected to be at the 50 percent design level. The results of the treatability study and subsequent proposed ISS field pilot study (see Section 7 of the Work Plan), as well as responses to comments from EPA on the Preliminary Design and any necessary remedial design revisions, will be incorporated into the subsequent Interim Design. Any feedback received from EPA and DEQ on the Interim Design will be addressed and incorporated into the Final Design. This approach enables efficient forward progress on design while facilitating completion of the field pilot study during the 2023 in-water work window and ensuring the necessary data and responses to EPA and DEQ comments are incorporated into the relevant phases of design.

A new Section 7 has been added to the Work Plan to describe the specific treatability study results that will be used to inform the field pilot study proposed during the summer 2023 in-water work window. NW Natural confirms that all Work Plan and the future proposed field pilot study results will be reported in the Interim Design.

EPA General Comment 10

Remedy Monitoring: EPA reiterates General Comment 5 on the PAR as it is also relevant to the ISSLPS WP: "The PAR suggests that the "Full Dredge and ISS Design" alternative would not require capping and would have reduced monitoring requirements compared to capping. The laboratory pilot study treatability testing results should be used to inform the need for capping subsequent to ISS implementation. Monitoring of the in-river remedy will still be required for the ISS remedy and these capping and monitoring requirements should be evaluated during future design stages."

NW Natural Response

NW Natural agrees that the treatability study results will be used to determine the diffusive flux from the treated layer and to design the appropriate materials overlying the cover or treated layer to address this potential chemical migration pathway.

EPA General Comment 11

Consideration of EPA Guidance: EPA's guidance for conducting treatability studies (EPA 1992) [see Sections 3.5 and 3.5.15] states that work plans should include the projected costs for completing the study. Potential cost categories include, but are not limited to, labor, administrative costs and fees, equipment and reagents, site preparation and utilities, permitting and regulatory fees, and sample transportation and analysis. NW Natural should consider this guidance to provide relative costs as appropriate.

NW Natural Response

The treatability guidance was written primarily to support EPA-funded treatability studies (see Section 1.5.2 of EPA's guidance: "This guidance is written to support the treatability study activities of an EPA RPM under CERCLA" [EPA 1992]). Section 2.5.6 of the guidance indicates that budgeting for EPA-funded treatability studies is important because treatability studies are funded through a different process than other costs, such as RI/FS costs:

> "The planning process for treatability studies should begin during the budget cycle in the year prior to the planned performance. The potential need for and scope of treatability studies should be identified and their costs estimated to ensure that adequate resources will be available. This information will be used to prepare the Region's Superfund Comprehensive Accomplishments Plan (SCAP)."

As described in the Work Plan, the ISS bench scale treatability study is an iterative process; therefore, it is not possible to provide a precise cost for the study. The range of potential costs for the study are included in the overall remedial design cost estimate that forms the basis for financial assurance provided under the Gasco Sediments Site *Administrative Settlement Agreement and Order on Consent* (ASAOC; EPA 2009a), and funding of all potential phases of the study has been approved by NW Natural.

A new Section 6 (titled "Bench Scale Treatability Study Costs") has been added to the Work Plan confirming that treatability study costs are within the remedial design estimate that forms the basis for financial assurance under the consent order, and no adjustment to the financial assurance is required because of this work.

EPA Specific Comments on ISSLPS Work Plan

EPA Specific Comment 1

Section 1 Introduction and Objectives, last paragraph, page 1: The text should be revised to accurately reflect EPA General Comment 1 on the PAR which stated that (particularly with regard to EPA "selecting" the preferred Full Dredge and ISS Alternative): "The PAR bases its conclusions on mostly conceptual approaches that will need to be verified during the pilot studies and/or future stages of design. EPA recommends future design deliverables clearly distinguish conceptual design concepts from design evaluations already conducted. Supporting evaluations are expected in the forthcoming revised Basis of Design Report (BODR). EPA agrees with the general approach of ISS treatment at the Gasco Project Area with the caveat that site-specific details of the approach will need to be further developed in collaboration with EPA during design of the ISS remedy." It is premature to state that EPA is selecting the Full Dredge and ISS Alternative without completing the laboratory and field pilot studies to evaluate the efficacy of an ISS remedy.

NW Natural Response

Section 1 has been revised consistent with the comment.

EPA Specific Comment 2

Section 1.1 Background, last paragraph, page 2: Revise the first sentence as follows: "Only one design alternative ***is anticipated*** to fully achieves all of EPA's design objectives and prevents sediment recontamination." (***Emphasis added***). EPA believes both alternatives presented in the PAR can be protective and would satisfy the requirements of the ROD, with the understanding that the two design alternatives included in the PAR have tradeoffs between other balancing factors that may favor one approach over another. In addition, text related to comparison of design alternatives should be removed from the ISSLPS Work Plan as this information was evaluated in the PAR.

NW Natural Response

The referenced sentence has been revised consistent with the comment, and text related to comparison of design alternatives has been removed from the Work Plan.

EPA Specific Comment 3

Section 1.1 Background, page 3: Whether ISS reduces or eliminates contaminant transport depends on the application. Until the pilot studies are completed it is premature to state that contaminant transport will be fully eliminated via any transport mechanism. Future design deliverables should note that ISS has the potential to eliminate contaminant transport via ebullition and advective flux, and this is contingent on the final design.

NW Natural Response

Section 1.1 has been revised to remove the subject statement. However, based on empirical data collected at the other ISS sediment cleanup sites referenced in the Work Plan, the Design Team maintains that ISS treatment will eliminate ebullition from the treated material and will eliminate advection to the extent practicable. These statements are not contingent on pilot studies or design.

EPA Specific Comment 4

Section 1.2 ISS Description, first paragraph page 4: Provide citations to support the following statement: "This physical and chemical modification of the impacted materials has been proven to be effective for NAPL [nonaqueous phase liquid] and a variety of contaminants in environmental media."

NW Natural Response

References have been added consistent with the comment.

EPA Specific Comment 5

Section 1.2 ISS Description, last paragraph, page 4: The text states that: "ISS has been effectively used for decades at hundreds of sites around the country, many of which are manufactured gas plant sites like Gasco." Revise the text to clarify if these applications have been mostly associated with upland remedial actions.

NW Natural Response

The referenced sentence has been revised consistent with the comment, and references to specific sites where ISS has been implemented have been added.

EPA Specific Comment 6

Section 1.3 Laboratory Pilot Study Objectives, pages 4 and 5: EPA has the following comments on this section and the ISSLPS Work Plan should be revised accordingly:

a. Revise the text to cite a few examples of the "numerous other sites with similar contaminants and conditions" where ISS has been used to achieve remedial objectives and clearly distinguish sediment remediation sites.

b. It is understood that the admixtures used to achieve stabilization will include cementitious materials such as slag or cement that are not ideal components of a natural habitat, and will change the nature of the substrate as well as potentially leach chemicals into the overlying water. These properties of the stabilization material may adversely affect the ability of the completed remedy to support habitat improvements. The ISSLPS Work Plan should provide clarification regarding potential adverse impacts to habitat due to the ISS admixtures.

NW Natural Response

a. Reference sites have been added to Section 1.2.

b. Concrete has been widely used for in-water construction projects and leaching of cementitious components has not been identified as an environmental concern. Nevertheless, the Work Plan has been revised to discuss potential adverse impacts to habitat due to the ISS grout addition.

EPA Specific Comment 7

Section 1.3.1 Physical Property Testing Objectives and Evaluation Criteria, second paragraph, page 4: The text defines the strength target as being "limited to placement of cover materials". Provide further definition of the cover materials, for example, whether it includes cover materials related to habitat restoration.

NW Natural Response

Section 1.3.1 has been revised consistent with the comment.

EPA Specific Comment 8

Section 1.3.1 Physical Property Testing Objectives and Evaluation Criteria, third paragraph, page 4: Revise the text to provide additional clarification regarding the last two sentences of this paragraph. Presumably, the chemical fate and transport evaluations will inform the determination of advective flux. EPA expects that the testing results and subsequent RD evaluations will be used to verify that the permeability performance criteria of 10^{-6} cm/s will be sufficient to minimize or eliminate advective flux.

NW Natural Response

This comment has been addressed per the response to EPA General Comment 5.

EPA Specific Comment 9

Section 1.3.2 Leachability Testing Objectives and Evaluation Criteria, second paragraph, page 5: Revise the text to clarify how NW Natural intends to verify that DNAPL in the ISS treated materials will be immobile. Also include citations for studies to support this assumption.

NW Natural Response

Consistent with the empirical testing results from the Gowanus Canal site, free-phase DNAPL is not expected to remain in ISS-treated samples (Olean et al. 2016). If free-phase DNAPL is not observed, it will be concluded that DNAPL is immobile. This information has been added to Sections 1.3.2 and 3.5.

EPA Specific Comment 10

Footnote 6 states that locations and depths of previous PTW-NAPL observations were used to help identify target sample locations and depths, but the presence of PTW-NAPL is not considered an essential criterion for ISSLPS sample materials. EPA believes that the ISSLPS would be incomplete without definitively evaluating grout blend designs for PTW-NAPL impacted sediments. Modify footnote 6 for clarification.

NW Natural Response

Footnote 6 (Footnote 8 in the revised document) has been modified consistent with the comment.

EPA Specific Comment 11

Section 3.2 Initial Characterization of Untreated Samples, second paragraph, pages 9: The untreated samples should be analyzed for contaminants with ROD Table 17 groundwater and riverbank soil/sediment CULs. Total organic carbon should also be analyzed as organic content can have significant influence on pozzolanic action of cementitious admixtures. Revise the text to include these analyses.

NW Natural Response

Note that the analyte lists for untreated bulk sediment and soil samples are addressed separately in this response.

Bulk untreated sediment samples: The objective of performing chemical analyses on the bulk untreated sediment samples is to provide a baseline chemical characterization for reference while interpreting the Phase III and IV untreated and treated sediment leachability testing results. In turn, the objective of performing chemical analysis on the Phase III leachates is to document and rank the reduction of COC leachability for various grout dosages. The objective of the Phase IV leachate testing is to quantify the COC mass flux and COC equilibrium concentrations in the pore space of the treated and untreated sediments to support chemical isolation evaluations, if determined to be needed through the ISS TS. NW Natural and EPA spent considerable effort negotiating a sediment chemical isolation evaluation approach that was ultimately approved in the *Final Pre-Remedial Basis of Design Technical Evaluations Work Plan* (TEWP; Anchor QEA 2019a). NW Natural's response to EPA General Comment 4 of the TEWP, as detailed in TEWP Appendix A-2, states, "Porewater concentrations will be used to evaluate cap compliance with ROD Table 17 groundwater cleanup levels during both remedial design capping demonstrations and long-term cap performance monitoring. ROD Table 17 *riverbank soil/sediment cleanup levels will not be used* for assessing cap performance during remedial design or long-term cap performance monitoring" [emphasis added]. Consistent with this previous agreement and the identified use of the Work Plan sediment leachability test results, the ROD Table 17 riverbank soil/sediment CULs are an inappropriate comparative endpoint for the untreated sediments and the Phase III and IV untreated and treated sediment leachability testing results, so analyzing for these contaminants will not support remedial design. Therefore, NW Natural has revised the Work Plan to include analysis of bulk untreated sediment analyses for all COCs containing a ROD Table 17 groundwater CUL, except for aliphatic hydrocarbons C10-C12. This analyte will not be included in Phase III and Phase IV leaching testing because Anchor QEA has not identified an analytical laboratory that is able to achieve the ROD Table 17 groundwater CUL of 2.4 micrograms per liter (µg/L). These samples will also be analyzed for permeability, grain size, bulk density, TOC, total solids, moisture content, Atterberg Limits, and porosity.

Bulk untreated soil samples: The objective of performing chemical analyses on the untreated soil samples is to provide a baseline chemical characterization for reference while interpreting the Phase III and IV untreated and treated soil leachability testing results. In turn, the objective of performing chemical analysis on the Phase III leachates is to document and rank the reduction of COC leachability for various grout dosages. The objective of the Phase IV leachate testing is to determine whether and to what extent diffusion from the riverbank ISS deep treatment barrier wall into the river via a potential chemical migration pathway under the ISS treated sediments may occur and whether this pathway may present a risk at the point of exposure in the river. The migration pathway associated with this exposure would include potential diffusion into groundwater from the river side face of the barrier wall. During the long-term remedy, groundwater extraction on the upland side of the wall will maintain a hydraulic gradient toward the upland through the wall. Advection through the wall will be minimal but will reduce the diffusive mass loss from the river side of the wall. Diffusion toward the river from the wall will only occur if concentrations on the river side of the wall are lower. However, COC concentrations on the river side of the wall will be similar. Therefore, the primary risk pathway on the river side of the wall beneath the ISS sediment zone will be advection through the full extent of untreated sediments under the in-water ISS treatment layer, with subsequent discharge along the channelward edge of the ISS footprint near the navigation channel. Groundwater advection on the river side of the wall will occur due to discharge of Deep Lower Alluvium groundwater, which occurs deeper than the extent of upland groundwater hydraulic control, and below the bottom elevation of the wall. The groundwater risk pathway on the river side of the wall will be evaluated by modeling during the remedial design. Diffusive mass flux from the wall will likely be negligible, but potential contribution will be evaluated. In any case, the appropriate comparative endpoint for this potential risk pathway is the ROD Table 17 groundwater CULs. Consistent with the untreated sediment baseline characterization, the ROD Table 17 riverbank soil/sediment CULs are an inappropriate comparative endpoint for both the untreated soils and the Phase III and IV untreated and treated soil leachability testing results, so analyzing for these contaminants will not support remedial design. Therefore, NW Natural has revised the Work Plan to include analysis of bulk untreated soil analyses for the identical list as the bulk sediment samples, as well as sulfate and chloride in accordance with DEQ Specific Comment 5. Sulfite will not be analyzed as requested in DEQ Specific Comment 5. It is highly unlikely to be detected at any level that could affect ISS cure properties and will not provide useful data. In addition, laboratory analysis of sulfite has a very short hold time of 24 hours, which is infeasible given the time the sampling, processing, and shipping timeframes.

EPA Specific Comment 12

Section 3.3 Grout Component Testing, pages 9 and 10: EPA has the following comments on this section and the text should be revised accordingly:

a. Revise the text to specify the type of Portland cement to be used. Additionally, analytical characterization of proposed admixtures (i.e., blast furnace slag cement (BFSC) and Portland cement (PC)) should be documented either through test results provided by vendor(s) or through independent analytical testing of cementitious materials.

b. There is no explanation or justification for the chosen BFSC to PC ratios or for the grout dosages. Sufficient literature citations should be added to support these grout blend compositions. This comment also applies to Appendix A, Section 5.2.

c. Provide clarification whether the selection of cementitious materials is based on ISS implementation at the sites mentioned in Section 1.2. If so, describe whether long-term monitoring has occurred at these sites to evaluate how leachability or habitat interactions may be impacted over longer time spans. Based on the timeline provided, Phase I-II will take place over the course of a year. Describe how long-term effects will be monitored and evaluated.

NW Natural Response

This response relates to the newly designated Phase 1 Grout Composition Testing (Section 3.4).

a. The treatability study will use Type 1L PC and grade 100 BFSC, consistent with the materials proposed for use during full scale ISS implementation. The Work Plan has been revised to include analytical characterization of the BFSC and PC. The analytical suite shall be consistent with the Phase IV leachability testing that consists of the full list of COCs containing a ROD Table 17 groundwater CUL except for aliphatic hydrocarbons C10-C12 due to the rationale provided in response to EPA Specific Comment 14a. TOC, DOC, pH, oxidation reduction potential (ORP), and specific conductivity will also not be analyzed because those analyses are specific to water testing.

b. The selected test ratios of BFSC and PC are based on direct experience from the Design Team on dozens of other upland ISS sites and the Design Team's understanding of ratios used at the small number of in-water ISS sites completed to date referenced in the Work Plan. If the range of proposed grout dosages is not meeting the project objectives, the range will be modified during the ISS treatability study implementation in coordination with EPA and DEQ.

c. The selection of cementitious materials is based on the Design Team’s experience on dozens of upland ISS sites in addition to the in-water sites identified in Section 1.2. The Design Team is not aware of any long-term monitoring data that have been published based on the identified ISS projects. The treatability test results will be used to estimate the long-term COC mass flux from the ISS-treated sediment and, if necessary, to design an appropriate cover to mitigate long-term risk. NW Natural will determine the data collection objectives and program to assess long-term performance in coordination with EPA and DEQ during remedial design.

EPA Specific Comment 13

Section 3.4 Strength and Permeability Testing, second paragraphs, pages 10 and 11: EPA has the following comments on this section and the text should be revised accordingly:

a. Revise the text to clarify why a grout dosage of 10% will be used for both sediment and soil in the grout testing phase but a 10% grout dosage is not considered for soils during the strength and permeability testing stage.

b. Revise the text to provide additional detail describing the method for determining when assessing the effective solubility of the NAPL is needed. It should be noted that additional supernatants/gels, leachates etc. may be produced during the curing process, in addition to NAPL. All of these observations should be recorded.

c. Text in the second paragraph states that sediment has higher moisture content and percentage of fines content compared to soil, which may affect the strength and permeability. This statement should include a more detailed description of the directional effect on strength and permeability (i.e., stronger/weaker and more/less permeable).

NW Natural Response

This response relates to newly designated Phase I Grout Composition Testing (Figure 3-1) and Phase 2 Grout Dosage Testing (Figure 3.2).

a. Please note that the objective of the Phase I Grout Composition and Phase II Grout Dosage Testing (previously this work was not designated as part of the phased approach) is to determine the optimum composition and dosage, respectively, of BFSC and PC over a range of water/cement ratios. Consistent with the comment, the Phase I Grout Composition Testing has been modified to use 10% grout dosage for the single sediment sample and 8% grout dosage for the single soil sample. In addition, the Work Plan has been revised to include a 10% grout dosage for soils during the Phase II Grout Dosage Testing with removal of the lower 4% grout dosage. The 10% grout dosage was added to the Phase II testing for soil for consistency with the Phase II testing for sediment to compare the results.

b. As stated in Section 3.6.2, following Phase IV leachability testing of the untreated sediments and treated cylinders, the water in the container will be allowed to equilibrate with the porewater in the sediments and cylinders and provide an approximate measurement of the aqueous concentrations within these solid materials. The equilibrated aqueous concentrations for the untreated samples should approximate the effective solubility of DNAPL components. The Work Plan has been revised to state that treated samples will be visually inspected for the presence of gels and supernatants and observations will be recorded and photo documented.

c. In general, higher fines and moisture content can retard strength development or decrease the unconfined compressive strength (UCS), while higher fines can decrease (i.e., improve) the permeability. Section 3.5 has been revised consistent with this comment.

EPA Specific Comment 14

Section 3.5.1 Leachability Testing Design, page 11: EPA has the following comments on this section and the text should be revised accordingly:

a. Chemical analysis of the leachate generated in both Phase I and Phase II leachability testing should include all contaminants with ROD Table 17 groundwater and riverbank soil/sediment CULs. EPA recognizes that some of these contaminants are not driving the design at the Gasco Project Area; however, at this stage of the ISSLPS all contaminants with ROD Table 17 groundwater and riverbank soil/sediment CULs should be analyzed for leachability testing in addition to the currently proposed analysis of PAHs, volatile organic compounds (VOCs), and arsenic.

b. Clarify why the American Nuclear Society (ANS) test method ANS 16.1 recommended by the ITRC (2011) and used in the Gowanus Canal ISS leachability testing is not being used.

NW Natural Response

a. See response to EPA Specific Comment 11 regarding the rationale for why the ROD Table 17 riverbank soil/sediment CULs are not applicable to the Phase III and IV leachate testing. NW Natural agrees that the ROD Table 17 groundwater CULs are applicable. The objective of the Phase III leachate testing is to evaluate the reductions in leachability between the untreated and treated sediments and soils. The greatest reduction in leachability will be associated with the chemicals that are the most mobile and contain the highest concentrations. The Design Team reviewed the full list of COCs containing a ROD Table 17 groundwater CUL and determined that the following subset of COCs includes a broad range of analytes for which leachability reduction is anticipated to be critically dependent on grout dose and therefore will be used for both the untreated and treated sediment and soil Phase III leachability testing: SVOCs (including PAHs), VOCs, arsenic, and cyanide. The leachate will also be analyzed for TOC, DOC, pH, ORP and specific conductivity.

Additionally, the Phase IV leachability testing data will be used to demonstrate that the full list of COCs containing ROD Table 17 groundwater CULs are protective of any measured chemical migration from the ISS treatment layer, so this full list will be analyzed via aqueous samples collected from the water bath. In addition, the full list will be analyzed via an extraction of COCs that have sorbed to the PDMS liners. Metals and cyanide that will only be analyzed in the water bath because these chemicals are not sorbed by the liners. Aliphatic hydrocarbons C10-C12 will not be analyzed in either the water bath or liner because the analytical laboratories are unable to achieve the ROD Table 17 groundwater CUL of 2.4 µg/L (see response to EPA Specific Comment 11). In addition, the water baths will be analyzed for TOC, DOC, pH, ORP, and specific conductivity. It is important to note that high-resolution methods will be required to attempt to achieve the significantly low DDx (0.001 µg/L), DDD (0.000031 µg/L), DDE (0.000018 µg/L), and DDT (0.000022 µg/L) CULs during the Phase IV leachability testing. The laboratories will need to report down to the estimated detection limits (EDLs), which cannot be predetermined because they are calculated at the instrument at the time of analysis for each non-detected result. Any matrix interferences encountered during the testing will increase EDLs and could lead to non-detectable concentrations above the CULs.

b. ANS 16.1 leach test is a flux-based test similar to EPA Method 1315 but specifically developed for assessing leaching of radioactive wastes. At the time of publication of the ITRC guidance (ITRC 2011), EPA Method 1315 had not yet been formally included in SW-846. EPA Method 1315 has also been modified to accommodate leach testing for organic contaminants.

EPA Specific Comment 15

Section 3.5.1.2.1 Phase II Leachability Testing, page 12: Specify the equilibration time that the untreated sediment and treated cylinder will be allowed to equilibrate for the estimation of equilibrium aqueous concentrations.

NW Natural Response

This information has been added to Section 3.6.2 of the Work Plan.

EPA Specific Comment 16

Section 3.5.1.3 Phase III, page 13: EPA has the following comments on this section and the text should be revised, if needed:

a. Due to the methods for leachability testing requiring modifications to make them more applicable to testing of ISS monoliths, EPA strongly encourages Phase III column testing be conducted. However, EPA agrees that this decision can be made after reviewing the Phase II leachability testing results.

b. Phase III testing would be important in areas where habitat layers are anticipated to be placed above the stabilized material. This can be addressed during development of the Phase III testing protocol in coordination with EPA.

NW Natural Response

As stated in the Work Plan, the need for Phase V testing (previously Phase III) for the in-water pilot study will be determined after reviewing the Phase IV leachability testing, microscale characterization, porosity, and DNAPL saturation results. If deemed necessary, details of Phase V column setup and operation will be developed in coordination with EPA. There is no technical rationale for performing Phase V testing for the soil pilot study.

EPA Specific Comment 17

Figures 2-2a through 2-2c: A similar figure series showing the locations of PTW-NRC observations should be added to the ISSLPS WP.

NW Natural Response

The requested figures have been added as Figures 2-4a through 2-4d.

EPA Editorial Comments on ISSLPS Work Plan

EPA Editorial Comment 1

Document Title: The document ideally should be referred to as ‘Bench Scale Treatability Study’ in accordance with commonly used terminology and EPA, 1992 instead of ‘Laboratory Pilot Study’.

NW Natural Response

The ISSLPS Work Plan will be retitled as requested to “Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan.”

EPA Editorial Comment 2

Figures 2-1a through c and Figures 2-2a through c: Specifically identify and highlight (e.g., by using a different color for the station’s label) those stations proposed for sample collection.

NW Natural Response

The requested figure revisions have been made consistent with the comment.

To Be Considered Comments on ISSLPS Work Plan

EPA To Be Considered Comment 1

Compressive Strength Performance Target: EPA recommends that the ISSLPS Work Plan also set a maximum strength target to ensure that the selected mix design can accommodate various future use scenarios. The maximum strength should be measured at 28 days of curing.

NW Natural Response

See response to DEQ General Comment 5a.

EPA To Be Considered Comment 2

Sample Location Selection: The ISSLPS Work Plan should be revised to include sediment sampling for treatability testing across the full depth of potential ISS application. It is anticipated that ISS treatment will extend more than 30 feet below the sediment surface in some areas.

NW Natural Response

It is not technically warranted to sample and analyze sediments deeper than 8 feet below mudline because representative physical and chemical characteristics throughout the Intermediate, Shallow, and Riverbank Regions of the Final Project Area occur shallower than this depth threshold. As discussed in Section 2.1 of the Work Plan, treating different grain sizes with ISS can generate a range of results for leachability. Therefore, the sampling locations were selected within the 0- to 8-foot depth interval to include a range of grain sizes that are representative throughout the full depth of contamination. In addition, depth intervals expected to have PTW-NAPL (which was identified much more prominently at shallower than 8 feet below mudline), based on observations in previously collected cores, were prioritized. Text has been added to Section 2.1 to address EPA TBC Comment 6 that indicates the selected depth intervals cover the range of measured grain sizes at locations with PTW-NAPL within the Final Project Area. Further, as discussed in response to EPA General Comment 3, the selected locations are expected to contain elevated concentrations of benzene and naphthalene.

In addition to targeting sediment physical and chemical characteristics, the relative ease of sample collection, coupled with relatively higher percent recovery using vibracoring technology (i.e., obtaining sediment samples from deeper depths is more difficult and can lead to much lower percent recovery than obtaining samples at shallower depth intervals), was considered as a secondary line of evidence. It is expected that multiple cores will need to be collected at each location to achieve all treatability study objectives, so the certainty of achieving consistent target recoveries at the target depth intervals is an important consideration.

EPA To Be Considered Comment 3

Sample Size: The ISSLPS Work Plan should provide more justification for the proposed number of samples to be tested in each phase of testing. For example, the ISSLPS Work Plan provides only one sampling location per soil sample type (“One sampling location and depth interval was selected from each WBZ [water bearing zone]”—i.e., the Fill WBZ, upper alluvium, and lower alluvium) and only two sampling locations for each of two in-water sediment sample depths. NW Natural should confirm that the number and type of samples will be sufficient to select the most representative grout blend design.

NW Natural Response

Sediment and soil sample locations were selected to be representative of Project Area and upland site conditions (see response to EPA General Comment 3 and EPA TBC Comment 2). However, at the request of DEQ (DEQ General Comment 6), two additional sampling locations (collocated with existing MW-21-165 and PW-10L) were added to the top of riverbank barrier wall soil sampling scope. One composite sample representative of the full soil boring depth will be collected at each soil boring location. This is intended to represent conditions during barrier wall installation using the revised DeWind OnePass technology. This technology homogenizes the soil to the full depth of the deep ISS treatment barrier wall. Additional detail regarding this revised design concept is provided below and will be further detailed in NW Natural’s future submittal to DEQ for the Revised Source Control Addendum.

The design concept for the ISS treatment barrier wall has been updated based on further preliminary design evaluations and detailed discussions with equipment vendors. As described in the *Source Control Addendum Report* (Anchor QEA 2022a), the original barrier wall design concept was to extend two rows of top of riverbank ISS columns to the depths required to form a continuous wall of overlapping columns with the directly adjacent riverbank ISS columns. The overlaps in the double row were intended to ensure that there would be no gaps left in the wall due to column deviations. This design concept is depicted in Figures 4-2 through 4-3e of the *Source Control Addendum Report*.

The maximum depth of the barrier wall will be as much as 155 feet below existing ground surface. After consultation with equipment vendors and review of this auger technology at other sites, including those constructed by members of the Design Team, NW Natural had concerns about the feasibility of this process to such depths and the difficulty of maintaining continuity between columns that might deviate from vertical. DEQ comments on the *Source Control Addendum Report* (see Comment 7a; DEQ 2022) identified similar implementability concerns associated with the previous ISS auger technology design concept to the significantly deep target depths. These concerns led to the identification of an upland field pilot test to field verify that this technology could achieve the design objectives to the target depths.

To minimize the identified risks by the Design Team and address the concerns expressed in the DEQ comment letter, the Design Team contacted DeWind OnePass Inc. to discuss their capabilities to construct a completely mixed soil-ISS barrier wall to the target depths. While other companies have similar equipment, only DeWind has developed equipment with the power and proven capacity to reach the target depths. The basic concept is a gigantic chainsaw that cuts through the ground as it combines grout and other additives into a soil-mix blend. During the machine's progress, the vertical profile is completely homogenized and mixed into a semi-fluid state with a thickness of 3 feet. After the machine passes, the homogenized blend sets up and attains the required design parameters. Information about the equipment can be found on DeWind's website.[1] Videos of the machine at work are available on YouTube, with one example at a depth of 145 feet deep.[2] DeWind has been continuing to extend the power and depth range of its equipment. For this project, their current capacity of 145 feet below ground surface will achieve the target depths—the work platform can be degraded slightly to bring the design depth of 155 feet below existing grade within reach.

This technology has the obvious technical advantage that the massive treatment blade must pass through the entirety of the soil profile with no possibility of leaving "windows" of untreated soils behind. In addition, there is no open trench at any time since it is always full of mixed soil-cement. This homogenization is accounted for in the revised soil sampling method of compositing the entirety of the soil column to the bottom depth of the barrier wall at each of the proposed five upland locations, as described in Section 2.2 of the Work Plan.

The Design Team member Sevenson Environmental Services has used this technology on a series of environmental containment projects, including one at a depth of more than 100 feet:

- Glassboro South Jersey Gas Former MGP—Glassboro, New Jersey (2022): Soil-cement bentonite wall with dimensions 200 feet long by 87 feet deep by 3 feet wide
- Harrison MGP Site—Harrison, New Jersey (2021): Soil-bentonite wall with dimensions 2,200 feet long by 76 to 104 feet deep by 3 feet wide
- Former Koppers Wood Treating Facility—Carbondale, Illinois (2004): Groundwater collection trench with dimensions 931 feet long by 35 feet deep with installed 4-inch HDPE SDR-11
- Newport S. Landfill Superfund Site—Newport, Delaware (2002): Permeable reactive barrier-ZVI wall with dimensions 1,887 feet long by 25 feet deep

DeWind projects exceeding 100 feet include the following:

- Pittsburg Landfill—Antioch, California (2021): Soil-bentonite wall with dimensions 3,800 feet long by 90 to 145 feet deep by 3 feet wide

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[1] Source: http://www.dewindonepasstrenching.com/slurry-walls-and-cement-bentonite-walls
[2] Source: https://www.youtube.com/watch?v=0fnZ5dpE8qs

- K+S Potash—Bethune, Saskatchewan, Canada (2020): Soil-bentonite wall with dimensions 2,297 feet long by 68 to 96 feet deep by 3 feet wide with a test section to 135 feet deep
- Mosaic-New Wales Potash Facility—Mulberry, Florida (2019): Soil-bentonite wall with dimensions 5,200 feet long by 55 to 100 feet deep
- Cleveland-Cliffs, Hibbing Taconite Mine—Hibbing, Minnesota (2018): Soil-bentonite wall with dimensions 3,910 feet long by 50 to 100 feet deep

Another significant advantage of the proven track record of this technology is that it should not require a pilot scale project to prove its feasibility.

EPA To Be Considered Comment 4

Statistics: The ISSLPS Work Plan should identify (and justify) the specific methods that will be used to analyze the laboratory testing results, including all comparisons that will be made and the targeted level of statistical power, as applicable. Absent this information (and a sufficient sample size), the results of the study may not be sufficiently reliable for future decision-making, including any decision to proceed with field-scale pilot testing.

NW Natural Response

Additional information has been added to Section 3.4 of the Work Plan that describes qualitative variables that will be assessed in the selection of grout dosages. The nature of these multiple line of evidence variables do not lend themselves to statistical analysis.

EPA To Be Considered Comment 5

Section 2.1 In-Water Sediment Sample Locations and Depths, page 6: The second item describes reviewing grain size data across three depth intervals, 0-4 feet, 4-8 feet, and 8-16 feet. However, the samples shown on Figure 2-3 are all less than 8 feet deep. Explain if it is or is not necessary to assess deeper sediments.

NW Natural Response

See response to EPA TBC Comment 2.

EPA To Be Considered Comment 6

Section 2.1 In-Water Sediment Sample Locations, page 6 and Depths and 2.2 Soil Sample Locations and Depths, page 7: These sections should provide a more quantitative justification as to the representativeness of the soil and sediment sampling locations. More specifically, the ISSLPS Work Plan should include histograms or similar representations of grain size (for locations with PTW-

NAPL, and within the project area more generally) and should indicate where, within these distributions, the selected locations fall.

NW Natural Response

The requested figures have been added as Figures 2-3a and 2-3b, and the text has been revised accordingly.

EPA To Be Considered Comment 7

Section 3.2 Initial Characterization of Untreated Samples, page 9: EPA recommends the homogenization of the samples be completed at the laboratory on undisturbed samples collected from the field.

NW Natural Response

To facilitate the submittal of samples and the large volume of soil/sediment to multiple labs/facilities, the sediment cores and soil borings need to be homogenized and processed in the field. Material processing is intended to be conducted in a manner to minimize volatilization. See also the response to DEQ Specific Comment 8.

EPA To Be Considered Comment 8

Section 3.3 Grout Component Testing, pages 9 and 10: The ISSLPS should be expanded to measure and evaluate VOCs in headspace (off-gassing), temperature, pH, and material phase separation (NAPL mobilization, formation of precipitates and/or other gels/supernatant during setting). In addition, underwater application should consider grout blend designs that are specifically developed for underwater applications (e.g., plasticizers).

NW Natural Response

See response to EPA Specific Comment 9 regarding DNAPL mobilization. Also, as discussed in response to EPA Appendix A TBC Comment 1, there is no headspace when cylinders are cast, so measuring off-gassing is not possible. Temperature and pH measurements are not part of any design mix program in our experience, will not support remedial design evaluations, and are difficult to measure given the ways the test cylinders are created. Therefore, these measurements will not be made. The use of plasticizers in underwater cement applications is primarily to reduce the water/cement ratio (for strength development) and potentially to increase workability. As such, it is generally considered unnecessary for ISS applications because the grout will be pumped and mixed directly into sub-bottom sediments where the water content is determined by the (water-filled) porosity.

EPA To Be Considered Comment 9

Figures 2-1a through 2-1c: These figures show PTW-NAPL observations between 0 and 16 feet below the sediment surface. Additional figures should be added to show the full depth of PTW-NAPL observations (i.e., EPA recommends that this figure series extend to the known depth of remedial action level (RAL) exceedances).

NW Natural Response

The requested figure has been added as Figure 2-1d.

EPA To Be Considered Comment 10

Figures 2-2a through 2-2c: These figures show grain size distributions between 0 and 16 feet below the sediment surface. Additional figures should be added to show grain size distributions representative of the full depth of RAL exceedances.

NW Natural Response

The requested figure has been added as Figure 2-2d.

EPA To Be Considered Comment 11

The Yakama Nation provided the following questions and comments they would like to have considered in the ISSLPS and explored further in future discussions and design documents:

- Will the ISS method, including the treatment barrier wall, impede future habitat restoration efforts in nearshore and upland areas – for example, once in place does the ISS barrier result in a no work or no modification zone?
- How does the ISS method, including the treatment barrier wall, allow for natural physical and biological processes to occur below and above the ordinary high water?
- What impacts may occur to ESA listed and tribally important aquatic species and terrestrial species and habitats, including the biologically active zone?
- What additives will be used for the ISS method? Will an evaluation of potential impacts to habitat and species of these additives be conducted?
- The Yakama Nation would like more specific information on how the ISS method allows for optimum design of habitat improvements – including input from habitat restoration experts and tribes. Also, they would like more information on how the ISS method improves habitat on its own without mitigation or restoration.
- What will the treatment barrier wall and other areas incorporating the ISS method look like? There are photos in the 8/23/2022 presentation but they do not show how a wall will look in the environment.

NW Natural Response

NW Natural provides the following responses to each of these considerations:

- Construction of the in-water ISS will result in a footprint of treated sediments that will need to be managed as part of an EPA-approved long-term monitoring plan. This monitoring plan will be based on the final remedial design and document whether any aspect of the ISS remedy will be designated as a no work or no modification zone. As detailed in the PAR, habitat improvements on top of the in-water treatment footprint are proposed.
- The ISS method will impact the natural physical and biological processes during construction and immediately after construction below ordinary high water from the displacement of the benthic community. However, material is expected to be deposited on top of the ISS surface, and the benthic community is expected to re-establish within a relative short time-frame. This recovery will be accelerated by placing a habitat layer over the ISS surface. As an example, post-construction monitoring of the benthic community occurred as part of the ISS pilot study in Springfield, Massachusetts. Monitoring results indicated that recruitment and re-establishment of benthic invertebrates in surface sediments occurred within 8 months of ISS construction without placement of a habitat layer on top of the ISS surface. Approximately 3 inches of material had accumulated over the ISS surface within the 8-month time period. In addition, monitoring indicated that the surface sediments in the pilot study area contained a benthic community similar to that of an area upstream of the pilot study area (Jansen et. al. 2016). Above ordinary high water, the natural physical and biological processes will also be impacted where ISS is used. However, habitat materials (e.g., soils conducive to vegetation growth) could be placed over the final ISS surface to support vegetative cover.
- Impacts are mainly related to the disturbance to and displacement of the benthic community and the potential for increased pH levels and turbidity levels in the water column.
- Grout material is expected to consist of PC and BFSC. The main potential impact from this mixture is related to the high pH associated with uncured PC, but the curing duration is relatively short (i.e., days), so any potential impact will be temporary. Best management practices can be implemented to minimize this potential impact.
- The ISS method minimizes impacts during construction compared to dredging. Because of the solidification and stabilization processes, it will allow for habitat to be developed on top of it without the risk of contaminant exposure to the species using the habitat. As mentioned above, it is expected that material migrating in the river

will deposit on top of the ISS surface and accumulate and the benthic community will re-establish. This natural deposition will provide functional habitat without any restoration actions.

- The ISS treatment barrier wall and in-water ISS treatment area will be buried and covered habitat substrate, so the treated materials will not be visible.

EPA General Comment on Appendix A (ISSLPS FSP) of the ISSLPS Work Plan

EPA Appendix A General Comment 1

ISS as a ROD technology: While EPA agrees that ISS is a remedial technology that is included in the ROD's selected remedy, the ISSLPD Work Plan and/or future design deliverables should clearly discuss the conditions under which ISS was retained in the Feasibility Study (FS) and included in the selected remedy (e.g., for areas where access and slope stability issues exist, and for PTW underneath and around pilings, docks, berthing or mooring dolphins, and other structures servicing active wharfs or shore-based facilities that remain intact). ISS was specifically retained as a technology for use in areas with PTW and where groundwater is affecting porewater, which EPA recognizes are significant issues at the Gasco Project Area.

NW Natural Response

Future design deliverables will discuss the conditions under which ISS was retained in the Portland Harbor FS and included in the selected remedy.

EPA Specific Comments on Appendix A (ISSLPS FSP) of the ISSLPS Work Plan

EPA Appendix A Specific Comment 1

Section 3.1 PTW-NAPL Identification, page 3: According to the EPA-approved Revised Pre-Remedial Design Data Gaps Work Plan (Anchor QEA 2019b), if PTW-NAPL is identified then the homogenized samples should be subjected to shake tests. This also applies to soil samples with PTW-NAPL.

NW Natural Response

As stated in Section 3.2.2.1.1 of the *Revised Pre-Remedial Design Data Gaps Work Plan* (Anchor QEA 2019b), shake tests were intended to separate PTW-NAPL from sediment as an additional line of evidence for NAPL fluid properties testing. However, as documented in Section 2.3.2 of the *Revised Final Pre-Remedial Design Data Gaps Summary Report* (DSR;

Anchor QEA 2022b), the recovered NAPL sample quantities from all attempted shake tests were insufficient to complete the proposed physical and chemical testing. As detailed in Field Change Request No. 11 (included in Appendix A of the DSR), NW Natural attempted to achieve the shake test data quality objectives by liberating NAPL from sediment via laboratory centrifugation; however, insufficient sample volume was recovered from centrifugation. The DSR further states, "A surrogate for sediment-specific NAPL physical and chemical properties are those measured in upland samples. Upland DNAPL would be expected to have similar properties to the NAPL in sediments because, based on the Gasco Sediments Site conceptual model, PTW-NAPL was emplaced in sediment due to historical overland discharges or upland runoff; therefore, as a result, there are no data gaps associated with NAPL mobility via the advection sampling objective."

If possible while still achieving the objectives of the laboratory pilot study, NW Natural will opportunistically sample sediments containing PTW-NAPL and will attempt to liberate NAPL from sediments via laboratory centrifugation. The procedures for this work are detailed in Section 3.2.3 of the ISSLPS FSP. No revisions have been made to the Work Plan.

EPA Appendix A Specific Comment 2

Section 4.4.1 Management of Investigation-Derived Waste, pages 16 through 18: Investigation-derived waste characterization should include total solids/percent dry weight, per Table 3-1 of the Contaminated Material Management Plan (Anchor QEA, LLC and Hahn and Associates, Inc. 2021). In addition, Oregon State Department of Environmental Quality should be copied on the transmittal of the waste profile package to the selected disposal facility requesting acceptance of the waste for disposal.

NW Natural Response

The investigation-derived waste characterization was revised to include total solids/percent dry weight. NW Natural agrees to copy DEQ on the transmittal of the waste profile package to the selected disposal facility requesting acceptance of the waste for disposal.

EPA Appendix A Specific Comment 3

Section 5 Chemical and Physical Testing, pages 19 through 26: Clarify why free liquid testing similar to the Gowanus Canal Treatability Study was not considered.

NW Natural Response

It is unclear from the "In-Situ Solidification Treatability Study Work Plan" (GEI 2012) how free liquid testing will confirm "full and proper mixing" of the samples or how the test is conducted. In Anchor QEA's experience, free liquid testing is conducted to confirm acceptability of dredged material for disposal at an approved disposal facility.

EPA Appendix A Specific Comment 4

Section 5.1.1 In-Water Sediment Sample Baseline Testing, second bullet, page 20: Organic content testing of sediment samples should be included as organic content can have significant influence on pozzolanic action of cementitious materials. Atterberg Limit testing should also be considered to measure plasticity of cohesive sediment, along with sediment moisture content. Also include relevant ASTM Standards or EPA methods for all the listed laboratory tests in this section.

NW Natural Response

Total organic carbon, moisture content, and Atterberg limits testing has been added for baseline testing of the untreated sediment and soil (Section 3.1 of the Work Plan). Relevant ASTM/EPA methods have been cited.

EPA Appendix A Specific Comment 5

Section 5.1.2 Soil Sample Baseline Testing, page 20: Organic content testing of sediment samples should be included as organic content can have significant influence on pozzolanic action of cementitious materials. Atterberg Limit tests should also be considered to measure plasticity of cohesive sediment, along with soil moisture content. Also include relevant ASTM Standards or EPA Methods for the listed laboratory tests in this section.

NW Natural Response

See response to EPA Appendix A Specific Comment 4.

EPA Appendix A Specific Comment 6

Section 5.2 Grout Component Testing, pages 20 and 21: Grout component testing should be conducted on more than one sediment sample location. Separate grout component testing should be conducted for sediments composed of different grain size distributions. EPA recommends at least one test be conducted on sediment that is predominantly fine-grained, and one test be conducted on sediment that is predominantly sand.

NW Natural Response

In general, higher fines can retard strength development or decrease the UCS, while higher fines have a lower permeability to begin with, and ISS may not provide much additional reduction. The higher fines samples will, therefore, provide the greater challenge for ISS to increase strength and reduce permeability, compared to a location with lower fines. NW Natural recommends keeping the grout component testing on the one location with the higher fines content. All locations will be analyzed during the Phase II grout dosage testing.

EPA Appendix A Specific Comment 7

Section 5.4.1 Phase I, pages 22 through 23: EPA has the following comments on this section and the text should be revised accordingly:

a. If DNAPL is present in the leachate sample, it can similarly be leaching from treated sediment under field conditions. Filtering the sample is likely to result in leachate concentrations that are biased low. Therefore, both filtered and unfiltered leachate samples should be analyzed.

b. Chemical analysis of the leachate should include all contaminants with ROD Table 17 groundwater and riverbank soil/sediment CULs.

c. Oxidation reduction potential (ORP) and conductivity measurements of the leachate should be included.

NW Natural Response

a. The purpose of the Phase III leachability testing is to determine the aqueous phase concentrations. Filtering using a ceramic filter ensures that the sample consists of only water. This does not bias the results low. If DNAPL or sheen is produced from a sample, it will also be noted, as stated in the Work Plan.

b. See response to EPA Specific Comment 11. Section 3.2 of the Work Plan has been revised accordingly.

c. ORP and specific conductivity of leachates will be measured and recorded. The Work Plan has been revised accordingly.

EPA Appendix A Specific Comment 8

Section 5.4.2.1 Phase II Leachability Testing, pages 23 through 24: EPA has the following comments on this section and the text should be revised accordingly:

a. Chemical analysis of the leachate should include all contaminants with ROD Table 17 groundwater and riverbank soil/sediment CULs.

b. ORP and conductivity measurements of the leachate should be included.

NW Natural Response

See response to EPA Appendix A Specific Comment 7.

EPA Appendix A Specific Comment 9

Section 5.4.2.2 Equilibrium Aqueous Concentration Assessment, last bullet, page 24: Revise the text to include a citation for the 8-week equilibration time for assessment of aqueous concentrations.

NW Natural Response

The text has been revised consistent with the comment.

EPA Appendix A Specific Comment 10

Section 5.4.2.3 Microscale Characterization and Pore Size Distribution Measurement, pages 24 and 25: Specify the test method for the scanning electron microscopy (SEM) analysis.

NW Natural Response

Although there is no standard test method for SEM analysis, references where SEM has been used to visualize the microstructure of ISS-treated soil/sediment have been added to Section 5.4.2.3 of the FSP.

EPA To Be Considered Comments on Appendix A (ISSLPS FSP) of the ISSLPS Work Plan

EPA Appendix A To Be Considered Comment 1

Section 5.2, Grout Component Testing, 2nd paragraph, page 21 and Section 5.4.1 Phase I, 1st bullet, page 22: The text states that after blending grout with sediments or soil, the mixture will be poured into a cylindrical mold, "tamped to eliminate air, and the top surface will be leveled…and capped with a plastic air-tight lid"; moreover, they will be cured "at room temperature until further testing." The Phase I leachability testing is stated to occur under static conditions, which the ISSLPS Work Plan asserts "will further mimic field conditions." This presents a concern that many of these conditions (e.g., curing temperature, curing within a mold, an absence of water flow) do not, in fact, mimic field conditions. The ISSLPS Work Plan should more carefully discuss, with appropriate evidence, how well these conditions do or do not comport with expected field conditions to which ISS-stabilized soils or sediments would be subject, and should consider modifications, as needed, to represent likely field conditions more accurately. The ISSLPS Work Plan should also address how results will be interpreted, in light of disparities between laboratory and field conditions.

NW Natural Response

Phase III (previously identified as Phase I leachability testing) leachability testing is a screening leachability test primarily intended to rank performance of grout composition and dosage(s) selected during the Phase II testing in terms of leachability reduction for a range of sediment types and levels of contamination. Text referring to mimicking field conditions has been removed. Absence of water flow will be similar in the field once the grout cures.

EPA Appendix A To Be Considered Comment 2

Section 5.4.2.3, Microscale Characterization and Pore Size Distribution Measurement, pages 24 and 25: This section addresses microscale characterization and pore size distribution measurements. It seems likely that these characteristics could differ considerably for sediments under field conditions as compared to lab conditions, as sediments under field conditions would be subject to higher levels of pressure (e.g., from overlying sediments and water). Consider expanding this section to address this issue and explain the relevance of the proposed laboratory tests for field conditions.

NW Natural Response

The objective of these measurements is primarily to understand the effect of grout addition on porosity and tortuosity to help interpret laboratory leachability test results (i.e., both performed on test cylinders prepared in the same way). Porosity reduction and tortuosity are likely to be enhanced in the field relative to laboratory test cylinders due to the higher overburden confining pressure, which is expected to permit less matrix deformation and greater infilling of pore space by cement hydration products.

EPA Specific Comments on Appendix B (ISSLPS QAPP) of the ISSLPS Work Plan

EPA Appendix B Specific Comment 1

Approval Page, page i: The EPA Region 10 Quality Assurance Manager is Cindy Fields and she should be listed on the Approval Page. Various Region 10 quality assurance staff are designees who can approve quality assurance project plans (QAPPs) and sign for the Quality Assurance Manager.

NW Natural Response

The text has been revised consistent with the comment.

EPA Appendix B Specific Comment 2

Distribution List, page ii: The specific ALS Environmental laboratory that will be used should be provided.

NW Natural Response

ALS Kelso will be the primary ALS lab that will sub samples to ALS Houston for perchlorate analyses. This has been added to the distribution list.

EPA Appendix B Specific Comment 3

Section 1, Introduction, page 1: It is stated that the goal of the QAPP is to ensure that data of sufficiently high quality are generated to support the project data quality objectives. The project data quality objectives should be stated or summarized here.

NW Natural Response

Data quality objectives are presented in Section 2.4, and the text has been revised to reference this section.

EPA Appendix B Specific Comment 4

Section 2.6.2, Preparation and Analytical Chemistry Records, page 6: It is stated that laboratory data packages will contain information necessary to perform a Stage 4 data validation, per EPA guidelines. It also states that Stage 2B validation will be performed for all data except geotechnical and DNAPL mobility data. State the reason for the data packages including information needed for Stage 4 data validation even though Stage 4 data validation will not be conducted. It should be stated if issues with data will trigger a higher level of validation to be performed.

NW Natural Response

Level 2 or Level 4 formats are the typical formats offered by laboratories. A Level 2 does not provide enough information to conduct Stage 2B validations; therefore, level 4 reports will be requested. The text has been revised to specify.

EPA Appendix B Specific Comment 5

Section 3.5.1.4, Field Quality Assurance Sampling, pages 16 and 17: State what type of water will be used for rinsate blanks.

NW Natural Response

The text has been revised consistent with the comment.

EPA Appendix B Specific Comment 6

Section 3.5.2, Laboratory Quality Control, pages 16 through 18: The section should state how the results will be reported; e.g. state whether results will be reported down to the reporting limits or method detection limits and how detections will be reported between the method detection limit and the reporting limit.

NW Natural Response

The text has been revised consistent with the comment.

EPA Appendix B Specific Comment 7

Figure B-1, Project Organization Chart: Change the EPA Region 10 Quality Assurance Manager from Don Matheny to Cindy Fields.

NW Natural Response

The figure has been revised consistent with the comment.

EPA Appendix B Specific Comment 8

Tables B-2 through B-5: It should be clearly stated who will perform the leaching tests and the laboratory that is doing each analysis.

NW Natural Response

The laboratory information has been added to Tables B-8 and B-9, which summarize all the solid and aqueous analyses presented in Tables B-2 through B-5.

EPA Appendix B Specific Comment 9

Table B-6, Field and Laboratory Quality Control Sample Analysis Frequency: There are no references in the Table for notes 3 and 4. EPH is not defined in the table notes.

NW Natural Response

EPH has been defined in the table notes, and the note references have been revised.

EPA Appendix B Specific Comment 10

Table B-8, Guidelines for Solid Handling and Storage: Define the acronyms PDMS and VOCs in the acronym list at the bottom of the table.

NW Natural Response

The acronyms have been added to the table notes.

EPA Appendix B Specific Comment 11

Attachment 1: Standard Operating Procedures:

a. Please confirm that unless a modification is called out in the standard operating procedures, methods 1312 and 1315 will be followed as written in the standard EPA methods.

b. EPA Method 1315 states that this method "is a characterization method and does not provide a solution considered to be representative of eluate under field conditions". EPA expects that leachability will be evaluated under field conditions during the field pilot study.

NW Natural Response

a. This statement is confirmed.

b. EPA Method 1315 is intended to characterize initial mass transfer rates from the ISS treated sediments. Mass transfer rates are important for determining concentrations immediately adjacent (e.g., above the treatment layer) and are expected to decrease over time as the outermost portions of the treatment layer become depleted of leachable contaminants. Direct measurement of leachability in the field during the pilot test is not feasible. If the pilot test is successful from a constructability perspective, the initial mass transfer rates measured by EPA Method 1315 will be used to estimate concentrations adjacent to the treatment layer and determine the need for and composition of cover on top of the treatment layer during a subsequent design phase.

EPA Appendix B Specific Comment 12

Attachment 2: In Situ Stabilization and Solidification Laboratory Pilot Study Data Management Plan: Add a statement to Section 1.2 (Data Management Objectives) that any Data Management Plan revisions will be transmitted to EPA in with redline/strikethrough format for review.

NW Natural Response

The text has been revised consistent with the comment.

EPA General Comment on Appendix C (ISSLPS HASP) of the ISSLPS Work Plan

EPA Appendix C General Comment 1

Note that EPA does not approve Performing Party health and safety plans but reviews for completeness.

NW Natural Response

Comment noted.

EPA Specific Comments on Appendix C (ISSLPS HASP) of the ISSLPS Work Plan

EPA Appendix C Specific Comment 1

Liability Waiver, pages L-1 through L-2: Some of the language, particularly in points 1, 2, and 4, seem to conflict with OSHA's General Duty Cause and the employer's obligation to provide a workplace free of recognized hazards likely to cause serious physical harm. Also, the language may appear contradictory to an employee's right to worker's compensation claims for valid, work-related incidents. Consider rewording.

NW Natural Response

The liability waiver is only for visitors to the site who are not Anchor QEA staff. Those who normally work on the site would not sign this document. It has been removed from the body of the ISSLPS HASP.

EPA Appendix C Specific Comment 2

Emergency Contact Information, Table A, page v: Client contact phone numbers are the same; update as needed.

NW Natural Response

Client phone numbers have been revised in Table A.

EPA Appendix C Specific Comment 3

Section 3.1, Project Scope of Work, page 4: Laboratory activities are covered under this HASP; update accordingly.

NW Natural Response

Soil borings along top of riverbank have been added to Section 3.1. Anchor QEA's Portland laboratory has a document called the Chemical Hygiene Plan, which covers health and safety topics. A health and safety section is included in each lab Standard Operating Procedure. In addition, the lab staff will review the contents of the field HASP to be sure they understand any hazards associated with the media being received for the project.

EPA Appendix C Specific Comment 4

Section 4.4, Project Field Team, page 8, last paragraph: Remove "(preferably an individual with HAZWOPER Supervisor training)". A Supervisor with HAZWOPER Supervisor Training must provide the described training.

NW Natural Response

Text has been updated consistent with the comment.

EPA Appendix C Specific Comment 5

Section 7.5, Field Communication, Table 7-1, page 22: Confirm that a compressed air horn will be onsite or adjust the communication device within this table accordingly.

NW Natural Response

The field team will confirm a compressed air horn is available and on site to support field communication, as needed.

EPA Appendix C Specific Comment 6

Section 9.6, Hazardous Waste Operations Training, page 28: This is general company Hazard Communication (HAZCOM) procedures. It is not explicitly clear that personnel on this project will be HAZCOM trained. To achieve this, update the appropriate job safety analyses (JSA's) to identify when HAZCOM training is required for this project.

NW Natural Response

Additional information has been added to Section 9.4 of the ISSLP HASP and JSAs. Anchor QEA is required by regulation to provide HAZCOM training, which we do with all HAZWOPER staff. HAZCOM training is required for all staff on this project.

EPA Appendix C Specific Comment 7

Attachment B, Job Safety Analysis Documents: Identify contaminant inhalation hazard and controls including monitoring in the appropriate JSA's.

NW Natural Response

Information has been added to applicable JSAs.

EPA Appendix C Specific Comment 8

Attachment C, Safety Data Sheets: Not all the safety data sheets conform with the Globally Harmonized System Standards (e.g., Diesel #2, Liquinox); update accordingly.

NW Natural Response

Correct. Safety data sheets have been updated.

EPA and NW Natural References

Anchor QEA, 2010. *Final Project Area Identification Report and Data Gaps QAPP – Gasco Sediments Cleanup Action*. Prepared for U.S. Environmental Protection Agency, Region 10. Prepared on behalf of NW Natural. July 2010.

Anchor QEA, 2018. *Interim Feasibility Study*. Gasco OU, ECSI No. 84. Prepared for NW Natural. November 21, 2018.

Anchor QEA, 2019a. *Final Pre-Remedial Basis of Design Technical Evaluations Work Plan*. Gasco Sediments Cleanup Action. Prepared for U.S. Environmental Protection Agency, Region 10. Prepared on behalf of NW Natural. August 29, 2019.

Anchor QEA, 2019b. *Revised Pre-Remedial Design Data Gaps Work Plan*. Gasco Sediments Cleanup Action. Prepared for U.S. Environmental Protection Agency, Region 10. Prepared on behalf of NW Natural. September 11, 2019.

Anchor QEA, 2021. *Combined Sediment Remedy Basis of Design and Preliminary Design Report*. Prepared for U.S. Environmental Protection Agency, Region 10. Prepared on behalf of NW Natural. April 30, 2021.

Anchor QEA, 2022a. *Source Control Addendum Report*. NW Natural Gasco Site, ECSI No. 84. Prepared for NW Natural. November 10, 2022.

Anchor QEA, 2022b. *Revised Final Pre-Remedial Design Data Gaps Summary Report*. Prepared for U.S. Environmental Protection Agency, Region 10. Prepared on behalf of NW Natural. January 28, 2022.

Anchor QEA and HAI, 2021. *Contaminated Materials Management Plan*. NW Natural Gasco Site. Prepared for NW Natural. November 19, 2021.

DEQ (Oregon Department of Environmental Quality), 2022. Letter to Bob Wyatt (NW Natural). Regarding: DEQ Comments on the Source Control Addendum Report, Former Gasco Manufactured Gas Plant Operable Unit, Portland, Oregon, ECSI #84, ECSI #183. December 22, 2022.

Eberhardt, C., and P. Grathwohl, 2002. "Time Scales of Organic Contaminant Dissolution from Complex Source Zones; Coal Tar Pools vs. Blobs." *Journal of Contaminant Hydrology* 59(1-2):45-66.

EPA (U.S. Environmental Protection Agency), 1992. *Guidance for Conducting Treatability Studies under CERCLA, EPA/540/R-92/071a*. October 1992.

EPA, 2009a. *Administrative Settlement Agreement and Order on Consent*. Gasco Sediments Site, Portland Harbor Superfund Site, Portland, Multnomah County, Oregon. CERCLA Docket No. 10-2009-0255. September 2009.

EPA, 2009b. *Statement of Work – Gasco Sediments Site*. U.S. Environmental Protection Agency Region 10. September 9, 2009.

EPA, 2019. *Guidance for River Bank Characterizations and Evaluations at the Portland Harbor Superfund Site*. August 27, 2019.

GEI, 2012. *In-Situ Solidification Treatability Study Work Plan*. Gowanus Canal, New York. April 24, 2012.

Grubb, D.G., T.M. Himmer, J.L. Gentry, A.J. Salter-Blanc, and C.D. Tsiamis, 2020. "Gowanus Canal Superfund Site. III: Leaching of In Situ Stabilization/Solidification Mix Designs." *Journal of Hazardous, Toxic, and Radioactive Waste* 24(4): 04020045.

ITRC (Interstate Technology and Regulatory Council), 2011. *Development of Performance Specifications for Solidification/Stabilization*. July 2011.

Jansen, P., M. Sabulis, and J. Clock, 2016. "In Situ Solidification (ISS) of River Sediments: Pilot Demonstration and Discussion of ISS as a Remedial Alternative to Dredging and Capping." *Remediation* 26(2): 25-49.

Olean, T.J., J.L. Gentry, A.J. Salter-Blanc, T.M. Himmer, M. Bruno, and C.D. Tsiamis, 2016. "In-Canal Stabilization/Solidification of NAPL-Impacted Sediments." *Remediation* 26(3): 9-25.

Ramboll US Corporation, Anchor QEA Engineering, PLLC, and Analytical & Environmental Services, Inc., 2019. *In-Situ Solidification/Stabilization Treatability Study Bench Testing Report*. Quanta Resources Superfund Site OU2, Edgewater, New Jersey. Prepared for Honeywell International Inc. August 2019.

DEQ General Comments on ISSLPS Work Plan

DEQ General Comment 1

DEQ clarifies that deliverables that include work conducted under the ASAOC and upland cleanup agreements are subject to approval by EPA and DEQ, respectively, and should be prepared and submitted to both agencies consistent with the requirements of applicable cleanup agreements. We consider joint agency review of the LPS WP as a "test case" for coordinating joint reviews of future design deliverables (assuming both EPA and DEQ approve the in-water and upland elements of the "Full Dredge and ISS" Design alternative and new source control alternative, respectively). If joint agency review and approval of the LPS WP is not possible, then DEQ will require that the LPS WP and all future deliverables related to the in-water and upland elements of the "Full Dredge and ISS" Design alternative and new source control alternative be submitted to EPA and DEQ separately.

NW Natural Response

NW Natural has revised the Work Plan as a deliverable submitted to DEQ under the voluntary agreement as well as to EPA under the 2009 ASAOC.

DEQ General Comment 2

Revise the LPS WP to clarify that the LPS WP, including appendices, have been prepared in accordance with the ASAOC and the Voluntary Agreement for Remedial Investigation/Feasibility Study (DEQ No. WMCVC-NWR-94-13), as amended.

NW Natural Response

Section 1 of the Work Plan has been revised accordingly.

DEQ General Comment 3

Portions of the LPS WP describe the ISS barrier wall as a component of the in-water remedy. These statements or implications are incorrect. Revise the LPS WP to clarify that the ISS barrier wall is an element of a proposed new source control alternative, subject to DEQ approval and oversight. In addition, revise descriptions of the ISS barrier wall location to clarify that it is located in the Gasco OU uplands.

NW Natural Response

The ISS barrier wall is designed to minimize groundwater discharge to ISS-treated riverbank soils and in-water sediments and is a component of the in-water remedy. The ISS barrier wall is also a source control measure subject to DEQ approval and oversight under the 2001 Memorandum of Understanding between EPA and DEQ and NW Natural's voluntary agreement with DEQ. The Work Plan has been revised accordingly.

DEQ General Comment 4

Revise the LPS WP to consider how various ISS grout additives may affect the geochemistry of the soil and groundwater, and how those geochemical changes would affect mobilization of contamination. The LPS WP should acknowledge that the water used during leachability tests may not be representative of the groundwater at the site and discuss how actual field conditions may differ from laboratory scale conditions. For example, the groundwater (and associated contamination) that would interact with the ISS-treated soils will be anoxic and highly reducing relative to the water used in the leachability tests. These reducing conditions have the potential to change contaminant transport or long-term leachability (e.g., for metals like arsenic and manganese).

NW Natural Response

See response to EPA General Comment 6.

DEQ General Comment 5

DEQ offers the following comments regarding the proposed selection criteria for the grout mix design for soils:

a. The LPS WP sets a minimum unconfined compressive strength (UCS) performance target of 50 pounds per square inch (psi). DEQ agrees that 50 psi represents a reasonable and appropriate minimum performance target for UCS. We recommend that the LPS WP also set a maximum UCS performance target (e.g., 150 psi) to ensure that the selected mix design can accommodate various known and unknown future use scenarios.

b. The LPS WP sets a permeability performance target of less than 10^{-6} centimeters per second (cm/s). DEQ agrees that this represents a reasonable and appropriate performance target.

c. The LPS does not propose leachability testing for upland soils. DEQ requires leachability testing for upland soils. DEQ is comfortable moving forward without numerical leachability goals, but notes that leaching (or diffusive flux) of contamination from the ISS-treated soils will need to be assessed to ensure that the ISS barrier wall is able to maintain long-term control of contamination to the Willamette River. The grout mix design that provides the greatest reduction in leachability (that also achieves the other performance targets and is constructable) should be selected for full scale application.

d. The LPS WP identifies limiting the overall volume increase (swell) during construction as a selection criterion. DEQ considers this objective secondary to achieving the strength, permeability, and leachability reduction goals.

e. In addition to the performance targets discussed in the LPS WP, selection of a grout mix design for the ISS barrier wall should consider other criteria applicable to full-scale ISS implementability. Revise the LPS WP to provide additional discussion of parameters that represent technology-specific or site-specific implementation limitations or challenges, such as ability of grout to flow through injector heads of an auger, application of ISS in limited access areas (beneath dock walkways, dolphin walkways, vegetation, utilities etc.), the effect of study parameters (including UCS, swell, etc.) on the use, maintenance, or function of upland infrastructure near the shoreline, and the ability to vary grout mixes through soils with different physical and chemical characteristics.

NW Natural Response

a. NW Natural will not set a target maximum UCS because a 28-day 50 psi target for the Work Plan is sufficient to accommodate existing and future site uses, there are no negative impacts to having the soil mass be stronger than this target as long as the other grout selection criteria identified in Section 3.4 of the Work Plan are achieved, the UCS will continue to increase after the 28-day testing period, and there may be high variability and significantly higher strengths depending on the base soil characteristics.

b. Comment noted.

c. The Work Plan has been revised to include Phase III and IV leachability testing for five upland soil locations after the Phase II testing. As stated in Section 3.4 of the Work Plan, the grout selected for full-scale application will be dependent on multiple lines of evidence, including meeting the target strength and permeability requirements, reducing leachability of the treated compared to untreated material tests, limiting the overall volume increase (swell) during the ISS construction, and providing a mix consistency that meets constructability requirements and is suitable for efficient blending of sediment or soil with the grout.

d. Comment noted.

e. SES has implemented dozens of upland ISS projects throughout the country under a variety of site conditions. The grout mix design will integrate the lessons learned during these projects and consider the properties of the blends at intermediate and at the end stages. Consistent with the grout selection criteria identified in Section 3.4 of the Work Plan, the grout mix consistency will be evaluated to determine whether it meets constructability requirements and is suitable for efficient blending of sediment or soil with the grout. The use of ISS in areas of limited access will be addressed during remedial design, and the mix would not be affected by such factors. In general, it is infeasible to vary the grout mixture to meet localized differences in soil characteristics. Further, as described in the response to EPA TBC Comment 3, the DeWind One-Pass Trenching technology completely homogenizes the vertical soil profile into a semi-fluid state with a thickness of 3 feet. After the machine passes, the homogenized blend sets up and attains the required design parameters. The objective of our grout design mix program will be to evaluate whether one or a small number of grout mixes can achieve the performance criteria for the range of empirically measured site conditions. all the site conditions upland and another mix that meets all the conditions in the sediments. NW Natural has determined that a 28-day 50 psi UCS and 10^{-6} permeability target is sufficient to maintain existing and future site use, maintenance, and function of upland structures near the shoreline.

DEQ General Comment 6

The number and location of proposed soil sampling locations are inadequate. The Gasco OU soil and groundwater along portions of the shoreline are contaminated with high concentrations of total cyanide, naphthalene, benzene and other volatile organic compounds (VOCs), chlorinated VOCs (cVOCs), and metals. As shown on Table 2-1 of the ITRC Guidance for the *Development of Performance Specifications for Solidification/Stabilization,*[3] ISS may not effectively control leaching of VOC contaminated media. The proposed boring adjacent to PW-2L will be informative for evaluating leachability of cVOCs. Further, application of ISS may mobilize high concentrations of metals to groundwater during construction as a result of pH changes. Revise the LPS WP to explain the rationale for selecting soil sample locations and depth intervals for testing, and how that rationale considers areas known to contain higher concentrations of these contaminants in order to evaluate short-term releases of these contaminants during construction and their long-term leachability from treated soils. In addition, revise the LPS WP to include the following:

a. DEQ requires another soil boring another located near the MW-21 monitoring well cluster (or an acceptable alternative location with significantly elevated benzene and naphthalene concentrations).

b. DEQ requires an additional soil boring location close to PW-10L, which is near the shoreline and the US Moorings property boundary.

c. DEQ requires that soil samples representative of the fill, upper silt unit, Upper Alluvium, and Lower Alluvium be collected from each soil boring location to evaluate the heterogeneities (hydraulic conductivity, soil types and grain size differences) within each of these hydrogeological units. Multiple samples from these hydrogeologic units within each boring may be appropriate to test a range of grain sizes and contamination characteristics.

NW Natural Response

The Work Plan has been revised to explain the rationale for the number and location of soil sample locations, including the two new locations identified by DEQ to be co-located with MW-21-165 and PW-10L. The soil sampling program presented in the Work Plan has been

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[3] Interstate Technology and Regulatory Council (ITRC). 2011. Development of Performance Specifications for Solidification/Stabilization. July.

revised based on NW Natural's revised intention to use the DeWind One-Pass Trenching technology for installation of the deep ISS treatment barrier wall, as discussed in response to EPA TBC Comment 3. This technology will effectively homogenize soils from top to bottom during trenching and grout mixing. As such, the Work Plan proposes composite sampling within each boring to collect a soil sample representative of the fully homogenized soil from the ground surface to the bottom depth of the wall at each location, as described in revised Table 2-2.

DEQ General Comment 7

Several sections of the LPS WP limit consideration of PTW-NAPL to DNAPL that is observed to ooze from sediments. This limitation does not apply to upland soils. DEQ requires that soil cores log all manufactured gas plant (MGP) residuals. These materials are identified on Interim Feasibility Study[4] Table 4-1. Furthermore, one of DEQ's core objectives of the LPS is to understand long-term leachability of contaminants from ISS-treated soil. While DNAPL represents a source of potentially mobile and highly concentrated contamination, other MGP residuals also represent sources of highly concentrated contamination with the potential to contribute to long-term leaching. Assessing LPS sample locations for all MGP residuals will reduce uncertainty about the long-term reliability and protectiveness of ISS.

NW Natural Response

Upland boring locations will be logged and described as per approved procedures for upland investigations, which includes description of the suite of MGP residuals as identified in Table 4-1 of the Interim Feasibility Study (Anchor QEA 2018). Table 2-2 of the Work Plan has been revised to include a description of the type and depth of MGP residuals that are anticipated to occur within each of the five proposed soil boring locations. As described in response to EPA TBC Comment 3, because the DeWind One-Pass Trenching technology mixes and homogenizes soils throughout the entire depth interval of the proposed deep ISS treatment barrier wall, strength, permeability, pre-treatment chemistry, and leachate chemistry testing is proposed to be completed on composite samples representative of the full soil column to be mixed during barrier construction, to include MGP residuals as encountered within the profile.

DEQ General Comment 8

Consistent with recommendations provided in Section 2.3 of the ITRC Guidance for the Development of Performance Specifications for Solidification/Stabilization, the grout mix designs tested as part of the LPS should include reagents and additives to evaluate the potential to further improve reduction

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[4] Anchor QEA, LLC. 2018. Draft Interim Feasibility Study. Gasco OU. Prepared for NW Natural. November 18 (final content received January 11, 2019).

of contaminant leachability. DEQ requires that bentonite clay, organophilic clay, oxidants (persulfate),[5] and activated carbon be tested. Different grout mix additives/reagents may offer advantages across different WBZs or GSAs with different characteristics and natures of contamination (i.e., cVOC impacted areas, DNAPL and other MGP residual-impacted areas, areas with high concentrations of benzene, naphthalene, and metals).

NW Natural Response

See response to EPA General Comment 7 regarding evaluation of reagents and additives to improve reduction of contaminant leachability. In addition, as discussed in response to EPA TBC Comment 3, the DeWind One-Pass Trenching technology mixes and homogenizes soils throughout the entire depth interval of the proposed deep ISS treatment barrier wall, so evaluation of reagents in different WBZs is not applicable.

DEQ Specific Comments on ISSLPS Work Plan

DEQ Specific Comment 1

Section 1.1, Background. Revise the third sentence the third paragraph to state, “An alternative source control approach, consisting of an integrated deep ISS barrier wall, groundwater interceptor trench, and network of monitoring wells, has been proposed to DEQ.” Refer to DEQ Comments[6] on the Source Control Addendum.[7]

NW Natural Response

This section has been revised consistent with the comment.

DEQ Specific Comment 2

Section 1.1, Background. The fourth paragraph states that the Full Dredge and ISS Design alternative “eliminates contaminant transport via advective flux, and ensures there will be no recontamination of the Project Area from the Gasco OU uplands…” Revise this paragraph to clarify that the objective of DEQ’s source control program at the Gasco OU uplands is to prevent recontamination of the Gasco Sediments Site. The existing groundwater source control measure for the Alluvium WBZ (the hydraulic control and containment [HC&C] system) is currently achieving source control objectives. The planned groundwater interceptor trenches and/or horizontal wells in the Fill WBZ are expected to achieve source control objectives. NW Natural submitted a Source

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[5] J. Bergman, H. Nord, P. Elander, S. Moeini, J. Molin, and B. Smith. 2022. Combined Remedies Evaluation to Treat Residual Contamination at a Former MGP Site. Presented by Jonny Bergman (RGS Nordic/Sweden), Battelle -Twelfth International Conference on the Remediation of Chlorinated and Recalcitrant Compounds proceedings, Palm Springs, California. May 25.

[6] DEQ. 2022. Letter to Bob Wyatt (NW Natural). Regarding: DEQ Comments on the Source Control Addendum Report, Former Gasco Manufactured Gas Plant Operable Unit, Portland, Oregon, ECSI #84, ECSI #183. December 22.

[7] Anchor QEA, LLC. 2022. Source Control Addendum Report, NW Natural Gasco Site, ECSI No. 84. Prepared for NW Natural. November 10.

Control Addendum to DEQ on November 10, 2022 that includes a new source control alternative consisting of an ISS barrier wall, groundwater interceptor trench, and a network of monitoring wells. DEQ provided comments on the Source Control Addendum on December 23, 2022.

NW Natural Response

This section has been revised to include the statement that the objective of DEQ's source control program at the Gasco OU uplands is to prevent recontamination of the Project Area.

DEQ Specific Comment 3

Section 1.3.2, Leachability Testing Objectives and Evaluation Criteria. The first paragraph states that after treatment, "there will be no pathway for advective flux through the treated areas." While DEQ agrees that the hydraulic conductivity of the treated soils will be very low, some amount of advective flux through ISS barrier wall will occur. As shown on Figure 3-1 of the ITRC Guidance for the Development of Performance Specifications for Solidification/Stabilization, there are several factors that may play a role in the long-term physical and environmental performance of cement-based materials that may result in some advective flux through the treated soils. DEQ does not believe these factors are likely to result in failure but may warrant further consideration to ensure that the ISS barrier wall is able to maintain long-term control of contamination to the Willamette River.

NW Natural Response

This section has been revised to state, "Given the expected final permeability target for ISS, there will be negligible advective flux through the treated areas." The advective flux will be estimated in the design stage after the ISS permeability data are obtained through the proposed treatability testing.

DEQ Specific Comment 4

Section 2.2, Soil Sample Locations and Depth. Delete the first sentence of the first paragraph. DEQ is the lead agency responsible for overseeing Gasco OU upland remediation and source control.

NW Natural Response

The requested revision has been made.

DEQ Specific Comment 5

Section 2.2, Soil Sample Locations and Depth. This section poorly explains the rationale for the proposed soil sampling locations and depths. Revise the LPS WP to include a matrix that relates each sample location and depth to each LPS objective and variable(s) being evaluated. At a minimum, the variables evaluated as part of the LPS scope should include, but not be limited to: grain size, hydraulic conductivity, moisture content, presence and type of MGP residual (including DNAPL), concentration of VOCs and SVOCs (e.g., benzene, naphthalene, TCE, etc.), concentration of site-specific COCs that may be affected by the grout mix design (e.g., total petroleum hydrocarbons (TPH), cyanide, pH dependent metals [arsenic, aluminum, iron, manganese, etc.]), constituents that affect leachate composition (e.g., total and dissolved organic carbon), and presence of constituents that may affect grout setting/curing or long-term performance[8] (e.g., sulfate, sulfite, chlorides).

NW Natural Response

Table 2-2 has been revised to provide the descriptive matrix requested by DEQ, including additional locations, sample depths, and testing parameters. The revisions include where treatability test samples will be collected, the WBZs from which test samples will be obtained, and MGP residuals types known to be present in those zones. As discussed in response to EPA TBC Comment 3, the DeWind One-Pass Trenching technology mixes and homogenizes soils throughout the entire depth interval of the proposed barrier, so composite samples will be collected and analyzed across all WBZs in each location. The five upland soil sampling locations target locations of potentially mobile DNAPL, which will include conservatively high concentrations of VOCs and semivolatile organic compounds (SVOCs) (e.g., benzene, naphthalene, TCE, etc.), and TPH. NW Natural did not include analysis of hydraulic conductivity or moisture content since those values may be reliably estimated using other available data. The text of Section 2.2 has been revised to better describe the (modified/expanded) testing program. See also EPA General Comment 6 regarding the potential effect of grout mix design on site-specific contaminants such as metals.

DEQ Specific Comment 6

Section 3.1, Sample Collection and Handling. Revise the LPS WP to provide the target volume from each of the sample locations.

NW Natural Response

The Work Plan has been revised consistent with the DEQ comment. Please also see revised Table A-2 in the FSP.

DEQ Specific Comment 7

Section 3.2, Initial Characterization of Untreated Samples. Upland soils should be analyzed for ROD Table 17 COCs with groundwater CULs, any other COCs that exceed ROD Table 17 cleanup levels within the Gasco Sediments Site and/or upland shoreline across any media, as well as

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[8] As shown on Figure 3-1 and Table 4-1 of the ITRC Guidance for the Development of Performance Specifications for Solidification/Stabilization, environmental attack of these constituents on Portland cement blends may lead to aggressive degradation.

constituents that may require special consideration for the ISS technology (See specific comment #5). This comment also applies to Appendix A Section 5.1.1 and Appendix B.

NW Natural Response

The analyte list for the untreated bulk soil samples is identified in Section 3.2 of the Work Plan.

DEQ Specific Comment 8

Section 3.2, Initial Characterization of Untreated Samples. DEQ recommends the homogenization of the samples be completed at the laboratory on undisturbed samples collected from the field.

NW Natural Response

To facilitate the submittal of samples and the large volume of soil/sediment to multiple laboratories/facilities, the sediment cores and soil borings need to be homogenized and processed in the field. Material processing is intended to be conducted in a manner to minimize volatilization.

DEQ Specific Comment 9

Section 3.3, Grout Component Testing. The LPS should be expanded to measure and evaluate TPH and VOCs in headspace (off-gassing), temperature, pH, and material phase separation (NAPL mobilization, formation of precipitates and/or other gels/supernatant during setting).

NW Natural Response

Section 3.4 has been modified to discuss visual assessment of DNAPL mobilization, formation of precipitates, gels, or other supernatants in ISS-treated materials during setting. Headspace sampling will not be performed at this stage; however, VOC leachate concentrations determined in the Phase III leachability tests will be used to estimate equilibrium vapor concentrations using Henry's law.

DEQ Specific Comment 10

Section 3.4, Strength and Permeability Testing. The LPS should be revised to provide additional detail describing the method for determining when the assessing the effective solubility of the DNAPL is needed. It should be noted that in addition to DNAPL, supernatants/gels and leachates may be produced during the curing process. All of these observations should be recorded, along with material temperatures, pH, and off-gassing (refer to Specific Comment #9).

NW Natural Response

As stated in Section 3.6.2, following Phase IV leachability testing of untreated and ISS-treated materials, the water in the container will be allowed to equilibrate with the porewater in the sediments and cylinder and provide an approximate measurement of the aqueous concentrations within these solid materials. The equilibrated aqueous concentrations for the untreated samples should approximate the effective solubility of DNAPL components. The Work Plan has been revised to identify that visual observations of supernatants/gels will be recorded. Please see response to EPA To Be Considered Comment 8 regarding testing for temperatures, pH, and off-gassing.

DEQ Specific Comment 11

Section 3.5.1, Leachability Testing Design. Leachate generated from soil samples during each phase of leachability testing should also be analyzed for TPH, total cyanide, lead, zinc, and pH dependent metals (e.g., arsenic, aluminum, iron, manganese, etc.). This comment also applies to Appendix A Section 5.4 and Appendix B.

NW Natural Response

The Work Plan has been revised consistent with the comment. Please also see revised Table 2-2.

DEQ Specific Comment 12

Section 5, Reporting. Revise this section to clarify that LPS data will be reported to EPA and DEQ (refer to General Comment #1). It is critical for NW Natural to complete the LPS and report all of the results, including recommended final grout mix designs, in the Intermediate Design.

NW Natural Response

Please see response to EPA General Comment 9.

DEQ Specific Comment 13

Table 2-2, Selected Soil Laboratory Pilot Study Locations and Depth Intervals. Incorporate additional sampling required in our comments herein. Provide additional rationale that includes discussion of other MGP residuals expected at each boring location, general material types and approximate thickness of each hydrogeologic unit at each boring, approximate depth intervals with elevated benzene, naphthalene, and/or cVOC concentrations.

NW Natural Response

The requested additional sampling and testing has been incorporated into the scope of work, and the additional rationale has been incorporated into the revised Table 2-2.

DEQ Specific Comment 14

Table 3-2, Strength and Permeability Testing Plan. Please include representative grain size data and total organic carbon for the upland soil samples. Where applicable, include effective solubility ranges.

NW Natural Response

The Work Plan has been revised to include grain size and total organic carbon data collection for untreated upland soil samples that will be collected for ISS treatability testing.
NW Natural requests DEQ clarification regarding the statement, "Where applicable, include effective solubility ranges." The Work Plan has also been revised to include a cross-section showing the various WBZs and designations of soil type.

DEQ Specific Comment 15

Appendix A, Section 2, Project Management and Responsibilities. Include the point of contact for the DEQ project manager.

NW Natural Response

Section 2 of Appendix A has been revised to include the point of contact for the DEQ project manager.

DEQ Specific Comment 16

Appendix A, Section 3.1, PTW-NAPL Identification. Revise this section or add a separate subsection that describes MGP residuals identification for upland soils.

NW Natural Response

Appendix A of the Work Plan has been revised consistent with the comment.

DEQ Specific Comment 17

Appendix A, Section 3.3.3, Soil Logging and Processing Procedures. Soil logging should include the presence and characteristics of subsurface debris.

NW Natural Response

Logging of anthropogenic debris is included in Section 3.3.3. It has been noted that the logging will include both the presence and characteristics of anthropogenic debris.

DEQ Specific Comment 18

Appendix A, Section 4.4, Management of Investigation-Derived Waste. IDW characterization should include total solids/percent dry weight, per Table 3-1 of the *Contaminated Material*

Management Plan.[9] In addition, DEQ should be copied on the transmittal of the waste profile package to the selected disposal facility requesting acceptance of the waste for disposal.

NW Natural Response

See response to EPA Appendix A Specific Comment 2.

DEQ Specific Comment 19

Appendix A, Section 5.2, Grout Component Testing. Grout component testing should be conducted on more than one (1) soil sample location. Separate grout component testing should be conducted for soils collected from different hydrogeologic units (i.e., fill, upper silt unit, upper alluvium, and lower alluvium). Grout component testing should also assess additional reagents and admixtures (refer to General Comment #8).

NW Natural Response

As discussed in response to EPA To Be Considered Comment 3 and DEQ General Comment 6, the DeWind One-Pass Trenching technology mixes and homogenizes soils throughout the entire depth interval of the proposed barrier, so composite samples will be collected and analyzed across all WBZs in each location.

DEQ Specific Comment 20

Appendix A, Section 5.3, Strength and Permeability Testing. Grout dose rates for upland soil may need to include rates higher than 10%, depending on the results of the grout component testing. Grout strength and permeability testing should also assess additional reagents and admixtures (refer to General Comment #8).

NW Natural Response

If dosage rates higher than the proposed 10% rate are identified during the Phase II testing, NW Natural will coordinate with EPA and DEQ to incorporate a higher dosage rate(s) in the testing. Please see response to DEQ General Comment 8 regarding the assessment of reagents and admixtures.

DEQ Specific Comment 21

Appendix A, Attachment A, Field Forms. Include field forms for soil logging and sample collection.

NW Natural Response

The requested field forms have been added.

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[9] Anchor QEA, LLC and Hahn and Associates, Inc. 2021. Contaminated Materials Management Plan. NW Natural Gasco Site. Prepared for NW Natural. November 19.

DEQ Specific Comment 22

Appendix B, Distribution List. Include Wesley Thomas, Project Manager, Oregon Department of Environmental Quality.

NW Natural Response

Wesley Thomas has been added to the Distribution List.

DEQ Specific Comment 23

Appendix B, Figure B-1. Include DEQ on the project organizational chart.

NW Natural Response

Wesley Thomas has been added to the project organizational chart.

Appendix E-2

Response to EPA March 14, 2023 Comments on the Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan and April 14, 2023 Comments on the In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan Addendum

6720 South Macadam Avenue, Suite 300
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ANCHOR QEA

Memorandum

May 19, 2023

To: Hunter Young, U.S. Environmental Protection Agency

From: Ryan Barth, Anchor QEA

cc: Bob Wyatt, NW Natural; Patty Dost, Pearl Legal Group; Lance Peterson, CDM Smith; Rob Ede, Hahn and Associates; Billie-Jo Gauley and Jen Mott, Anchor QEA

Re: NW Natural Responses to EPA March 14, 2023 Comments on the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (dated February 16, 2023) and EPA April 14, 2023 comments on the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan Addendum* (dated March 13, 2023) for the Gasco Sediments Site Project Area

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This memorandum was prepared by Anchor QEA on behalf of NW Natural and provides responses to the U.S. Environmental Protection Agency (EPA) March 14, 2023 comments on the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (Revised TSWP; dated February 16, 2023) and EPA April 14, 2023 comments on the *Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan Addendum* (Revised TSWP Addendum) dated March 13, 2023, for the Gasco Sediments Site Project Area (Project Area). Any necessary revisions to the treatability study based on these responses to comments have been incorporated into the *Additional Revised In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan* (Work Plan) dated May 19, 2023.

This memorandum does not provide responses to the Oregon Department of Environmental Quality (DEQ) March 15, 2023 comments on the Revised TSWP and Revised TSWP Addendum. These DEQ comments relate solely to the integrated upland top of riverbank in situ stabilization and solidification (ISS) treatment barrier wall and associated hydraulic controls. NW Natural is continuing to perform detailed technical evaluations regarding the various methods for construction of the wall and associated hydraulic controls. Following completion of these evaluations, NW Natural will submit responses to the DEQ comments and an additional revised version of the Work Plan that addresses any modifications to the upland treatability study scope of work based on the responses or other project needs.

EPA General Comments on Revised TSWP

EPA General Comment 3a (January 18, 2023)

EPA Response (March 14, 2023)

Considerations for Sample Location Selection: The response is acceptable; however, item 2.a.iv in Section 2.1 states that: "Anchor QEA confirmed that metals sediment concentrations at the four proposed sample locations and depth intervals are generally representative of the central tendency of metals concentrations within the ISS treatment area." For completeness, revise the text or include a table to provide the range of metals sediment concentrations at each of the four proposed sediment sample locations along with the central tendency statistics within the ISS treatment area.

> ***NW Natural Response (May 19, 2023)***
>
> The Work Plan has been revised to state, "Anchor QEA confirmed that metals sediment concentrations at the four proposed sample locations and depth intervals are generally representative of the metals concentrations within the ISS treatment area, as shown in Table 2b."

EPA General Comment 7 (January 18, 2023)

EPA Response (March 14, 2023)

Grout Blend Design: The response is acceptable; however, depending on the results of the bench-scale treatability study and field pilot, the need for amended caps will be evaluated in future stages of design. Revise the text to acknowledge this, as appropriate.

> ***NW Natural Response (May 19, 2023)***
>
> NW Natural agrees that the results of the bench scale treatability study will be used to inform the potential need for a cap overlying the ISS treatment area, including any amendment addition to the cap materials. The Work Plan is focused on the treatability testing and only generally states that the treatability results will be used during remedial design to identify the appropriate materials to be placed on top of the ISS treatment zone to be protective of any measured chemical release. A discussion of the potential need for amended caps is beyond the scope of this document, so the Work Plan has not been revised to address this comment.

EPA General Comment 9 (January 18, 2023)

EPA Response (March 14, 2023)

Pilot Study Schedule: Considering the significant change in remedial technology selection, EPA believes that comments on the Final Design are possible and NW Natural should be prepared to address the comments in some manner.

NW Natural Response (May 19, 2023)

NW Natural will be prepared to address comments on the Final Design Report, if applicable.

EPA General Comment 10 (January 18, 2023)

EPA Response (March 14, 2023)

Remedy Monitoring: NW Natural's response and the revised TSWP use the term cover while EPA's comment was specific to capping. Based on the results of the treatability study and subsequent design evaluations of contaminant flux EPA will determine the need for a cap or cover. Distinguishing between a cap and a cover has implications regarding long-term performance monitoring that are important to clarify. Revise the TSWP to acknowledge that a cap may be needed to address contaminant flux.

NW Natural Response (May 19, 2023)

Sections 1.3.1, 1.3.2, and 3.6.3 of the Work Plan have been revised to address this comment.

EPA Specific Comments on Revised TSWP

EPA Specific Comment 5 (January 18, 2023)

EPA Response (March 14, 2023)

Section 1.2 ISS Description, last paragraph, page 4: Some of the referenced sites do not have associated citations and footnote 4 is missing from the text. Revise the list of sites to include citations (if available) and footnotes as appropriate. Note that EPA cannot verify the information for sites where the Design Team performed the work, but a published report or literature is unavailable.

NW Natural Response (May 19, 2023)

Footnote 4 was located on page 4 of the Revised TSWP. Citations for the referenced sites have been added to the Work Plan, where available.

EPA Specific Comment 9 (January 18, 2023)

EPA Response (March 14, 2023)

Section 1.3.2 Leachability Testing Objectives and Evaluation Criteria, second paragraph, page 5: The response and associated TSWP revisions are acceptable. Similar to Olean et al. (2016), observations of potential stabilized NAPL in cylinders subjected to UCS testing should also be documented.

NW Natural Response (May 19, 2023)

Section 1.3.1 of the Work Plan has been revised to state that observations of potential stabilized NAPL in cylinders subjected to unconfined compressive strength (UCS) testing will be documented.

EPA Specific Comment 11 (January 18, 2023)

EPA Response (March 14, 2023)
Section 3.2 Initial Characterization of Untreated Samples, second paragraph, pages 9: C10-C12 aliphatic hydrocarbons should be analyzed using a lab that can achieve reasonably low detection limits close to the CUL of 2.6 µg/L. Additionally, sediment samples should also be analyzed for sulfate and chloride because of potential impacts to meeting ISS objectives and long-term permanence of the remedy.

> ***NW Natural Response (May 19, 2023)***
> Section 3.2 of the Work Plan has been revised to identify that sulfate, and chloride have been added to both the baseline untreated bulk sediment and riverbank soil sample analytical suite. Section 3.6.2 has been revised to describe why C10-C12 aliphatic hydrocarbons are not being tested as part of Phase III or IV leachability testing. Note that sampling is proposed after the completion of the ISS field pilot study for ROD Table 17 contaminants with groundwater CULs not included in the Phase IV testing; this will include C10-C12 aliphatic hydrocarbons.

EPA Specific Comment 14a (January 18, 2023)

EPA Response (March 14, 2023)
Section 3.5.1 Leachability Testing Design, page 11: EPA will provide a response to this comment after reviewing the TWSP addendum for proposed revision to Phase IV leachability testing.

> ***NW Natural Response (May 19, 2023)***
> Comment noted.

To Be Considered Comment on Revised TSWP

EPA To Be Considered Comment 3 (January 18, 2023)

EPA Response (March 14, 2023)
Sample Size: The revised TSWP does not propose testing of material representative of riverbank soils. The riverbanks included within the Gasco Sediments Site vary between the Gasco property and the Siltronic property, as a result of placement of different fill materials over different time periods. While the Revised TSWP proposes collection of upland soils that would include these fill materials, NW Natural has proposed compositing soils over the full depth of the proposed barrier wall, and not testing of discrete hydrogeologic units. The properties of riverbanks soil could differ enough from the proposed sediment samples and composited upland soil samples to warrant treatability testing to identify an appropriate grout mix design for that region. EPA recommends at least one treatability testing sample be collected from both the Gasco property riverbank and Siltronic property riverbank.

Note that EPA understands DEQ plans to require NW Natural to collect and test upland fill soils separately from the composite samples.

> ***NW Natural Response (May 19, 2023)***
>
> As requested, the Work Plan has been revised to include two riverbank treatability testing samples, one from the Gasco property and one from the Siltronic property.

General Comment on Revised TSWP Addendum

EPA General Comment 1 (April 14, 2023)

Analytical Suite Rationale: The rationale provided for the selected Phase IV testing analytes defers to the findings in the Pre-Remedial Basis of Design Technical Evaluations Work Plan (TEWP; Anchor QEA 2019). Presumably, this is a reference to the discussion of candidate chemicals for consideration in cap design modeling in TEWP Appendix D. This screening was based on evaluation of cleanup level (CUL) exceedance ratios and mobility based on partitioning coefficients for each Table 17 contaminant with a groundwater CUL. The former is still a reasonable line of evidence for screening contaminants; however, it is unclear if the sediment-porewater partitioning behavior provides information related to ISS leachability. Instead of deferring to the TEWP discussion, which was developed for cap design, the ISS TSWP Addendum should be revised to discuss the rationale for excluding PCBs, pesticides, herbicides, semivolatile organics, and perchlorate as it relates to ISS treatment and the overall Gasco conceptual site model (CSM).

As noted in EPA's March 14, 2023 response to Specific Comment 11 on the In Situ Stabilization and Solidification Bench Scale Treatability Study Work Plan (revised document dated February 16, 2023), C10-C12 aliphatic hydrocarbons should be analyzed using a lab that can achieve reasonably low detection limits as close as practicable to the CUL of 2.6 µg/L.

> **NW Natural Response (May 19, 2023)**
>
> The Work Plan has been revised to discuss the rationale for excluding PCBs, pesticides, herbicides, SVOCs, C10-C12 aliphatic hydrocarbons, and perchlorate as it relates to ISS treatment and the overall Gasco CSM for treated sediments. See response to EPA Specific Comment 1 (April 14, 2023) regarding not including untreated sediment samples in the Phase IV leachability testing.

Specific Comments on Revised TSWP Addendum

EPA Specific Comment 1 (April 14, 2023)

Revised Phase IV Sediment Laboratory Testing Program, first paragraph, page 1: The text states that, "The Phase IV testing of untreated sediment samples is not necessary to support remedial design." However, a technical rationale was not provided to support this determination. Testing both untreated and treated samples will provide an estimate of reduction in leachability due to ISS treatment. Phase III untreated samples cannot be used for this purpose because Phase III uses a different method than the Phase IV testing method. Additionally, Phase IV testing is anticipated to occur over multiple timesteps and without testing untreated samples over the same timesteps there will be no baseline measurements against which treated sample results can be compared to evaluate treatment effectiveness. Therefore, Phase IV testing of untreated samples should be retained.

NW Natural Response (May 19, 2023)

Phase IV testing of untreated samples is not necessary to support the remedial design. Phase III testing using untreated sediment *and* treated sediment is expected to demonstrate that leaching from treated material is generally less than that from untreated material. Quantifying the exact reduction in leaching by diffusion in comparative (treated and untreated) Phase IV tests is not required to achieve a successful remedy. Also, such tests would underestimate the full benefits of ISS because ISS will practically eliminate the mass flux associated with advection (which would still occur if the sediment was not treated by ISS). The ultimate goal of the remedy will be to achieve shallow porewater concentrations that meet the Table 17 groundwater CULs. The post-remedy porewater concentrations will depend on the flux of COCs out of the *treated sediment* and the characteristics of the overlying cover materials. Diffusion rates of COCs from *untreated sediment* have no relevance for the remedial design, nor for monitoring the remedy after construction. Thus, the additional cost for Phase IV tests of *untreated* sediment is not justified, and Phase IV tests will focus solely on treated materials. This rationale was added to the Revised TSWP Addendum.

The Work Plan has been revised to include this rationale.

EPA Specific Comment 2 (April 14, 2023)

Revised Phase IV Sediment Laboratory Testing Program, second paragraph, page 2: In addition to the discussion of cost considerations, literature information on leachability of Table 17 contaminants with groundwater CULs not included in the Phase IV testing analytical suite should be discussed, if available.

NW Natural Response (May 19, 2023)

Section 3.6.2 of the Work Plan has been revised to discuss how estimated effective diffusion coefficients calculated from Phase IV testing of ROD Table 17 contaminants with groundwater CULs target COCs will be used in combination with sediment-water partitioning values (see Appendix G of the Combined BOD-PDR; Anchor QEA 2021) for non-target COCs to assess the potential diffusive flux of non-target COCs. In addition, sampling is proposed after the completion of the ISS field pilot study for ROD Table 17 contaminants with groundwater CULs not included in the Phase IV leachability testing.

EPA Specific Comment 3 (April 14, 2023)

Phase IV Soil Laboratory Testing Program Is Unnecessary and Should Be Eliminated, pages 2 through 3: The text states that the design team determined that testing untreated and treated Phase IV soil samples is unnecessary. The text goes on to state that, "Unlike ISS in subaqueous sediments, the ISS treatment barrier wall remedial design does not require analysis of soil leachate concentrations to estimate the reduction in diffusive mass flux in ISS-treated soils over time." However, additional clarification is needed as to explain this determination. If NWN intends for upland soil to be representative of riverbank soils, then it will need to be determined if the ISS treated riverbank soil leaches contamination to the river. This could have the potential to impact the effectiveness of the in-water remedy and the expectations for reducing recontamination of the remedy from riverbanks. Revise the text to provide technical justification to support the design team's determination that Phase IV soil testing is not required.

NW Natural Response (May 19, 2023)

As discussed in NW Natural's May 19, 2023 response to EPA's March 14, 2023 To Be Considered Comment 3, the Work Plan has been revised to include baseline characterization of untreated riverbank soil and Phase I through III testing of untreated and treated riverbank soil samples to be collected at two riverbank angled borings on the Gasco and Siltronic properties. In addition, technical justification is provided to support why Phase IV testing will only be conducted for treated sediment.

EPA and NW Natural References

Anchor QEA, 2019. *Final Pre-Remedial Basis of Design Technical Evaluations Work Plan*. Gasco Sediments Cleanup Action. Prepared for U.S. Environmental Protection Agency, Region 10. Prepared on behalf of NW Natural. August 29, 2019.

Anchor QEA, 2021. *Combined Sediment Remedy Basis of Design and Preliminary Design Report*. Prepared for U.S. Environmental Protection Agency, Region 10. Prepared on behalf of NW Natural. April 30, 2021.

Anchor QEA, 2022a. *Source Control Addendum Report*. NW Natural Gasco Site, ECSI No. 84. Prepared for NW Natural. November 10, 2022.

Anchor QEA, 2022b. *Revised Final Pre-Remedial Design Data Gaps Data Summary Report*. Gasco Sediments Cleanup Action. Prepared for U.S. Environmental Protection Agency, Region 10. Prepared on behalf of NW Natural. January 28, 2022.

Anchor QEA, 2023. Memorandum to: Hunter Young, U.S. Environmental Protection Agency. Regarding: *Final Revised Additional Depth of Contamination Characterization Addendum within the Gasco Sediments Site Project Area*. Gasco Sediments Cleanup Action. March 23, 2023.

DEQ (Oregon Department of Environmental Quality), 2022. Letter to Bob Wyatt (NW Natural). Regarding: DEQ Comments on the Source Control Addendum Report, Former Gasco Manufactured Gas Plant Operable Unit, Portland, Oregon, ECSI #84, ECSI #183. December 22, 2022.

Grubb, D.G., T.M. Himmer, J.L. Gentry, A.J. Salter-Blanc, and C.D. Tsiamis, 2020. "Gowanus Canal Superfund Site. III: Leaching of In Situ Stabilization/Solidification Mix Designs." *Journal of Hazardous, Toxic, and Radioactive Waste* 24(4): 04020045.

Olean, T.J., J.L. Gentry, A.J. Salter-Blanc, T.M. Himmer, M. Bruno, and C.D. Tsiamis, 2016. "In-Canal Stabilization/Solidification of NAPL-Impacted Sediments." *Remediation* 26(3): 9-25.

Ramboll US Corporation, Anchor QEA Engineering, PLLC, and Analytical & Environmental Services, Inc., 2019. *In-Situ Solidification/Stabilization Treatability Study Bench Testing Report*. Quanta Resources Superfund Site OU2, Edgewater, New Jersey. Prepared for Honeywell International Inc. August 2019.